STUDIES ON THE PRODUCTION MANAGEMENT IN THE SEAFOOD PROCESSING INDUSTRY IN KERALA

THESIS

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BY

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DECLARATION

I, A. Ramachandran, do hereby state that the thesis "Studies on the production management in the Sea Food Processing Industry in Kerala" is my original work and no part of the thesis has hitherto been submitted for a degree in any University.

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Certified that the thesis"Studies on the Production Management in the Sea Food Processing Industry in Kerala" is the record of bonafide research carried out by Mr. A.Ramachandran, under our guidance and no part of this thesis has hitherto been submitted for a degree in any University.

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A C K N O W L E D G E M E N T

The study was carried out at the Department of Industrial Fisheries of Cochin University of Science and Technology,Cochin, under the guidance and supervision of Prof. (Dr) C.T. Samuel, Head of the Dept. of Industrial Fisheries and Prof. N.Ranganathan, Director, School of Management Studies of the University. I am grateful to them for the guidance, supervision and encouragement given during the course of the study.

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I N T R O D U C T I O N

1. HISTORY, GROWTH AND PRESENT STATUS OF SEAFOOD INDUSTRY IN THE WORLD.

Though the food technology owes much to the industrial revolution ,many of the methods used in processing and storage of food are really old. The present methods are only modifications or improvements made on the existing ones; with the development of science and technology. Traditional methods of fish preservation were evolved over centuries to meet the particular needs of small communities. They have proved to be adequate for many purposes, but where industrialisation has led to the growth of large urban communities, these methods were found to be incapable of maintaining an adequate fish supply for every section of the market.

The important fish processing methods available are broadly classified into drying, salt curing, smoking, freezing and canning.

1.1. Drying :-

This is one of the primitive methods of preserving fish. In this process, the fishes are dried either in open sunlight on the beaches or over wood fires. This method was in practice from prehistoric time onwards. The process is slow and may take several days to complete depending on the size of the fish and on the climate. The term drying usually implies the removal of water by evoporation, but water can also be removed by pressure or by the use of absorbent pads or by salt.

Various attempts have been made in India and elsewhere to improve,by dehydration, the character and palatability of dried fish products. When relying on natural climatic conditions for drying, the results may be rather variable. Sometimes adverse weather conditions can lead to total loss because of putrefaction during the early stages of drying. Drying in control atmosphere can overcome these problems but it is energy consuming and costly (Poul Hansen, 1980). Fish drying in the tropical countries often involves greater problems with insect infestation both during and after drying,resulting in great loss of fish protein. Controlled solar drying, however, may overcome this problem because it operates above 45°C, at which temperature fly maggots cannot survive (Anon, 1977). Trim (1985), demonstrated that solar drying of laminated bombay duck is a feasible technical proposition. But its technical and economic viability are yet to be studied with respect to other species.

1.2. Salt Curing :-

Salt curing is a traditional process. Common salt is used for preserving the fish products for a long time. The bactericidal property of salt is made use of in preserving the fish. The world production of salted fish is still increasing due to low cost of production. This is a widely used preservation technique in many of the South East Asian and African countries. There is a decrease in popularity for salted fish products in Western Europe, U.S.A. and some of the other developed countries due to the shift in consumers' taste and high purchasing power existing in these countries. The preference here is more for fresh, frozen and canned products.

The main features of salting are removal of some of the water from fish flesh and its partial replacement by salt (Burgess, 1967). There are two types of curing - Dry curing and Pickle curing. In dry curing, split fish is burried in salt and the brine liquor is allowed to escape. After a period of salting, the fish is usually dried. Dry salting is suitable for lean fishes. In pickle curing the fish is preserved in air tight barrels in a strong pickle formed by salt dissolving in the body fluids. This is mainly used for fatty fishes.

1.3. Smoking :-

It was probably prehistoric man who discovered that flesh could be preserved for long periods by heavy smoking and salting. During the Middle Ages a variety of traditional food stuffs were developed. These traditional products are not widely relished in the world today with the development of modern methods of preservation. Presently, the products are therefore salted and smoked mainly to give them a mild, savoury flavour. They have only a short shelf-life of about one week at room temperature. In smoked products, the preservative effect is contributed by the combined effect of drying and bactericidal chemicals in the smoke. There are two types of smoking - cold smoking and hot smoking. In cold smoking, the temperature is maintained around 30°C. In hot smoking, the intention is to cook the fish as well as smoke it. Here the temperature in the kiln may go upto 120°C.

1.4. Freezing and cold storage :-

Natural freezing is a known method of preservation since time immemorial in temperate countries. Notable developments have taken place in fish freezing technology recently. But commercial freezing was practiced more than 100 years ago (Borgstrom, 1965). Ice and salt mixtures were employed for fish freezing early in the 19th century. Several types of freezers were devised in many countries. When the compressor was developed in the later part of the nineteenth century, it was immediately employed for fish freezing and rapid development followed. Freezing fish in low temperature air was first patented in the United Kingdom in 1842 by V. Benjamin.

Freezing fish by machinery appears to have been first done by the Russians in 1888 at Astrakhan (Heen and Karsti, 1965). Immersion freezing of fish was introduced by France in 1898. Later, German companies built several fish freezing establishments in Russia during 1908 to 1913. During and after the First World War, pioneering work concerning the theory of freezing was carried out by Plank and his associates (Plank, et al., 1916). Large fish freezing plants operating at -25°C and -30°C were in business during the early 20th century. This period of active experimentation led to the development of equipments and freezing apparatus. Later, spray freezing with highly chilled brine solution was developed by a Norwegian engineer which was further modified into a kind of immersion freezing by a Danish fish exporter. This was achieved by using eutectic brine solutions (-18.2°C) as the freezing medium. Clarence Birdeye (U.S) in 1929 improved the plate freezer of Cooke (1965). This laid a firm foundation for the modern phase of fish freezing. The freezing of fillets was developed by R. Kolbe (1926) and later became the chief method for retailing frozen fish.

A great deal of research and development was required to establish a sound frozen fish technology. A major part of the water content in fresh fish is converted into ice during freezing. This should be completed within a short period of time. Slow freezing results in the formation of large ice crystals within the muscle which inturn causes irreversible damage to the fish quality. On the other hand, quick freezing within minutes results in physical breakage to the muscle (Poul Hansen, 1980). There are two main defects which can occur during frozen storage - those affecting the fish surfaces, and those affecting the entirety of the tissues. Both these defects can be minimized by lowering the storage temperature to -30°C or lower.

1.4.1. Latest developments in freezing :-

Mechanization has been stimulated by the desire to replace man power that has been too expensive or inadequate in advanced countries. It has been facilitated by the concentration of processing operations in large modern factories, where the volume of material to be handled is large.

The earlier models of filleting machines of commercial value were developed in the early 1950s by Baader (Anon, 1951). Filleting machines have come into increasing use with the development of modern hygienic processing plants. Through research and developments, machines have become smaller, less complex and comparatively cheaper in terms of output, especially when yields are taken into account. Mechanical filleting and gutting machines are among the most complex machine tools of any kind ever produced. Until recently most of the filleting and gutting machines had to be fed by hand.

For peeling of smaller sized shrimp, various types of machines have been developed. Deboning machines were first used to recover the edible flesh left on the skeleton after filleting. The product was used to manufacture second grade fish fingers and fish cakes, and as a filler in sausages and similar products. Since then, a variety of products have been developed using low priced species and processing waste. A parallel development of much commercial application is the production of'surimi'. The technology of surimi processing was first commercialized in 1960. Efforts to improve the quality were finally successful, and production increased dramatically in 1963. By 1965, Alaskan pollack surimi was being produced on factory ships. This utilisation of the more or less wasted meat of Alaskan pollack was the first objective in the development of the technology.
At present, frozen surimi is used as a starting material in the production of Kamoboko in Japan. The advantage of using frozen surimi rather than whole fish is not only to cut down the processing procedure, but also to ensure a standard quality (suzuki, 1981). A number of scientists are working on this aspect to improve the technology of surimi production, especially in the developed nations (Lee, 1984 ; Babbit, 1986 ; Regenstein, 1986). Surimi can be made from many species but at present 95% of the Japanese products are made from pollack. Atlantic cod,

blue whiting, sardines are becoming potential source of raw materials for surimi production (Feldt, 1984). A wide variety of kneaded products from surimi like kamoboko, hampen, fish ham and sausages are popular in Japan and their production processes and ingredients are described by Yasumatsu et al., (1985).

The latest addition of freezing technology is in the form of spiral belt freezers. This allows continous freezing of products in Individually Quick Frozen form (I Q F). The spiral arrangement considerably reduces the space requirement for setting up the freezer and other processing facilities.

The objective of such developments is to utilise, for human consumption, very large quantities of raw material at present under-priced or underutilized. It will perhaps allow the fishery industry to produce a wider range of more or less standard products of which the best existing example is the fish finger.

1.5. Canning :-

Canning of fish was first reported in United Kingdom in 1817 (Dewberry, 1957). In the early days , the process was called as appertization after Nicholas Appert who invented the process. The appertized foods were packed in glass containers. By about 1820, tin plate containers were used instead of glass containers. Around 1840, a sardine canning industry was established in France; various fish products were canned in

England and America canned oysters which had a wide distribution. In 1864, canning was started on the U S Pacific Coast, where an abundant supply of salmon gave rise to rapid expansion (Dewberry, 1954). Later canneries spread further north up to Alaska. Around 1870, canning of sardine in France also expanded and it spread to Portugal, Spain and later to Morocco.

With the increased mechanization of all the steps in the process, canning showed steady expansion and diversification. A large variety of machines are continuously put on the market (Anon, 1960), Not all canneries are in a position to adopt such modern ways of production . Installation of very expensive machinery is not always feasible due to the seasonal nature of fish catch. This is very much true in the case of countries like India where mixed species fishery exist. On the other hand wherever labour costs are high, mechanization opens way to reduce production costs,besides increasing output. The important canned fish products available in international markets are canned sardine, shark, suckers, saury, milk fish, eel, cod roe, tuna, shrimps, crabs, clams etc. The canning of several other species has been studied and are being utilised on a commercial scale.

2. HISTORY, GROWTH AND PRESENT STATUS OF SEAFOOD INDUSTRY IN INDIA

2.1. Cured fish trade :-

For centuries, India has been and continues to be an exporter of fish products. Our fish export from pre-independence time till 1953 was centred around dried products only. The main importers of our dried products were Sri Lanka, Malaya, Singapore and Hong Kong. The complete absence of modern preservation and processing facilities at that time and the demand from the neighbouring countries paved way for a brisk trade in these commodities. Centres like Calicut, Cochin and Tuticorin flourished in this trade during pre-war days. Cochin alone exported about 6,000 tons annually. However, the Second World War brought about the beginning of the set-back to this vital industry as most of the buying countries began taking measures to restrict imports and encourage internal production in the wake of their own independence. At the same time, the curing industry did not take into account the changing needs of the buying countries. It continued to be operated on a cottage industry level. Potential alternate markets like the West Indies and the African countries could not be exploited owing to stiff competition from countries like Canada and U.S.A. who organised fish curing on an industrial basis. The result was a sudden fall in our export of these commodities, bringing down the total value of exports from over 6 to 7 crores of rupees to less than 3 crores annually (Pillai and Govindan, 1969).

2.2. Birth of seafood freezing industry :-

The freezing industry was born with the installation of a one tonne freezing plant by a private entrepreneur in Cochin in 1953. The storage capacity (cold store) of this plant was 50 tonnes. This was installed for the production of frozen shrimps. The industry leaped into development with the addition of more freezing plants and by 1956 and 1957, the freezing capacity had a five fold increase (Alexander, 1967). In 1967, there were 109 freezing plants in India. From 13,268 kg in 1953, the quantity exported has reached over 11 million kg in 1966, valued at over 125 million rupees (Anon., 1967).

As per the study of the Indian Institute of Foreign Trade, by the end of 1968, the country had 48 freezing factories. The total freezing capacity in the country was roughly about 59,000M.tons of which Kerala alone accounted for 49,400M.tons, Bombay and Goa, 4,400M.tons and Mangalore,4,300M.tons (Anon., 1970).

A phenomenal progress was achieved by the industry and by 1970, India exported 25,073M.tons of frozen products worth Rs. 28 crores. Some more products like frozen frog legs and frozen lobster tails were exported on a larger scale; while fish and mussel meat were added later on, in a very modest scale, with prawns still heading the list . Prawns contributed about 86% of the frozen fishery products in value terms. Out of the total export value of Rs.35.5 crores in the year 1970, 79% was contributed by frozen fishery products (Govindan, 1972) .

The export trend of marine products from India during 1962 to 1985 is presented in Fig. 1. Upto 1978, the quantity-wise export showed a progressive trend; after that period, the quantity exported showed a declining trend. The export trend of frozen shrimp from 1962 to 1985 is presented in Fig.2. The export quantity shows stagnation and signs of decline after 1978. The value of the product shows a progressive trend during the entire period. The export trend of frozen lobster tails

FIG.1.

EXPORT TREND (TOTAL) DURING 1962-85

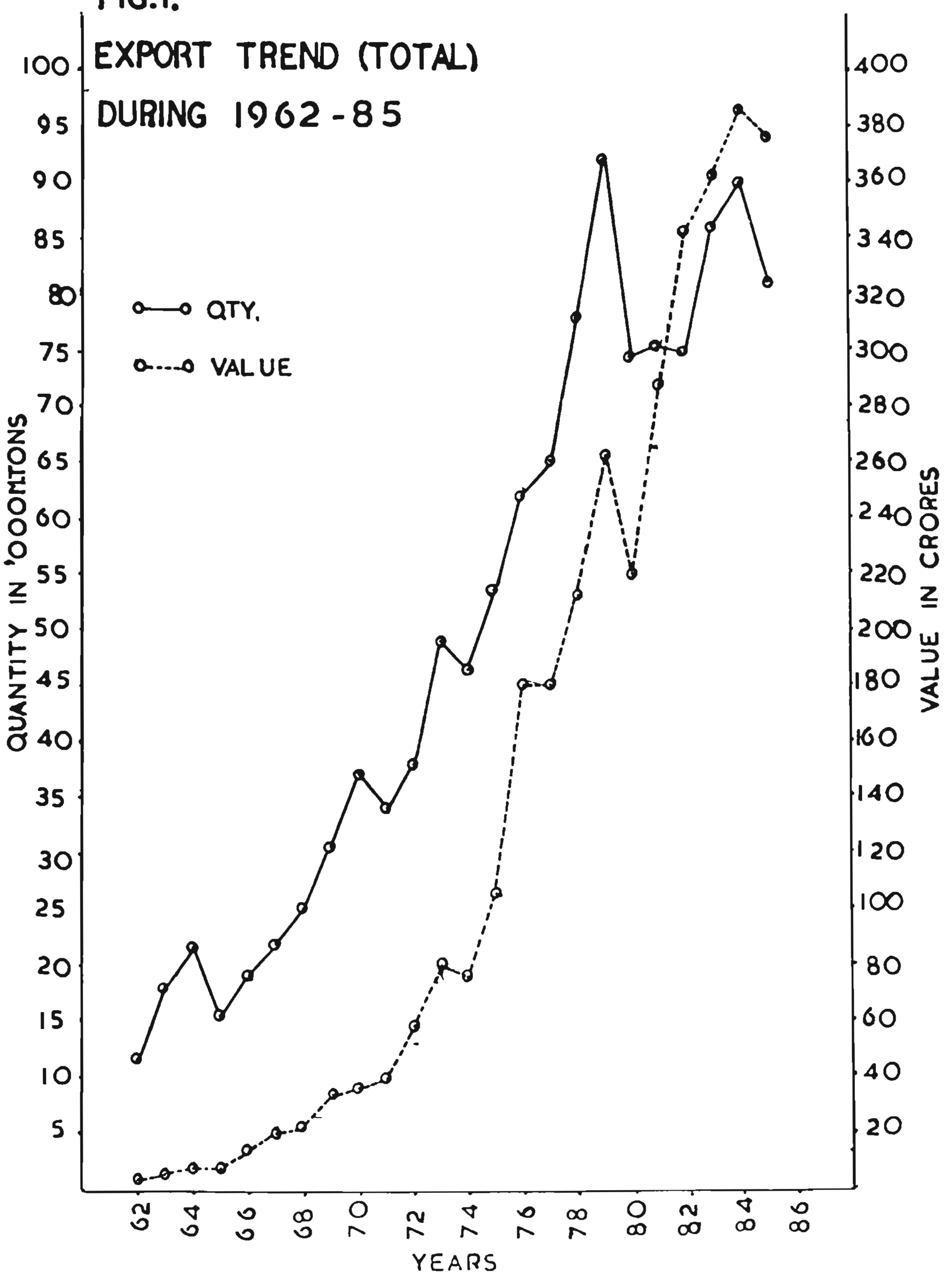
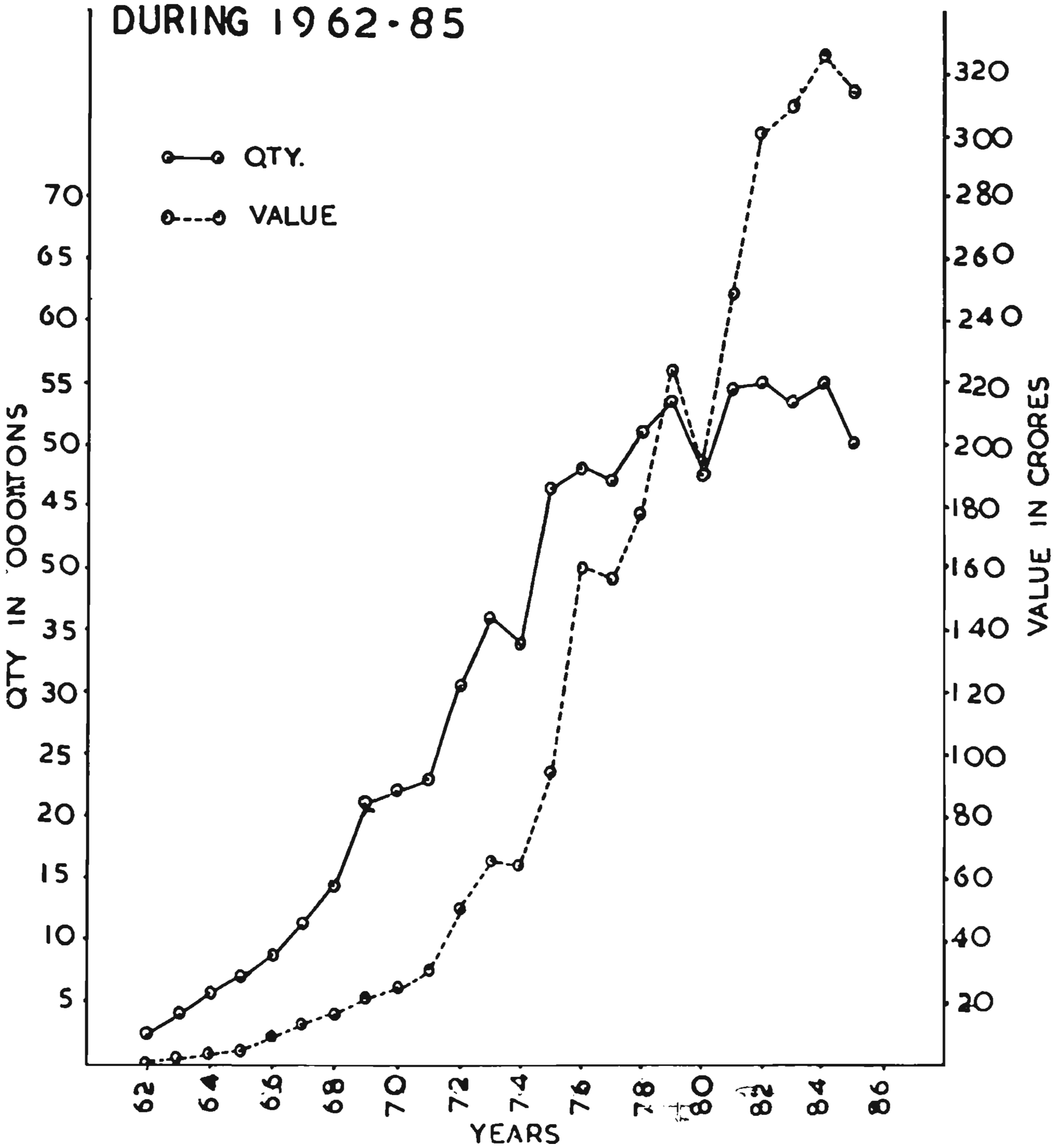


FIG.2.
EXPORT TREND OF FR.SHRIMP
DURING 1962-85



from 1962 to 1985 is shown in Fig.3. The lobster tail export shows a progressive growth both in quantity and in value. Export trend of frozen frog legs during the same period is presented in Fig. 4. The frozen frog legs export shows a gradual progress during the period. But with the recent legislation in Parliament, this product is banned from export due to the inclusion of frogs under wild life protection act.

The dried fish export showed a gradual reduction till 1974 and thereafter showed a slight progress upto 1978 and again declined. The export trend of dried products are presented in Fig.5. The export of dried shrimp was once a lucrative business but the export has dwindled during the last fifteen years. The export trend of the product is presented in Fig. 6. Export of fish and frozen fish was negligible till 1975, but thereafter showed a sudden growth during the period 1976 - 80 due to the new charter policy introduced by the Government of India. Under this charter policy, Indian companies are allowed to hire foreign deep sea vessels and crew for exploitation of fishery resources of the Indian waters. But after 1980, the fish export declined due to the withdrawal of charter facilities given to some of the companies. The export trend of fresh and frozen fish items from 1962 to 1985 is presented in Fig.7.

2.3. Capacity utilisation :-

Huge profit margin obtained by the processors during the beginning of the frozen fish trade attracted a large number of private entrepreneurs to the industry. This resulted in uncontrolled expansion of freezing facilities and other ancillary

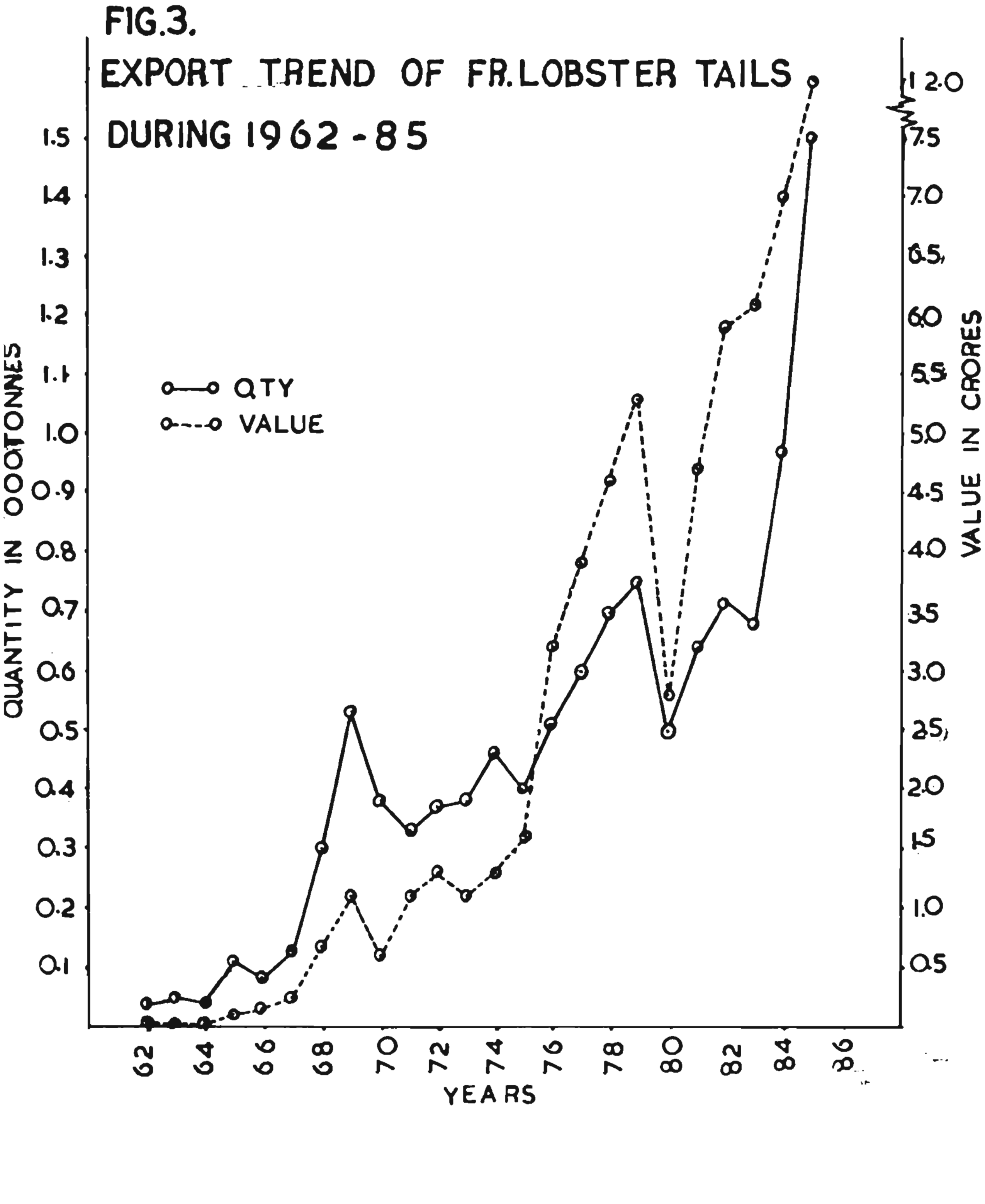


FIG.3.
EXPORT TREND OF FR.LOBSTER TAILS
DURING 1962-85
QTY
VALUE
QUANTITY IN OOOTONNES
VALUE IN CRORES
YEARS
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
12.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
62
64
66
68
70
72
74
76
78
80
82
84
86

FIG. 4.
EXPORT TREND OF FR. FROG LEG DURING 1962-85

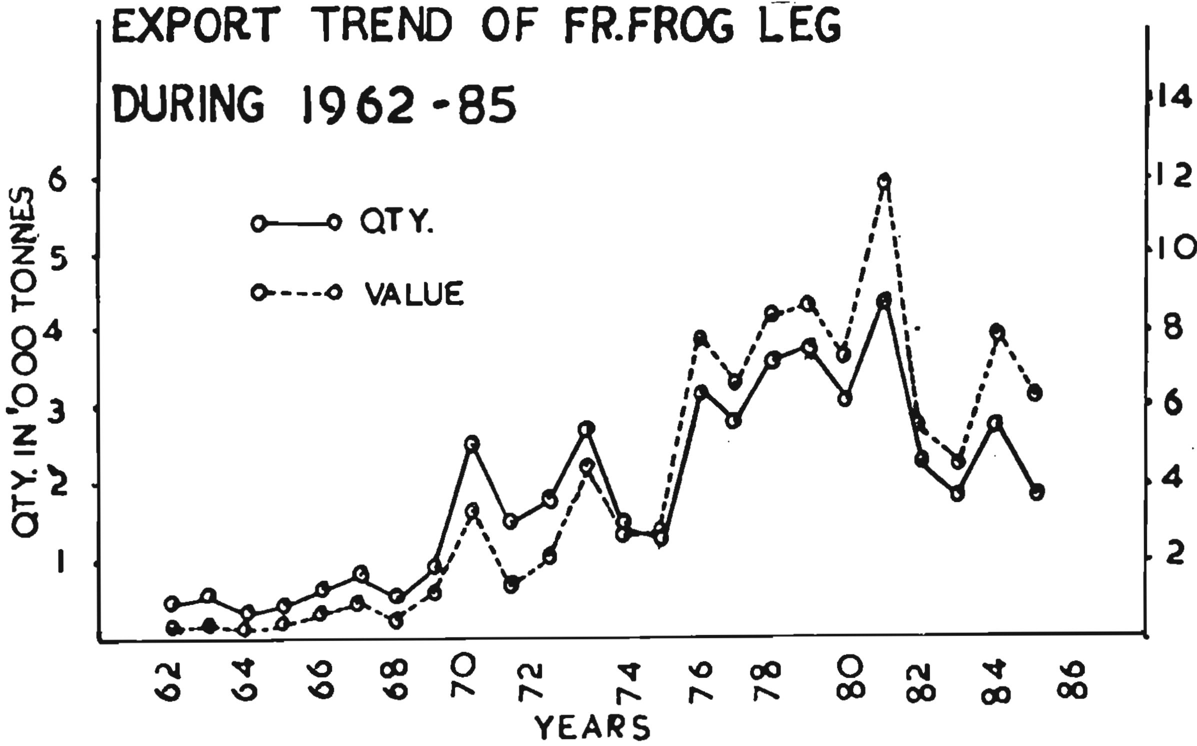
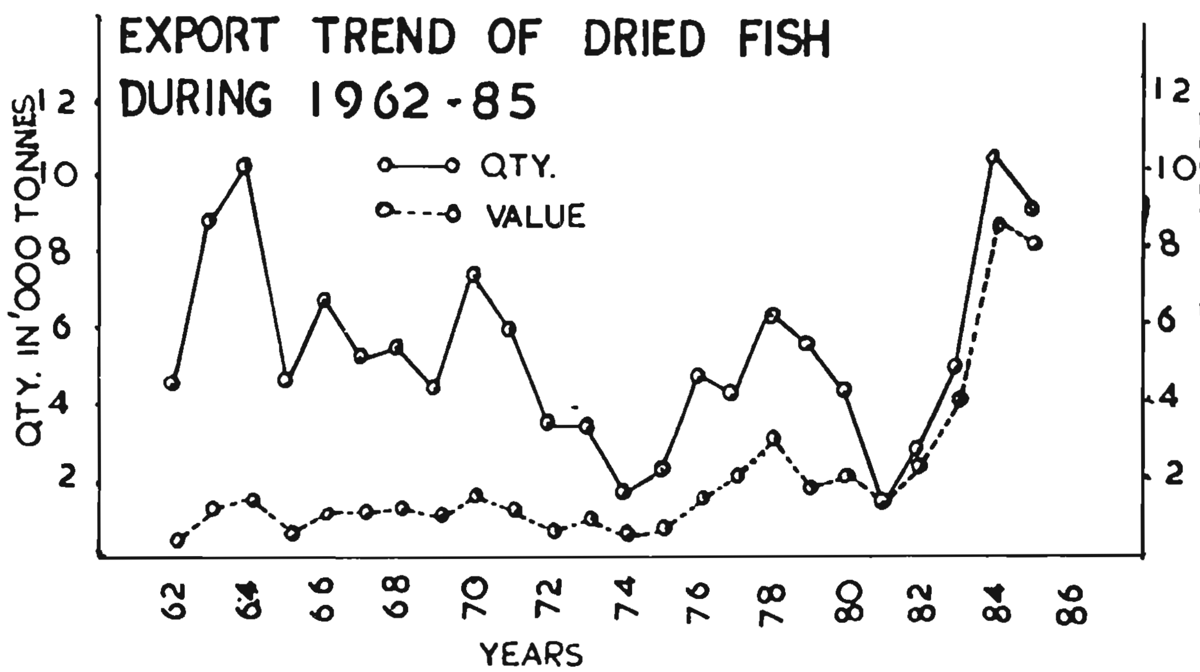


FIG. 5.
EXPORT TREND OF DRIED FISH DURING 1962-85



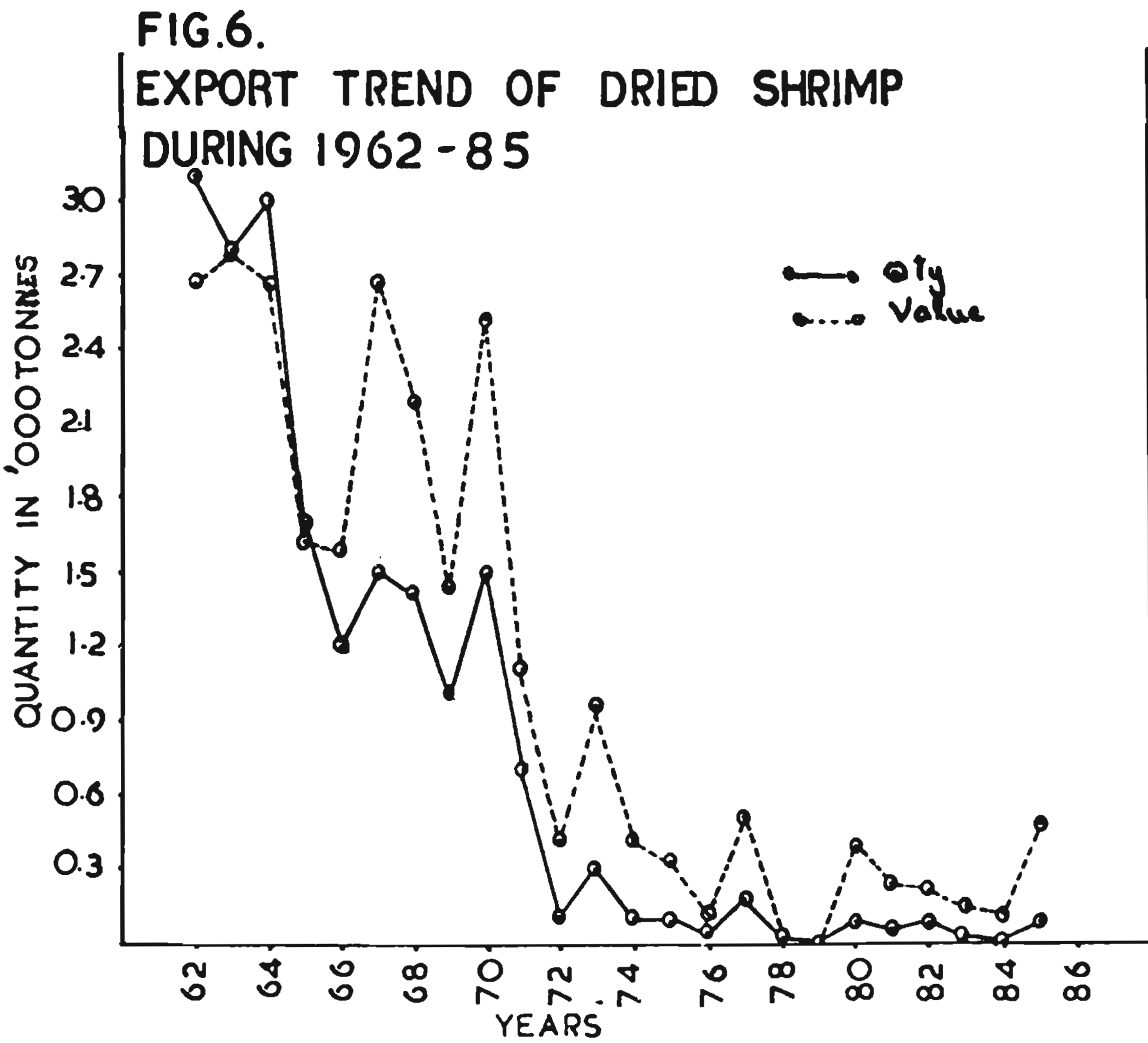


FIG.6.
EXPORT TREND OF DRIED SHRIMP
DURING 1962-85
QUANTITY IN '000 TONNES
VALUE IN CRORES
Qty
Value
YEARS
3.0
2.7
2.4
2.1
1.8
1.5
1.2
0.9
0.6
0.3
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
62
64
66
68
70
72
74
76
78
80
82
84
86

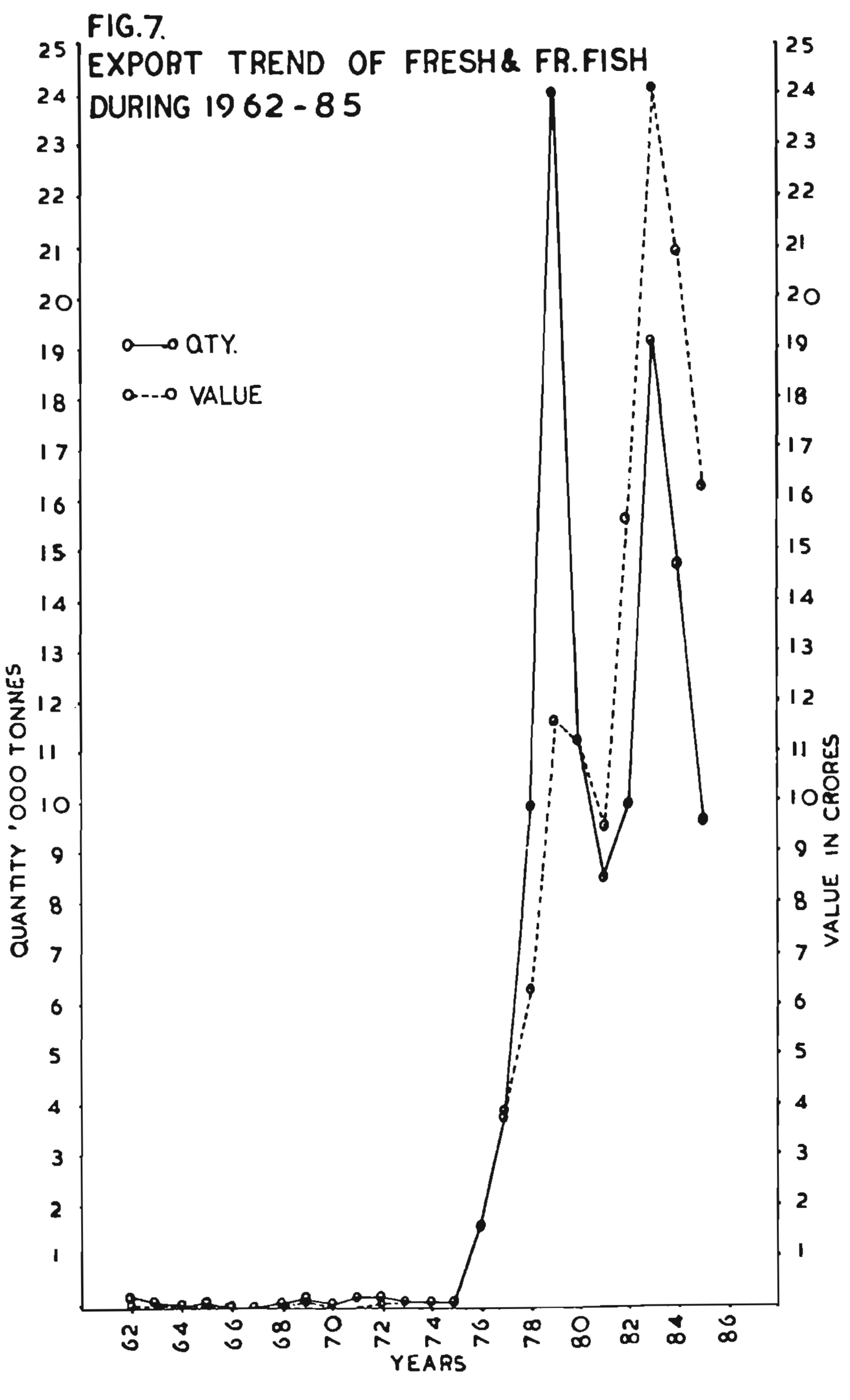


FIG.7.
EXPORT TREND OF FRESH & FR. FISH
DURING 1962-85
QTY.
VALUE
QUANTITY '000 TONNES
VALUE IN CRORES
YEARS
62
64
66
68
70
72
74
76
78
80
82
84
86

facilities. There was no restriction for the new entrants into the field. This ultimately resulted in the establishment of a number of factories in Kerala and inturn resulted in huge idle capacity of the facilities. Of the existing capacities during the early 1960s only 25% were utilised at that time. This was attributed to the non-availability of adequate and regular supply of raw materials, for these units. To reduce the burden of their fixed and overhead costs, many freezing units leased or hired out their idle facilities. But the parties who hired the freezing facilities did not stick to that arrangement for long. For example, out of over 90 such parties who started freezing operations in Cochin area during the mid sixtees, only 15 putup their own plants during 1967-68, while about 58 had to go out of business by 1968 due to losses incurred by them (Anc [illegible]., 1970).

Another important feature of the industry at that time was the continous expansion of the freezing capacity despite the under utilisation of the existing capacity. The seasonal nature of the prawn fishery was responsible for this phenomenon. Although more than 80% of the fishing is spread over a period of 6 to 8 months, the peak season lasts for only three to four weeks at a stretch, when the catch is large enough to use the entire processing capacity. With such a fluctuating fishery, the processing industry had to choose between two alternatives - (1) a limited capacity to attain higher percentage of utilisation during a major portion of the year and thereby reducing the burden of fixed investments (2) a peak load capacity to take advantage of the bumper catch periods. The optimum capacity would be the one which minimizes the cost of idle capacity and maximizes the gain for the seasonal abundant catches. The processing industry in India has made its choice in favour of having large capacities. The seafood freezing industry in U.S.A. and some of the Central American countries have a capacity utilisation of about 50 to 60% (Anon., 1970).

The latest study conducted by Iyer et al.(1982, 1982a,1985) on the utilisation of freezer capacity in India revealed that about 75% of the capacity was idle during the study period. The idle capacity in Kerala is to the tune of 83% which is much higher than the all India average.

The seafood freezing , canning and other ancillary facilities in the important seafood processing centres in Kerala is presented in table 1. Cochin is having the maximum facilities for freezing and canning. Then comes Shakthikulangara.

The canning sector, like the freezing industry originated during the same period. But the canning plants ceased to grow immediately after a short period of growth in the 1960s. All the canning plants in Kerala except one or two are either closed down or converted for other business.

3. Scope of the study

India has vast fishery resources and the country is top in fish production among the commonwealth nations (Anon.,1985). But our utilisation of fish landed is far from adequate. Even though

Table : 1

SEAFOOD FREEZING AND CANNING FACILITIES AVAILABLE IN IMPORTANT SEAFOOD PROCESSING CENTRES IN KERALA

Sl.No.	Facilities	Cochin		Shaktikulangara – Neendakara		Total in Kerala
		Units/No.	% of total	Units/No.	% of total	Units/No.
1.	Fishermen population	59,060	9.7	-		6,11,700
2.	Ice plants	69	40.6	27	15.9	170
3.	Capacity of ice plants	1,046 MT/D	39.3	407.5 MT/D	15.4	2662 MT/D
4.	Cold stores	7	58.3	1	8.3	12
5.	Capacity of cold stores	265 MT	-	101 MT	-	1900 MT
6.	Freezing plants	54	66.0	18	20.0	90
7.	Capacity of freezing plants	439 MT/D	65.0	92.5 MT/D	13.7	675.85 MT/D
8.	Frozen storages	54	62.8	-		86
9.	Capacity of frozen storages	6,606 MT/D	68.2	-		9,683 MT/D
10.	No. of canning plants	4	25.0	2	12.5	16
11.	Capacity of canning plants	-		8.5 MT/D	13.3	64.15 MT/D
12.	Mechanized boats (Registered)	1600	-	1480	-	-
13.	Non mechanized boats	948	3.4	415	1.5	27,559
14.	Av.Fish landings (1969-76)	41,453 MT	10.8.x	72,206 MT	18.8	3,84,000 MT

Based on data furnished in "Marine Fish marketing in India" (1984) published by Indian Institute of Management, Ahmedabad.

there exists a demand for a variety of fish products which can be produced from the available fish landings, our processors are still concentrating on shrimp based products as was the practice in the beginning stages of the industry. With the growth of the export trade of frozen shrimp products during 1950s and 1960s, a large number of factories have come up without any planning and control from the Government. This resulted in piling up of facilities and stiff competition among the processors for the seasonally available limited shrimp resources. This has brought down the profit margin of the processors in addition to depletion of the shrimp stock in our coastal waters (Joseph, 1972).

The seasonality and shortage of shrimp landings cause idling of men and facilities. A number of processing plants have closed down and more are being closed or leased out due to low productivity. This inturn resulted in unemployment and uncertainity among those involved in this trade.

The seafood products from India have to compete with products from other countries in international trade. The products from the processing plants have to pass through strict quality control and inspection before being accepted by the importing countries. The quality of our products is not consistent due to non standardization of processing methods. This results in problems in marketing like rejection by the inspecting agencies, non acceptance by the buyers, black listing by the buying countries etc. To cite an example, during 1978-79 period, USFDA (U.S.A) reported contamination of the products(shrimp) with Salmonella. This resulted in detention of our consignments in various U.S. ports and ultimately they'block listed' Indian shrimp from being imported to U.S.A. (Anon., 1982). Similarly our products were later block listed for filth contamination.

The trade delegation sent by Marine Products Export Development Authority, Cochin to study the export prospects in Japan reported the important defects of the Indian products. The important defects they pointed out are the following.

1. Mixing of spoilt pieces with good quality material.
2. Arrangement of shrimps in blocks is not always done carefully or aesthetically leaving much to be desired.
3. Very often glazing is not uniform and the square shape of block is not retained.
4. Inner cartons are in bad shape.
5. Broken pieces of shrimp shell, antennae, and foreign bodies appearing in Indian frozen blocks reduces its consumer appeal.
6. Sometimes a few pieces of smaller or bigger size shrimp that can very well go with blocks of lower or higher counts as the case may be, are seen in a particular block (Anon., 1982a).

Such products result in a great loss of valuable foreign exchange in addition to tarnishing the image of the industry for ever.

Though studies were conducted on the technological and quality aspects, no in-depth study has been under taken to estimate the level of underutilisation of facilities like processing, freezing and cold stores and the reasons for low productivity of the plants. No attention has been given to improve the process control and scheduling which inturn reduces wastage and improves quality and labour utilisation.

A seminar conducted by Indian Institute of Foreign Trade at Ernakulam in 1964 on 'Marine Products Exports' had recommended the need for a detailed study of the location, layout and productivity of the seafood plants. But till date no work has been carried out on these aspects in detail (Anon., 1964).

4. ABOUT THE STUDY

Kerala was the pioneer in modern seafood processing and exporting. But now the industry is facing a lot of problems due to low productivity and deterioration in the quality of the products. Only about 17% of the installed freezing capacity in sea food processing industry was reported to be utilised during 1979-80. The price of the export commodities is decided by the buyers based on international supply and demand pattern and based on the strength and weakness of dollar/yen. The only way to increase the profitability of the processors is to reduce the cost of production to the possible extent. The individual processors find it difficult to continue in this field due to low productivity and quality problems.

The main objectives of the research are to find out how the production is being managed in the seafood processing(freezing) industry in Kerala and the reasons for low productivity and poor quality of the products. The study includes a detailed analysis of

1. Location of the factories.
2. Layout
3. Purchase, production and storage patterns.
4. Production planning and scheduling.
5. Work Measurement of the processing of important products.
6. Quality Control and Inspection.
7. Management Information System.

Suitable management measures are suggested to improve the productivity of the processing plants. This will reduce the idleness of men, equipments and other facilities and improve the employment opportunities. Measures are also suggested to improve the quality of the products and market intelligence.

An overview of the important findings is given below.

The study on the locational significance of the processing plants shows that most of the plants are located close to the main landing centres. Processing plants collect raw materials from a number of landing centres/pre-processing centres scattered all along the South West Coast of India and even upto East Coast. Processing of seafood is highly labour intensive and sufficient labour (both skilled and unskilled) is available locally. Frequent power failure is found to affect the smooth functioning of the plants. This inturn affects the quality of the products due to delay in processing and fluctuations in cold store temperature . The plants are found to receive all the inputs locally or from nearby places. 91% of the processing plants in Cochin region are located within 5 Km range of Cochin Port from where export of seafood is carried out. The liquid waste from the processing plants are discharged to the nearby water bodies and solid wastes are either given to feed/manure manufacturers or is disposed at open places. A comparison of good locations available in Kerala was carried out using 'Delphi - Method' and found that Cochin region is the best location for establishing future processing plants.

All the fish processing (freezing) plants in Kerala have a process layout. None of the processing plants have a balanced layout and the materials handling and movement in the processing line varies from plant to plant. An improved layout is developed using 'Travel Chart or Load Path Matrix Method'. This will reduce material handling and process cycle time in addition to preventing cross contamination. An improved design for cold store door is suggested which reduces temperature fluctuations in cold stores during loading and unloading of products. Automation of the master carton sealing process is suggested to reduce holding time of frozen products at higher temperature during master cartoning.

The study shows a wide fluctuation in purchase pattern of raw materials among the plants located in an area. It is found that when a plant in a locality is having peak production some other plants in the same locality have no production at all. This is due to poor purchase and information systems existing in the plants. It has been found that about 76.5% of the total operational cost of the plants goes for purchase of fish alone. There is a wide gap between capacity available and capacity utilized. The pre-processing of shrimp and other raw materials are mostly done outside the processing plants and the pre-processed material is used as the starting material in processing plants. The pre-freezing stage has excess capacity in all the plants studied. The main constraint was found to be the freezing activity which consumes about 75-77% of the total process cycle time. The capacity utilization of cold stores is estimated to be only 13%. 32.5% of the plants produced only shrimp based products in 1984. 92% of the total quantity exported by the plants studied in 1984 were shrimp based products. This declined to 80% in 1985.

A wide fluctuation was noticed in the process cycle time of products. Work measurement of the processing of important products were carried out as described by Levin et al. (1974). The normal and standard times worked out will help to decide the facilities and labour required at each stage of production. This will also help to improve the production schedules and to introduce incentive system for workers.

A Raw Material Availability Calendar is developed using the data published by various research organisations and the State Government. This helps the processors to get an idea about the availability of various species of marine organisms during different seasons. This will help in production planning and marketing of products. Linear Programming (L.P) is found to be useful for short term scheduling in seafood processing plants. A linear programming model is developed to select the best product mix during a season which maximizes the total contribution towards overheads and profit.

A production schedule is developed with the application of 'Gantt Load Chart' which fully utilises the freezing and other facilities of the plant. An improved shift schedule is suggested which reduces three shift system (of 8 hours) to two shift system without affecting the continous production in the plant. This will help to reduce the workers requirement in the pre-freezing stage by about one third. The existing priority rules for sequencing the production of different products is not suitable for deciding the sequence of production of products in seafood processing plants. The main reason for this is that unlike in other industries, the raw materials here are having varying shelf-life and quality problems. Hence a new priority rule which is suitable for seafood industry is developed.

A wide fluctuation is noticed in the freezing time, freezing and cold store temperatures. The study shows that the processors are losing about 3% of Peeled and Deveined Shrimp and about 5% of Peeled and Undeveined shrimp in excess of the required level due to variation in raw material quality and non-standardization of processing methods especially that of excess weight requirements in different grades. Non-uniformity of grades was another problem noticed during the study. This is due to lack of proper process control and training of workers. The bacterial quality of the products was found to be within the prescribed standards. Control charts are suggested to control the process deviations. The need for establishing 'Quality Circles' is emphasized to improve workers involvement in productivity and quality control.

Existing Management Information System in the processing factories is found to be weak and inadequate. New reports and charts are suggested to get upto date information on raw material availability and existing market price; demand pattern and price offered for the products etc. Workers output charts and Idle time analysis report are suggested to improve the efficiency of the processing plants.

DATA AND METHODOLOGY

The study is mainly based on primary data collected from sea food processing factories and specific experiments conducted there. The secondary data from various sources like Marine Products Export Development Authority, Central Institute of Fisheries Technology, Central Marine Fisheries Research Institute, Indian Institute of Management, Ahmedabad, Department of Fisheries of Kerala state,etc. were also made use of for this study.

There are 90 seafood processing (freezing) plants in Kerala. Out of which 60% are located in Cochin region and 20% in Quilon region(Shakthikulangara-Neendakara). The other places where processing plants exist are Alleppey district, Calicut and Cannanore. This region wise classification is based on the report of Indian Institute of Management (Anon, 1984). All the active fish processing plants are located in Cochin and Quilon regions except a few in Alleppey district and one in Calicut. The list of processing plants provided by the Seafood Exporters Association of India, Cochin was made use of for selecting the plants for the study. 'Stratified Random Sampling technique' was applied to select the plants for the study. 15 plants from Cochin, 6 from Quilon and the only functional plant in Calicut were selected for collecting primary data. Since all the plants in Kerala follow similar type of processing method, the sample size selected from these three regions give a good representative picture of the seafood industry in Kerala.

A proforma was formulated and pre-tested. The modified (pre-tested) proforma (Annexure 1) was used for collecting information on location, layout and various aspects of production including working capital requirements, investments etc.

The data which could not be collected through the proforma were collected by personal discussion with the concerned personnels and from the records and registers maintained in the processing plants.

The following specific studies were also carried out:

1. Comparison of locations by 'Delphi Method' for selecting the best location for setting up of future seafood processing units.
2. Using 'Travel chart or Load Path Matrix Method' an improved layout for seafood processing plant was worked out.
3. Analysis of daily purchase pattern of four randomly selected seafood processing plants in Cochin region for a period of two years.
4. Analysis of month-wise production of various products in selected plants in Cochin and Quilon for two years.
5. Analysis of cold storage utilisation.
6. Analysis of month-wise shipment of various products for a period of two years.
7. Work measurement of the processing of important seafoods.
8. Preparation of'Raw Material Availability Calendar' based on the secondary data available on fish landings and

their seasonality.

9. Application of simplex method of Linear Programming to develop a suitable model to select the best product mix.
10. Preparation of suitable production schedules using Gantt Load Chart method.
11. Development of a suitable priority rule for sequencing the production of various products in a production line.
12. Process and Quality Control studies like fluctuation in process cycle time, Freezing time, Freezer Temperature, Cold Store Temperature, Drained Weight in thawed frozen blocks, Counts, Total Bacterial Count, and presence of Vibrio cholerae and Salmonella in seafoods.
13. Analysis of existing Management Information System in in the seafood industry.

Source of data and methodology for specific studies as cited above varies with the study and are described in detail under the respective chapters for the sake of convenience and to avoid repetition.

Some information like investments, earnings etc. could not be collected from all the plants selected due to the unwillingness on the part of the management. Similarly, experiments on organoleptic and microbiological assessments were done only in plants where permission was given to do so.

Work measurement of the processing of various products was carried out in the plants where sufficient quantity of a particular product was produced. Some of the plants were found to have too little production to undertake work measurement.

LOCATION OF SEAFOOD PROCESSING PLANTS

1. INTRODUCTION

Kerala is one of the most important maritime states in India with plenty of fisheries resources. The state is in the forefront as far as the number of fish processing plants and export of marine products are concerned. The state has 90 out of the total 247 processing(freezing) plants in India with a per day capacity of 676 metric tons and cold storage capacity of 9,683 metric tons. The ice plant capacity of the state is 2565 metric tons per day (Anon., 1984)

The important seafood processing centres in Kerala are Cochin, Shakthikulangara-Neendakara region, Calicut, Alleppey and Cannanore. The growth of the seafood processing industry in Kerala is mainly due to the various locational advantages, especially, that of Cochin and Quilon (Neendakara-Shakthikulangara region).

1.1. Raw material sources :-

1.1.1. Marine :- Kerala has a coast line of 560 Km and a continental shelf of about 36,000 Sq.Km. The coastal region of Kerala is by far the richest in the country. The important marine fishery resources of Kerala are Penaeid prawns, Oil-sardine, mackerel, cephalopods, ribbon fishes, sharks, pomfret, lobsters, tuna, clams, mussels and crabs. The table 1 gives the landings of marine fishes during the last 10 years in Kerala.

TABLE : 1

MARINE FISH LANDINGS IN KERALA

(1975 - 1984-85)

(Figures in tonnes)

SR. NO.	SPECIES	1975	1976	1977	1978	1979	1980	1981-82	1982-83	1983-84	1984-85
1.	ELASMOBRANCHS	10,292	7,308	5,796	9,302	6,954	6,803	5,414	5,634	9,848	6,486
2.	CAT FISHES	32,603	12,743	7,947	9,125	11,328	13,936	9,326	9,922	16,122	10,487
3.	OIL SARDINE	97,183	1,23,937	1,17,356	1,17,356	1,16,834	66,667	1,72,326	1,59,488	1,49,740	1,28,239
4.	SAURIDA & SAURUS	11,294	99	5,169	6,246	5,326	7,080	5,648	5,466	5,572	6,991
5.	PERCHES	14,741	3,069	14,121	24,989	20,239	17,814	9,172	10,780	11,826	28,713
6.	SCIAENIDS	16,811	6,955	11,965	11,045	5,237	6,164	2,747	3,857	7,431	9,799
7.	RIBBON FISH	15,175	7,687	7,440	24,207	25,718	12,937	7,058	11,046	11,127	6,557
8.	CARANX	7,190	10,478	15,673	7,197	12,339	4,399	1,753	3,523	5,346	5,427
9.	LEIOGNATUS	5,211	2,729	7,708	3,040	3,597	4,147	3,124	9,093	9,185	3,783
10.	LACTARIUS	963	468	823	1,533	253	861	935	1,840	953	[illegible]
11.	POMFRETS	1,181	799	3,712	1,614	1,737	907	1,421	4,381	1,771	1,608
12.	MACKEREL	14,930	19,978	19,968	25,917	18,585	18,474	12,786	9,270	12,708	12,937
13.	SEER FISH	4,065	5,636	3,250	3,354	6,275	3,763	4,422	5,199	6,578	6,495
14.	TUNNIES	5,845	12,880	6,705	6,548	15,391	10,611	6,938	6,305	5,934	6,128
15.	SPHARAENA	396	494	353	721	477	330	903	543	1,105	1,081
16.	SOLES	6,932	3,567	5,778	7,276	4,487	4,394	4,564	12,160	13,664	18,447
17.	PENAEID PRAWNS	77,207	34,478	40,150	45,034	29,522	52,633	21,809	32,288	26,100	37,168
18.	NON-PENAEID PRAWNS	755	55	174	394	75	1,742	142	33	170	719
19.	LOBSTERS	31	50	40	38	26	18	59	110	56	96
20.	OTHER CRUSTACEANS	1,797	1,316	4,621	2,116	7,643	7,286	3,056	5,731	8,976	6,846
21.	CEPHALOPODS	3,342	872	4,973	6,516	2,976	4,244	2,904	3,206	1,677	7,170
22.	OTHERS	98,797	77,742	61,315	57,130	35,490	34,333	28,299	4,959	87,165	70,761
	TOTAL	4,20,936	3,31,047	3,45,637	3,73,339	3,30,509	2,79,543	3,04,808	3,48,443	3,63,054	3,77,475

SOURCE:- STATISTICS OF MARINE PRODUCTS EXPORTS (1985) PUBLISHED BY MARINE PRODUCTS EXPORT DEVELOPMENT AUTHORITY, COCHIN, INDIA.

1.1.2. Kerala Backwaters :- The backwaters of Kerala comprise a system of interconnected lagoon, bays and swamps penetrating the mainland. The total area of Kerala backwaters is estimated to be about 500 Km^2. A rough estimate shows that fish landings from the backwaters of Kerala amounts to 14,000 to 17,000M.tons per year (George and Sebastian,1970). In addition, about 88,000 M.tons of live clams are collected annually from the backwaters. The composition of fish and prawn catches from the backwaters is as follows: Prawns - 60 to 70%; Mullets - 11%; Pearl spots - 10%; Cat fishes - 9% and others 1% (Jhingran, 1982).

The Vembanad, the largest among the backwaters of Kerala, extends from Crangannore in the north to Alleppey in the South with a length of 96.5 Km. The total area of the water spread is about 256 Sq.Km (Shetty, 1963). The upper reaches of the Cochin backwater is connected to the Arabian sea by a 450 M wide channel which helps the sea going boats to transport the landings to the interior parts of the backwater system. Ashtamudi lake is next in importance. This lake is also equally productive

1.1.3. Fresh water system :- There are 44 rivers with a total length of about 4,827 Km. In addition to rivers, the state has 9,000 hectares of lakes,reservoirs and ponds(Anon, 1984). The fresh water system is a good source of prawns, carps, tilapia, etc.

1.1.4 Paddy fields :- It has been estimated that the state is having 4,000 hectares of paddy fields suitable for aquaculture. After harvesting the paddy, the fields in the low lying coast of the backwaters, especially along the coast of Vypeen Island and nearby places are being utilised for prawn filtration. During this period, the bunds provided with sluices are strengthened and during high tide, millions of prawn fry are let into the paddy fields along with the incoming water.This process is repeated with every tide,during autumn. The trapped fry are allowed to grow in the field till the next monsoon period (upto May) and harvested. This is a good source of prawns to the factories during this period.

1.1.5. Mud Banks :- This is a peculiar phenomenon occuring during the South West monsoon at some parts of the South West Coast of India especially the Kerala Coast. During the South West Monsoon while the sea becomes rough along the coast, the inshore water becomes calm over limited areas of varying extent ranging from 10 to 25 Sq.Km. in a semi-circular form on account of the fine clayey mud of one to two metres thickness, the surface layers of which are kept in a thixotropic colloidal solution that absorbs all the wave energy. Such quiscent areas are called mud banks, popularly known as 'chakara'. The mud banks have been reported to have appeared at several places between Mangalore in the North and Quilon in the South (Anon, 1980).

During the S.W. Monsoon, when fishing is almost suspended all along the Kerala Coast, the mud banks formed at certain places close to shore are real blessings to the fishermen. Mud banks provide ideal harbouring facilities to the cannoes and traditional crafts as perfect calmness is always assured at the mud banks. During 'chakara' fishermen get very good catch. This is a good source of raw materials to the processing plants at the time when all the fishing activities in other parts of the coast are suspended due to unfavourable weather conditions.

1.2. Community View Point:-

People in Kerala relish fish eating. The level of fish consumption in Kerala is four times the national average. Until very recently, fish was a relatively cheap source of good quality protein. In the early part of the 1970's fish consumption stood at 15 Kg. per head per annum. But according to Gulati (1983) this figure is reported to be declined.

As per the latest information, the fishing population amounts to 7,70,000 belonging to 1,59,000 households. Thus one out of every 30 households in the state is that of a fishermen. Fishermen families belong to all the three major religions of Kerala, namely, Hindus, Christians and Muslims. Even the non-fishermen population are attracted and engaged in various fisheries activities, namely, boat construction, repair of craft and gear, fish processing, marketing, fisheries education and research (Gulati, 1983). Moreover, fisheries occupy an important place in the economy of Kerala as follows:

1. It is an important source of food and protein.
2. It is a major avenue of employment and
3. It has become a major source of foreign exchange.

Thus most of the people in Kerala welcome fisheries activities and development in one form or other. People of the state are habituated to tolerate the peculiar smell of fish and fish processing activities emit to some extent especially those living in the coastal belt. The community as a whole in the coastal region tolerate the seafood processing activities as in their area if it does not pollute the environment. Moreover this will generate local employment opportunities. The Government also promotes the fisheries activities through various schemes and projects, as it is one of the main sources of foreign exchange and employment.

1.3. Water Resources :-

Water is one of the most important inputs required continously for the fish processing industry. Without good quality water no seafood processing plants can function. It is estimated that for processing one kilogram of shrimp about 12 litres of water is required (Anon, 1984 a). Water is required at every stage of fish processing starting from raw material entry into the processing hall till it is processed and stored. Water is also required for ice making, cleaning of premises and for personal use of the workers to maintain the sanitary and hygienic conditions of the processing plants.

The Bureau of Indian Standards has set standards for the chemical quality (IS: 3025 - 1964) and the microbiological requirement (Thomas, 1979) of the water used in the food processing units.

Kerala is blessed with suitable good quality water sources for the purpose of food processing. Out of the 44 rivers in Kerala, 41 are flowing towards the Arabian Sea. This network of rivers helps the state to supply adequate water for the industr

Moreover, the underground water in most of the coastal areas is suitable for fish processing. Even though there are general shortages in municipal supply during summer , the fish processing centres have alternate water resources to meet the demand. Infact, fish processing centres in Kerala are receiving sufficient water when compared to processing centres in other states.

1.4. Labour :-

Seafood processing in Kerala and elsewhere in India is highly labour intensive. Skilled labour is a must for pre-processing and processing activities. Unskilled labour is required for other activities like cleaning of premises, transportation of raw materials and in-process materials,etc. The man power available in fisheries in Kerala (excluding non-fishermen community) is as follows:

Fishermen population (1977)	- 6,11,700.
Fishing villages	- 248.
Full-time fishermen	- 3,13,019.
Part-time fishermen	- 46,379.
Processing and curing	- 13,849.
Net making and curing	- 27,293.
Marketing of fish	- 32,726.
Others	- 1,24,549.

Source: Marine Fish Marketing in India, Vol.II a, Indian Institute of Management, Ahmedabad (1984).

Apart from the fishermen communities more and more people from other communities are also being attracted to the industry due to the employment opportunities in various primary and ancilliary fields of fisheries. The Cochin University of Science and Technology, Agricultural Universities and various other organisations like Central Institute of Fisheries Technology, Integrated Fisheries Project, etc. are also training people in the field of Fish Processing Technology for the industry.

1.5. Transport Facilities :-

All the important fish landing and processing centres are well connected with roads and water ways. The fish landed in one corner of the state can be transported to the other corner within few hours of time by road and moreover all the landing centres in Tamil Nadu and Karnataka are also well connected by roads to the processing centres in Kerala. All the important fishing centres except Alleppey are also connected by rail.

Most of the processing plants have their own fleet of insulated vehicles to transport fish and finished products. Transport facilities are also available in all the fish processing centres on rental basis.

1.6. Export Facilities :-

Since all the existing fish processing plants cater to the needs of export demand, harbour facilities must be available locally to reduce transportation cost and temperature fluctuations during transportation of products. Maximum export of marine products from India takes place from Cochin Port. In 1984, Cochin Port exported 30,385 tons of marine products with an export value of Rs.14,02,456,000. Cochin has regular shipment facilities to almost all the international markets. This will help the processors in Kerala to reduce the inventory to the minimum. On an average every week, there is a shipment to all the important importing countries. The Table.2 gives the share percentage of total exports of marine products from India carried out by Cochin and Calicut Ports during 1971 to 1984.

1.7. Historical importance of Cochin :-

Cochin has been the traditional centre of fish trade all these years. Next to pepper and other spices or 'Malabar produce' the most important indigenous export product of the ancient port of Cochin was dry prawn. The business houses dealing in prawn and dry fish congregated in the southern area of the business town of Cochin known as Jew Town. It was in this area where freezing of shrimp began for the first time in India. Apart from this, the location had the following advantages.

1. Proximity to the important fish landing centres of Cochin region.
2. Proximity to Cochin Harbour from where the export of this product was possible
3. Easy way of transporting the fish through waterways and roadways.
4. Local availability of processing workers from the nearby areas like Vypeen Island, Palluruthy, Aroor, etc.

The industry was originally established for processing (freezing) shrimp (Cheryan , 1967; Alexander,1967).

TABLE: 2.

PERCENTAGE SHARE OF EXPORTS OF MARINE PRODUCTS FROM INDIA CARRIED OUT BY COCHIN AND CALICUT PORTS DURING 1971-1984.

YEAR	QUANTITY/VALUE	COCHIN	CALICUT
1971	Q	63.30	0.08
	V	76.98	0.01
1972	Q	66.54	0.14
	V	72.70	0.01
1973	Q	63.10	0.09
	V	67.96	0.01
1974	Q	51.93	0.68
	V	56.75	0.07
1975	Q	60.53	0.28
	V	57.45	0.03
1976	Q	49.92	0.21
	V	48.88	0.01
1977	Q	42.73	0.07
	V	41.54	0.01
1978	Q	40.61	0.26
	V	40.02	0.05
1979	Q	39.32	0.39
	V	41.85	0.07
1980	Q	37.75	0.46
	V	40.35	0.07
1981	Q	42.32	0.47
	V	43.35	0.05
1982	Q	43.85	0.14
	V	40.42	0.04
1983	Q	37.73	0.05
	V	38.71	0.01
1984	Q	33.79	0.21
	V	36.38	0.04

Source: Statistics of Marine Products Exports, 1984, Marine products Export Dev. Authority, Cochin.

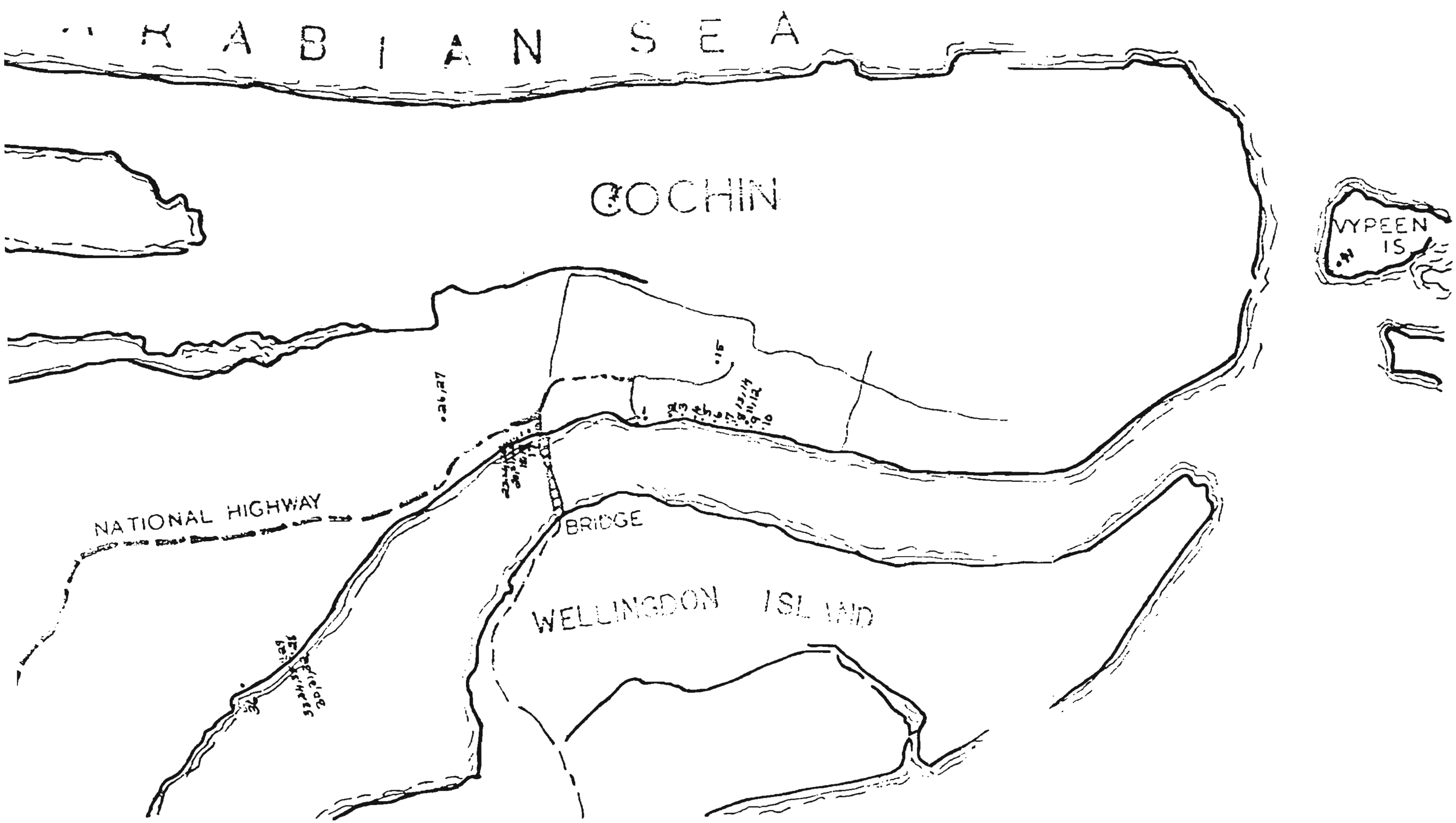
But at present due to high competition and shortage of shrimp landing coupled with many other reasons the industry is facing several problems.

The study was carried out to find out the locational advantages and disadvantages of the important fish processing centres in Kerala and to suggest measures to select the best location for the establishment of future seafood processing units in Kerala.

2. METHODOLOGY

The seafood processing plants are located in Cochin (Fig.1), Quilon (Fig.2), Alleppey, Calicut and Cannanore. Cochin has 60% and Quilon 20% of the total freezing plants in Kerala. Since these two centres have all the active plants in Kerala except for one at Calicut, these two centres were selected for in depth study of the processing plants in terms of their locational significance.

The general information of the location of the important centres were collected by visiting those centres and from the data available with various fisheries organisations. For a detailed study, 15 plants in Cochin region and 6 plants in Quilon region were randomly selected from the list of the plants available with the Seafood Exporters Association of India, Cochin. A proforma (Annexure.1.) was formulated to collect data from the owners , Partners , Managing Directors, Production Managers, Technologists and workers of the processing plants.



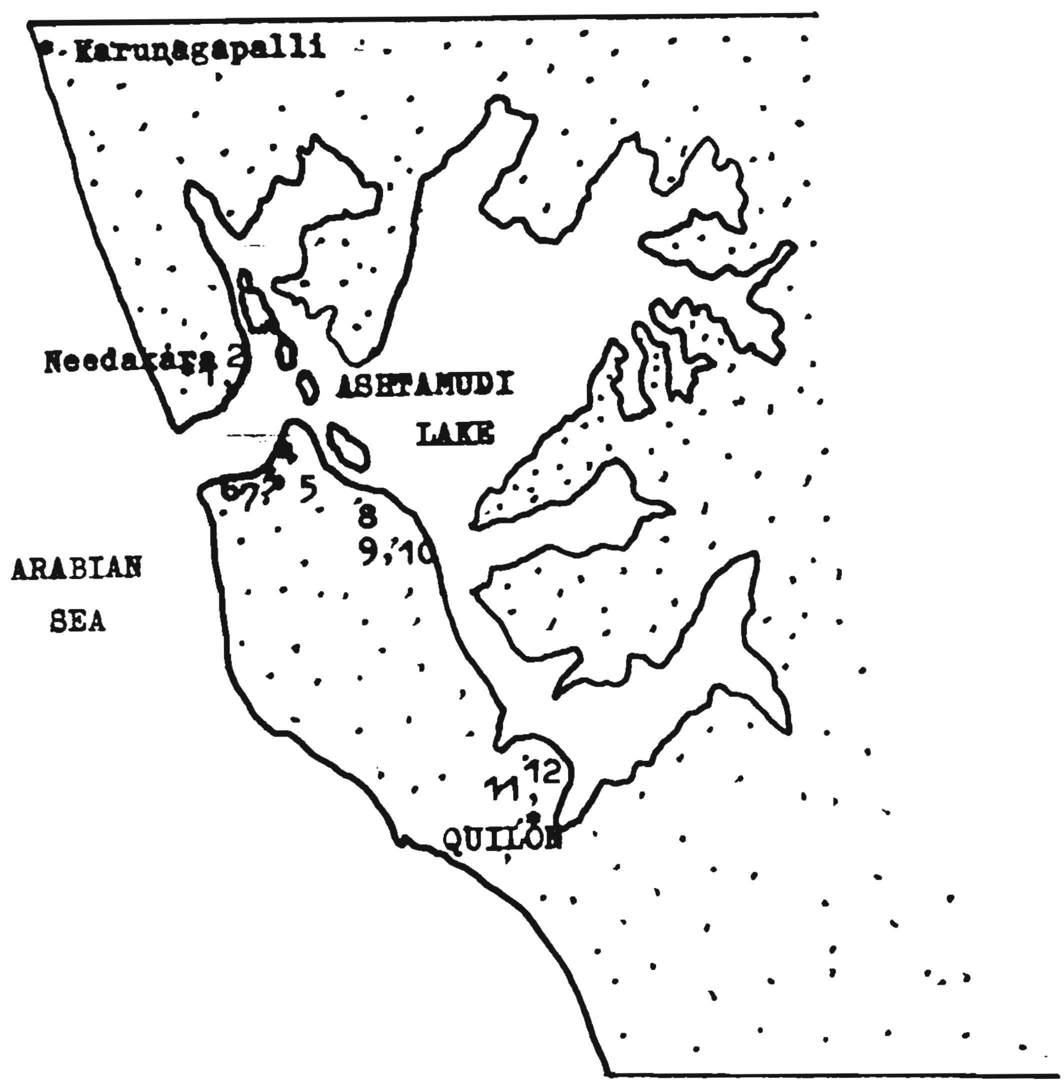
13. Top Frost
14. Toyo Sea Foods
15. National Sea Foods
16. Chemeens (Regd.)
17. Karthika Marine Industries
d. 18. Karthika Fisheries
td. 19. Mangala Sea Products

25. Metro Exports
26. Geo Sea Foods
27. Sea Rose Marine (P) Ltd.
28. Fibrite Fisheries
29. Sea Mates India
30. M.K. Fisheries

37. Peevees Enterprises
38. Roshan Exports
39. Blue Water Fisheries Company
40. Canning Industries Company Ltd.
41. Elite Sea Foods
42. Universal Trades Corporation

FIGURE : 2.

SHAKTHIKULANGRA-NEENDAKARA REGION (QUILON)
(Not to scale)



1. Kerala Sea Foods 2. King Fisheries Ltd.
3. Oceanic Products Exporting Company
4. Kala Cartons Ltd. 5. Capithan Exporting Cpmpany
6. Francson Agencies 7. Phoenix Fisheries
8. Emmario Export Enterprises
9. Gopinath Fish Exporting Company 10. King Marine Products
11. Poyilakada Fisheries 12. Poyilakada Fisheries (P) Ltd.

To select the best location for the establishment of future plants, a comparative study was carried out with the existing best locations - Cochin, Quilon and Calicut - by 'Delphi Method' as described by More and Hendrick (1978). For this study, ten processing experts who have thorough knowledge of all fish processing centres in Kerala were chosen to score the data sheet. The factors considered for the study were:

1. Nearness to maximum raw material source.
2. Availability of local labour.
3. Availability of good quality water.
4. Nearness to the exporting port.
5. Proximity to inspection agencies and research organisations.
6. Availability of other inputs like packaging materials, refrigerants etc.
7. Land cost and availability of suitable land.

3. RESULTS AND DISCUSSION

3.1. Distance of fish processing plants from main landing centre :-

Raw material availability is the foremost problem faced by all the processing plants in Kerala and proximity to the main landing centre in an area assures some amount of raw material due to regular monitoring and contact the company can have with the suppliers at the landing centre . For plants in Cochin region, Cochin Fishing Harbour with a registered fleet of about 1,600 mechanized boats is considered as the main landing centre. In Quilon region, Shakthikulangara-Neendakara fishing centre is the main landing centre. The table 3 gives the frequency distribution of seafood processing plants with respect to distance from the main landing centres. The distance range of the plants located in Cochin and Quilon regions from their respective main landing centres is given as follows: 60% of the plants in Cochin region are located between one and 10 Km. from Cochin Fishing Harbour, whereas majority of the plants (67%) in Quilon region are within one Km. from the main landing centre. The combined frequency of the plants in these two centres shows that about 50% of the plants are located within one Km. from the main landing centre .

3.2. Raw Material (fish) Sources :-

No plant is receiving sufficient raw material from a single supplier or a landing centre. Plants receive raw materials from a large number of landing centres and suppliers. The important landing centres from which raw materials are procured by the processing plants in Kerala are the following:

Landing centres at Ambalapuzha, Shakthikulangara-Neendakara and upto kovalam in the South, Aroor upto Ambalapuzha, Kalikavillai and upto Kanyakumari, Cochin Fishing Harbour, Kozhikode and upto Mangalore, Vypeen, Tuticorin, Thirichandur and Mangalore.

The percentage number of processing plants in Cochin and Quilon regions which are receiving raw materials from different landing centres is given in Table.4. Majority of the plants (78%) receive raw materials from Ambalapuzha upto Neendakara and only 13.5% of the plants collect raw materials from outside the state.

TABLE: 3.

FREQUENCY DISTRIBUTION OF SEAFOOD PROCESSING PLANTS WITH RESPECT TO DISTANCE FROM MAIN LANDING CENTRE.

DISTANCE RANGE	COCHIN (%)	QUILON (%)	COMBINED AVERAGE(%)
Within one Km.	33.0	67.0	50.0
Between 1 and upto 10 Km.	60.0	33.0	46.5
Between 10 Km. and upto 25 Km.	7.0	--	3.5
Above 25 Km.	--	--	--

TABLE: 4.

THE PERCENTAGE NUMBER OF PROCESSING PLANTS IN COCHIN AND QUILON REGIONS WHICH ARE RECEIVING RAW MATERIALS FROM DIFFERENT LANDING CENTRES

MAIN LANDING CENTRES	COCHIN	QUILON	COMBINED AVERAGE
Cochin Fishing Harbour	50.0	33.0	41.5
Ambalapuzha upto Neendakara	90.0	66.0	78.0
Neendakara upto Kovalam	80.0	66.0	73.0
Kalikavilai & upto Kanyakumari.	20.0	66.0	43.0
Arror upto Ambalapuzha	80.0	50.0	65.0
Vypeen Island	10.0	17.0	13.5
Tuticorin & Mandapam	10.0	17.0	13.5
Thirichandur	10.0	17.0	13.5
Mangalore	10.0	17.0	13.5
Kozhikode & North upto Mangalore	40.0	17.0	28.5
others	80.0	50.0	65.0

3.3. Mode of procurement of raw materials :-

Different methods are adoped by processors to purchase raw materials. They are: 1. through agents, 2. through contract, 3. direct purchase, 4. through own depots at the landing centres, and 5. partially from their own boats and partially from agents or contract. The percentage number of processing plants which are using different modes of raw material procurement is given in table 5.

3.4. Means of raw material transportation :-

The percentage number of processing plants which are using different means of raw material transportation is given in Table.6. The study shows that 82% of the processing plants collect raw materials either by their own fleet of insulated trucks or through hired insulated trucks. Only 12.5% of the plants receive raw materials through seaways also,ie by boats.

3.5. Time lag between purchase of raw materials at the landing centres/pre-processing centres and their arrival at the processing plants :-

As the raw materials are procured from different landing centres and pre-processing centres, the time taken for procurement and transportation of them varies according to the distance of the landing or pre-processing centre from the plant. Since fish is a highly perishable item, it needs processing with minimum time lag between harvesting and processing. Normally a fish starts spoiling within 6 hours of harvest at room temperature. This period can be extended for one to few days depending on the icing practice. But as the fish caught by boats are

TABLE: 5.

THE PERCENTAGE NUMBER OF PROCESSING PLANTS IN COCHIN AND QUILON REGIONS WHICH ARE USING DIFFERENT MODES OF RAW-MATERIALS PROCUREMENT

Mode of procurement	Cochin (%)	Quilon(%)	Combined(%)
By auction through agents	70.0	75.0	72.5
By contract	20.0	25.0	22.5
By direct purchase	80.0	50.0	65.0
Partially from their own boats and partially from agents	--	25.0	12.5
Through own depots at the landing centres	20.0	75.0	47.5

TABLE: 6.

THE PERCENTAGE NUMBER OF PROCESSING PLANTS IN COCHIN AND QUILON REGIONS WHICH ARE USING DIFFERENT MEANS OF TRANSPORT FOR RAW-MATERIAL TRANSPORTATION

Means of R.M. transportation	Cochin	Quilon	Combined average.
Own insulated vehicle & hired vehicles	89.0	75.0	82.0
Hired insulated truck alone	11.0	25.0	18.0
Owned insulated truck alone	--	---	---
Own open trucks	11.0	50.0	30.5
Own autorickshaw	22.0	25.0	23.5
By boat	--	25.0	12.5
Door delivery by suppliers	78.0	100.0	89.0

usually improperly iced and as the fish is exposed to sun without ice during purchasing, a safe time of a maximum of 24 to 36 hours (depending on the species of fish) could be considered as the tolerable time lag between procurement and processing.

The time lag observed between procurement of raw materials and its arrivals at the processing plants in Cochin and Quilon regions are presented in table 7. 64% of the plants in Cochin have an average time lag ranging between 4 and 6 hours between raw material purchase and its arrival at the processing plants. The time lag observed in plants at Quilon region is between 6 and 8 hours. It is found that none of the plants have an average time lag beyond 8 hours. This shows that the raw material arrival in the plants after procurement is quick and the raw material received in the plants is in good condition. Udupa et al. (1986) while studying on the arrival time, waiting time to unload, unloading time and waiting time for departure of purseseiners at Mangalore landing centre, estimated about 5 - 7 minutes in loading half a ton of fish in a nearby tempo from a purseseiner by employing 9 $\pm$ 2 labourers.

3.6. Availability of labour :-

The fish processing activities in Kerala and elsewhere in India are highly labour intensive. Skilled labour is required for pre-processing and processing activities in the processing plant. Unskilled labour is also required for various activities like cleaning of premises, transportation and storing of materials, etc.

The study shows that there is no shortage of skilled as well as unskilled labour for the processing plants in these regions. 91.9% of the processors in Cochin region pointed out that they have just sufficient technologists in that region, whereas 50% of the processors in Quilon region are of the opinion that they have surplus technologists in their region. The only problem, some processors pointed out, was the discontinuation of the technologists from the service in search of better job opportunities.

3.7. Water source:-

The main sources of water to the processing plants are municipal supply and bore-well. At present there is no regular system prevailing in Kerala to supply water from distant places by tankers like in places like Veraval, Porbunder etc.,where acute shortage of water is experienced at the processing sites. Occasionally when water shortage is severe in some locations in Cochin and Quilon, plants resort to tanker water. 91% of the plants in Cochin and Quilon region have bore well whereas only 53.5% of the plants have sufficient municipal supply.

In Cochin region, 82% and 40% of the plants have regular municipal water supply and good quality bore well water facilities respectively. In Quilon region, plants located in municipal limit get sufficient municipal water supply.

3.8. Electricity supply :-

Like water, electricity is also a very important input for the processing plants. It is required at every stage of production and storage. Failure of electricity supply for a few hours will stop the working of freezers and various other machineries and equipments. The cold store has to be maintained between -18°C and -23°C. Stoppage of power supply even for a short time will increase the temperature in the cold store, which affects the quality of the products. Kerala was one of the leading power producing states in India, but the state suffered a severe power shortage in 1983 due to an extreme drought situation. 72.5% of the processors complained about the discontinous nature of the power supply and the related problems faced by them. 27.5% of the processors complained about the undependable nature of the power supply.

This forced the processors to install generators to tide over the situation. Most of the plants (78% in Cochin and 100% in Quilon) studied installed generators of various capacities to safe guard their products and to facilitate continous production.

3.9. Other raw materials :-

The processing plants require a long list of various other inputs for day to day functioning. The important inputs required are:

1. Waxed cartons of different sizes and standards for packing different products.
2. Master cartons of various types.
3. Polythene bags and sheets of different guages.
4. Gar straps/plastic straps.
5. clips.
6. Rubber bands.

7. Refrigerants like Freon 22, Liquid Ammonia etc.
8. Chemicals and microbiological media
9. Deodorants , disinfectants, cleaning solution etc.
10. Utensils.

A shortage of any one of the above mentioned inputs will hinder production. The plants located in both Cochin and Quilon regions are found to get sufficient raw materials(other than fish items) within their teritory itself.

3.10. Space for expansion :- When a factory is constructed, provision should be made for future expansion. In most of the existing plants there is no provision of space for future expansion. Only 45% and 33% of the plants studied in Cochin and Quilon regions respectively have some space for further expansion. The exact area available in these plants could not be worked out due to non willingness on the part of the management.

3.11. Local Transport Facilities :- No plant can provide all the transport facilities required for it. As described earlier, the raw materials required for the plants have to be collected from different landing centres. Availability of transport on rent at the landing centres will help to procure the raw material as and when it is available. This will help the processors to invest less on the transport facility. It is found that sufficient transport is available in all the important landing centres.

3.12. Proximity to port :-

The two ports in Kerala from where the marine products are being shipped are Cochin and Calicut. Other nearby ports from where marine products are being shipped are Tuticorin and Mangalore. The study shows that all the plants in Kerala depend on Cochin port for shipments. A minor quantity is being shipped from Calicut and Tuticorin. The distance from Cochin port is one of the important factors to be taken into account while choosing location for processing plants. It is found that 91% of the plants in Cochin region fall within 5 Km. range from the harbour. The plants in Calicut and Quilon regions are about 250 Km. and 130 Km. away from Cochin harbour. This shows that the plants in Cochin have a special advantage over the plants located elsewhere. This reduces the shipping time and cost of transportation of the processors in Cochin region when compared to Calicut and Quilon.

3.13. Facilities for waste disposal :- All the plants surveyed were found to be on the banks of lake/backwater system or sea. All the plants discharge their liquid waste into the respective water bodies. The liquid waste consists mainly of fish particles like meat, water soluble constituents of fish etc. and as the discharge quantity is not very high, it does not pose pollution problems to the water system. The water system where the plants are mainly located is directly connected to the sea in both Cochin and Quilon regions. This helps in immediate dilution of the waste and the tides help to clean the premises.

The solid wastes are either discarded to the nearby water bodies or to the nearby open shore/place from where it is later removed for the purpose of making manure or fish meal. About 30% of the solid waste in Cochin region is found to be procured by the fish meal/manure producers from the factory premises itself.

3.14. Environmental conditions and surroundings :-

The environmental conditions prevailing in different localities are presented in table 8. In both Cochin and Quilon regions, the weather is found to be humid most of the time and the temperature is in the medium range. The surroundings of 64% of the plants surveyed in Cochin were found to be clean, whereas it was only 25% in Quilon region.

3.15. Comparison of alternative locations for setting up of future seafood processing plants :-

Preliminary studies showed that the best locations available in Kerala are in Cochin, Quilon and Calicut. The result of the study on the comparison of alternate location is furnished in tables 9 and 10.

Cochin ranked the top for the overall scores obtained for all the factors put together. Quilon is found to be the best location for raw material availability. For other factors like availability of good quality water, nearness to other raw materials source, proximity to exporting port, local availability of labour and nearness to inspection agencies and research organisation, Cochin stood first. Calicut did not show any better advantage in any of these factors.

From this it can be interpreted that Cochin is still the best location for establishing new units due to its various unique advantages,followed by Quilon.

TABLE: 7.

TIME LAG FOR RAW MATERIAL PROCUREMENT AND PERCENTAGE FREQUENCY DISTRIBUTION OF FACTORIES

Time lag between purchase and arrival at the factory	Cochin	Quilon	Combined
Upto 2 hours	--	--	--
Between 2 and upto 4 hours	18.0	--	9.0
Between 4 and upto 6 hours	64.0	--	32.0
Between 6 and upto 8 hours	18.0	100.0	59.0

TABLE: 8.

SURROUNDINGS AND ENVIRONMENTAL CONDITIONS OBSERVED AND FREQUENCY DISTRIBUTION (%) OF FACTORIES IN QUILON AND COCHIN REGIONS

Surroundings/Environmental conditions.	Cochin	Quilon	Combined
Surroundings:			
1. Clean and neat	64.0	25.0	44.5
2. Moderately clean and neat	36.0	50.0	43.0
3. Dirty	--	25.0	12.5
Weather:			
1. Dry	--	--	--
2. Moderately humid	--	--	--
3. Humid	100.0	100.0	100.0
Temperature:			
1. Low - below 30°C throughout the year	--	--	--
2. Medium - Below 36°C throughout the year	100.0	100.0	100.0

TABLE: 9.

THE AVERAGE SCORE GIVEN BY TEN PROCESSING EXPERTS FOR DIFFERENT FACTORS WHICH CONTRIBUTE TO THE SELECTION OF LOCATION

Location	Nearness to R.M. source	Availability of good quality water	Avail. of labour locally	Nearness to other R.Ms. source	Nearness to Inspection & Res. Orgns.	Nearness to exporting port	Land cost & availability of suitable land
Cochin	3.5	3.9	3.5	3.6	4.2	5.5	2.8
Quilon	4.0	3.1	3.6	3.3	3.0	2.5	3.7
Calicut	2.5	3.0	2.9	3.1	2.8	2.0	3.5

TABLE:10.

THE TABLE SHOWING THE RATED VALUE FOR DIFFERENT FACTORS FOR THE SELECTION OF LOCATION

Location	Nearness to R.M. source	Availability of good quality water	Availability of labour locally	Nearness to Inspection & Res. Orgn.	Nearness to other R.Ms. source	Nearness to exporting port	Land cost & availability of suitable land	Total rated score
Cochin	140	78	52.5	21	18	27.5	28	365
Quilon	160	62	54.0	15	16.5	12.5	37	357
Calicut	100	60	43.5	14	15.5	10.0	35	278

Ratings given for various factors:

1. Nearness to R.M. source = 40%, 2. Availability of good quality water = 20%, 3. Availability of Labour locally = 15%, Nearness to exporting port = 5%, Nearness to Inspection agencies and Res. Organisations = 5%, Nearness to other R.Ms. source = 5%, 7. Land cost & availability of suitable land = 10% TOTAL = 100%.

FACILITIES LAYOUT AND LINE BALANCING

1. INTRODUCTION

A plants internal arrangement of facilities, that is its layout should be designed to permit the economical movement of material through processes and operations. The travel distances should be as short as possible and the picking up and putting down of products should be done within minimum time.

The main considerations when planning to construct a new plant or modifying the existing plant must focus on the financial, material and technical aspects of the plant. The ultimate objective must be to have a plant which minimizes the holding time and handling of the material in the production line to the extent possible, especially at higher temperature.

Many researchers have established the importance of hygienic handling and quick processing of fish to extend its shelf-life. Johnny (1982) discusses the problems of fish handling and transportation under three heads.

Temperature control : - He establishes storage as a function of temperature of different products against logarithmic time scale and enormous differences is found in the keeping time, particularly in cold storage. He stresses the importance of temperature control to maintain quality.

Rational Handling within minimized time:- Rationality in handling/transportation is important both with regard to economy and quality of products. In addition to temperature, the quality is mainly a function of time. He describes how the 'temperature-time tolerance' method is used for predicting quality of frozen food after a given temperature-time course.

Hygienic and mechanical careful handling :- Hygienic standard is important in both the handling of raw material as well as in production, since bacterial growth is the main deterioration process in unfrozen tissue.

The Bureau of Indian Standards, New Delhi has formulated a code for sanitary conditions, handling and transportation in fish industry (I.S. 4303 - 1975). It lays down the sanitary conditions and requirements for handling and transportation of fish on board fishing vessels at the point of unloading and from the unloading point to the processing site. Indian Standard (I.S. 5735 - 1970) gives guidelines for sanitary conditions for food processing units. These standards must be taken into account while planning a layout.

Johnny (1982 a) suggests that when we plan fish handling systems, we must observe the same principles of good economy and efficiency as in other fields. A general trend in transportation of goods has been the increased use of standardized units and specialised handling devices. Rapid efficient handling has to be combined with the highest possible flexibility depending on the type of goods that are to be transported.

Many authors have also pointed out the possible loss of nutrients during ice storage. Govindan (1962) found out rapid fall in total nitrogen, water soluble nitrogen and non-protein nitrogen during storage of prawns in ice. The moisture content of the muscle was found to rise. The rate of these changes increases in the order of whole, headless and peeled and deveined prawns and this might be attributed to the amount of surface area exposed in the respective cases. He also noted that the solid material leached out by the melt water was 15% of the original weight of the muscle in two days and it slowly increased to 29.85% in four days.

Velankar, et al.(1961) revealed that considerable losses of 'extractives' such as the free amino-acids occur during storage of prawns in ice due to leaching. Work done in U.S.A. by Collins, et al.(1960) and Iyengar, et al.(1960) have also shown that water soluble chemical compounds including those produced through spoilage leach out during storage in ice.

Nair., et al.(1962); Govindan (1970); Solanki (1978); Chidananda and Srikar (1982); Surendran and Iyer (1985); and others have also established that nutrients from fish muscle are lost during ice storage.

This characteristic feature of the raw material/in-process material has to be taken into account while setting facilities in processing plants since the material/in-process material in our plants are stored temporarily in ice. The objective is to keep the material in ice at a minimum possible time.

1.1. LAYOUT PATTERNS

There are four basic patterns of layout. First -'Product Layout' refers to the grouping of machines required to make certain products along lines down where the products move continously as in an assembly line. Departments are places where particular products are made. Second, 'Process Layout' refers to the grouping of similar machines into department where only certain kinds of work are done. Third, 'Group Layout' sometimes regarded as a separate kind of layout, is really just one kind of product layout. In group layout, parts and components are set apart to work only on such parts and to do everything needed to make them complete. Fourth, is 'Fixed Position Layout' which applies to complex assembled products being put together in one spot. Most companies use predominantly one or the other of these layout patterns.

The application of the principles of plant layout in the modern methods of fish processing like canning and freezing is universal in advanced countries. Its benefit even in the case of traditional methods of fish processing like fish curing have been discussed by Sripathi (1967). However, published literature on this subject in relation to seafood processing plants is scanty, and our processors are not sufficiently conscious of the layout.

In Kerala all the fish processing(freezing) plants have a'process layout'. Most of the activities in the processing plants in Kerala are being done manually. Some of the well established lines of production and automatic machineries popular in developed countries are discussed below.

1.1.1. Shell fish processing :- Franken B.V. is marketing a complete line of shell fish processing(declamping, washing, grading, cooking meat/shell separation machines etc.) A large number of models of fish scaling, skinning, deboning, filleting, grading, freezing and packaging machines are available in international markets. These are all specialised machines for a particular type or variety of product. Simnar is one of the leading manufacturers of scaling, heading and eviserating machines (Anon.,1985 a).

1.1.2. Automatic grading and weighing system :- These systems are now available in advanced countries. For instance, Netherlands has a well established model for grading and weighing. A British manufacturer has developed a system of washing fish boxes and crates which is said to be more efficient than conventional washers in removing dried or frozen guts. The machine soaks the containers in a special liquor at 40°C. The tank is steam heated and surrounded by double skin panels to minimise heat loss. Crates enter the machine on an overhead rail, leaving the same work station after rinsing and drying at a rate of 300 per hour. Operation of this machine is by one man (Anon., 1983).

1.1.3. Fish Finger Line :- Several models of fish finger lines are popular in western countries, Japan and U.S.A. A new type of high speed automatic fish finger line has been introduced by Metal Box Ltd.

1.1.4 Mechanised Scampi Peeler :- A machine for the extraction of meat from Nephrops tail has been developed by a firm in Canada.

1.1.5. Continous Freezing Lines:- Instead of batch freezing in plate freezers or blast freezers, continous freezing machineries are now available. This is specially useful for fillets and Individually Quick Frozen (I.Q.F.) products. A popular line is spiral freezers where the material to be frozen passes through spiral conveyors in the freezer. The freezing time can be adjusted as per the requirement by reducing the speed of the conveyor. Recently, one of the new factories in Cochin has installed this machinery for I.Q.F. products. Three factories in Gujarat (Veraval and Porbunder) have also set up I.Q.F. machinery for the production of I.Q.F. Shrimp (Ramachandran, et al., 1988).

1.1.6. Automatic Straping System:- A company based at United Kingdom is producing an automatic straping system suitable for seafood packaging in both land-based processing plants and on board fishing vessels. The feeding is by a conveyor system. The sealing process joins plastic straps in just half a second

1.2. LATEST RESEARCH AND DEVELOPMENT IN THIS FIELD:-

1.2.1. Skin Vacuum Packaging :- This is a new type of packaging system introduced in Japan. It consists of an almost invisible film over the food product placed on a polysterene form tray. The film which stretched over the tray forms a tight, contoured skin, over the product and the tray surface. This eliminates air around the product and thus creates a vacuum. The packaging process goes through several steps. The capacity of the machine ranges from 5000 to 24,000 trays per day(8 hours) for the double chamber machine and from 4,000 to 17,000 trays per day for the single chamber machine (Anon., 1983 b).

1.2.2. Controlled Atmosphere in Air Tight Pouch :- This method is tried by Fisheries Technologies Research Institute, Norway. The research shows promise of keeping fish fresh for longer period even in relatively high ambient temperature. The 'Control Atmosphere' consists of the same gases as in normal air, but in different proportions. The method has been in use for preserving meat and vegetables for years, but only recently has it been tried in fresh fish. Combined with adequate refrigeration, fish was found to keep freshness for periods of upto 12 days (Anon., 1983 c).

1.2.3. Electronic Weighing and Control Systems:- An Iceland based firm has developed an'Electronic Weighing and Control System' for fish processing factories. The computer control prevents over weight give-away and provides control of yield and other factors (Anon., 1985 b).

A detailed study on the existing layouts of processing plants in Kerala was carried out to work out an improved layout design to achieve the following objectives:

1. To reduce holding time and handling of materials
2. For better man power utilization.

3. For better utilization of facilities.
4. To avoid cross contamination of products with raw materials, processing waste etc.
5. To reduce processing cost and wastage.

This improved layout is designed taking into account the fluctuations and seasonality in fish landings, the special nature of the quality problems associated with the production of different products etc.

2. DATA SOURCE AND METHODOLOGY

The primary data required for the study were collected from the plants selected for the study through a proforma (Annexure: 1.) and by personal discussion with the concerned people/or from the documents maintained in the plants.(The details regarding sampling, sample size etc. are described under the chapter on 'Data Source and Methodology').

The various activities involved in the processing of products were studied and 'work measurement' of the processing of important products were carried out to find out the actual job content and sequencing of various activities in the production line. The detailed description of the materials and method used for work measurement is given in chapter on 'Work Measurement'.

Improved Layout:- An improved layout for fish processing (freezing) plants in Kerala is worked out using the 'Travel Chart or Load Path Matrix Method' for process layout as described by More and Handrick (1978). Here the main attention is given to reduce the handling and transportation of inprocess materials from work station to work station.

Acceptability Test:- An experienced test panel consisting of processing plant owners, production managers, technologists, scientists, and engineers (Total 10 members) were asked to compare eight layouts of the processing plants which were selected as the best among the plants studied with that of the 'improved layout' developed by the researcher. The comparison was made as per 'Delphi Method' described by More and Hendrick, (1978). The factors considered for the study were

1. Minimum holding time and handling of materials (25)
2. Shortest Process Cycle Time.(25)
3. Better man power utilisation (20)
4. Minimum possibility of cross contamination and quality problems (15)
5. Minimum cost of production and wastage(10)
6. Better utilization of facilities (5)

The figures in brackets are the ratings given for the respective factors.

3. RESULTS AND DISCUSSION

3.1. Layouts of fish processing plants in Kerala:-

All the fish processing plants in Kerala have a process layout. This is the same in the case of other states in India as well as in most of the developing countries. This is mainly due to the following reasons:

1. Cheap and sufficient availability of labour.
2. Vast variation in fish landings of a particular species of fish.
3. Variation in the size of the fish available during different seasons.
4. Insufficient landing of a particular species throughout the year which hinders processors from establishing specific product line for each product due to economic reasons.(Three plants in Gujarat have recently acquired shrimp peeling and grading lines (Ramachandran, et al.,1988). This is mainly due to the shortage of skilled workers in Gujarat for shrimp peeling and grading. Usually when the fishing season starts, skilled workers are going to Gujarat from Kerala, where surplus labour is available.)
5. High cost of establishing product lines.
6. Lack of indigenous product line machineries.
7. Our products are mainly industrial based (The frozen blocks which are being shipped from Kerala are used as raw materials in the re-processing plants in the importing countries like Japan, U.S.A. etc. The re-processing company produce consumer packs from these frozen materials with their brand names.) (Anon., 1982; Anon., 1982 a).

The entire processing activities in processing plants in Kerala are done manually except in a few cases like washing of Peeled and Deveined shrimp in some plants.

The important products produced in the processing plants using the same common facilities are Frozen Headless Shrimp, Frozen Peeled and Deveined Shrimp(P.D. Shrimp), Frozen Peeled and Undeveined Shrimp (P.U.D. Shrimp), Frozen Whole Cuttle-fish, Frozen Whole Squid, Frozen Cuttle fish Fillet, Frozen Squid Tubes, Frozen Whole Cooked Lobster, Frozen Lobster Tail, Frozen Clam meat, Frozen Fish items, etc.

The raw materials for the above products arrive in the plants with very wide fluctuations and it is difficult to predict the quantity and type of material which would be arriving on a particular day. (Details of the purchase pattern of raw materials and the processing of it are discussed in detail under the chapter on ' Productivity study in seafood processing industry'.) So the only possible alternative is to keep the facilities open and flexible to absorb the available raw material. In this situation, it is preferable to have a 'process layout' than 'product layout' to minimize the idle capacity and cost of production.

In contrast, in developed countries, especially in temperate countries, the product line layout is common. This is mainly due to the following reasons:

1. In temperate waters commercially exploitable varieties are few.
2. The few available varieties are available in large quantities and the fishing season is longer than in tropical countries.
3. Large landings are available due to extensive purse seine, deep sea and factory ship operations.
4. Shoaling fishes like herring, sardines, cod, etc. are

available in uniform sizes.

5. High labour cost.
6. High cost of land and building.
7. Well established fish products like fish fingers, surimi based products, 'ready to serve products', etc. are very popular(Hotta, 1982; Johnson,1982). These products are very well suitable for production in automatic or semi-automatic production lines.

No two plants were found to have a similar type of material movement in the processing plants. None of the plants have a balanced layout (Capacity at each stage of production in the plants studied are given in the chapter on'Productivity study in seafood processing industry'.)

The important observations on the existing layouts in processing plants are the following:

1. Unbalanced line of production resulting in piling of in-process material in the raw material store, and in between operations especially at the freezing station.
2. Irregular and unnecessary movement of raw material and in-process material in the production line resulting in crossing of finished or semi-finished product with raw material, waste etc. This results in quality problems.
3. Deficient planning in the construction of the plant buildings.

4. Unnecessary handling and movement of workers.
5. Forced idleness of workers at one work station or the other due to non-availability of facilities continously in the next or subsequent work stations. For instance, the cycle time at freezing stage in most of the plants is four hours whereas pre-freezing stage requires only one hour. This unbalanced state results in idleness of workers at the pre-freezing stage after every batch of production. (Detailed study on this aspect is included under the chapter on 'Work Measurement'.)
6. Unusual and unnecessary exposure of raw materials and in-process materials at higher temperature due to poor arrangement of work facilities.
7. Difficulty in the free movement of men and materials due to want of space in between operations as well as for transportation of materials from one work station to other.
8. Unnecessary investments on the facilities which are unproductive.
9. Poor floor arrangement and drainage system resulting in waste water logging at some places and hindrance to free movement of waste water through the drainage system.
10. Unplanned allocation of space at different work stations.

3.2. IMPROVED LAYOUT

An improved layout is worked out which reduces the above mentioned defects to the extent possible. The layout is given at the end of the chapter (Fig. 1.). A flexible process layout with continous flow of material like that of a product line is suggested. This takes into account the special nature of the industry, future diversification and expansion. The important features of the improved layout and the guidelines for its use are given below:

3.2.1. Building:- The processors who are planning to construct a new building for a seafood freezing plant must bear in mind that the factory building is only secondary in importance to the primary objective of efficient, hygienic and economic production of frozen goods of high and consistent quality as prescribed by the Government of India as well as by the buying countries. The building constructed must suit the layout of the plant. The entire production activity must be carried out in the ground floor. The first floor can be utilised for the purpose of office, laboratory, recreation facilities, retiring rooms, etc. The present study is confined only to the requirements of processing facilities. The space requirement and location of each work site is clearly given in the layout. The layout has to be converted as per the requirement of the civil engineer while constructing the building.

The important points to be taken into account while constructing a building for processing plant are:

1. The building should be in the east-west direction This helps in preventing direct sunlight from falling on the work sites.
2. Inner wall of the plant above the floor should be fixed with glazed tiles for about 1.5 to 2 M for easy cleaning and for quality reasons.
3. The entire stretch of the outside wall of pre-processing hall, chill room, processing hall and packaging section above 2.0 to 2.5 M must be provided with transparent glass windows to get natural day light in the production sites.
4. The floor of the building must be constructed to help quick drainage in the opposite direction of the material flow. This helps in preventing cross contamination of meat from waste water.
5. Sufficient light arrangement must be made to have day light brightness. This helps in easy identification and location of foreign particles in the materials while processing. Sufficient water points of good quality water should be provided at the work sites.

3.2.2. Work stations in processing plant

3.2.2.1. Raw material purchase section :- The raw materials purchase section is the first station in the production line where raw materials arriving from different landing centres as well as from local suppliers are regularly being purchased. For quick purchasing and supervision, the entire purchasing section must be provided with facilities for all the purchasing functions. This includes the facilities for weighing, quality checking, grading, accounting, supervisors room, purchase managers room,etc. The purchase section must be provided with platform balance for weighing of the raw material and water facilities to wash off the ice and dirt from the material before weighment.

3.2.2.2. Raw material store room :- A separate raw material store room should be provided as given in the layout. Instead of the common practice of providing permanent concrete tanks in the store room, small easy to handle type standard plastic tubs are suggested to keep the raw material. This helps in avoiding unnecessary handling of raw material during pre-processing. The present practice is to fill the concrete tanks or huge galvanized iron tanks with raw material and ice. The ice-fish mixture sometimes becomes a block and during the next operation, the workers have to exert pressure using shovel,etc. to break the block .

A standard plastic box which has a capacity of 25 to 30 Kg. each (some models are developed by Marine Products Export Development Authority, Cochin.) must be used in all the work stations. This helps in directly taking the material in trolleys from one work station to another without transfering the material further. This also helps to store different lots of material arriving from different places with different quality separately for applying priority rule while processing the material.

3.2.2.3. Pre-processing hall :- The present practice of directly taking the raw material from the purchase section or raw material store to the processing hall is against the sanitary and hygienic practice of fish processing. Currently the washing of material, regrading,etc. are being done in the processing hall itself. No material should be allowed to enter the processing hall directly from the purchase section or raw material store.

Most of the raw materials for processing plants in Kerala arrive after pre-processing.(For example, peeling,deveining, or beheading in the case of prawns or beheading in the case of lobsters or cooking and deshelling in the case of clams,etc.) Eventhough the raw material arriving at the processing plant is already pre-processed, the material is found to be not properly washed and cleaned. Moreover, the raw materials are being purchased from different landing and pre-processing centres and hence the quality of the washing and cleaning also vary widely. It is advised to wash and clean the raw materials at the pre-processing hall before storing the material in the chill room or taking to the processing hall. Some materials may require rechecking of grades and sorting. This also must be done at the pre-processing hall. The pre-processing hall must be provided with processing tables, washing machine and containers for keeping the materials.

3.2.2.4. Chill room :- Presently, most of the plants are keeping the purchased material directly in the chill room before washing, cleaning, sorting and grading. There is no separate raw material store in most of the plants. They keep the material directly in the'so called chilled room' or is taken directly to the processing hall for processing before it is being washed or graded. This will create quality problems as discussed above. In the chill room only the thoroughly washed, graded and sorted material should be stored. The chill room is placed,in the layout,in between pre-processing hall and ice plant and the processing plant is adjacent to it. This helps to reduce material handling and movement considerably. An ice crusher must be installed close to the chill room and the ice store which will help to crush the ice both for internal use as well as for taking in insulated trucks for procurement of raw material.

3.2.2.5. Ice plant :- An ice plant of 16 ton capacity is suggested. This is sufficient for internal use of ice in plant as well as for procurement of raw materials from landing centres. Since the layout is provided with an ice store close to chill room, ice can be taken to the chill room or pre-processing hall or processing hall or to the outside with minimum handling and movement. The ice plant must be provided with a pulley-chain-rail arrangement or crane to lift the ice blocks and to keep it in the store.

3.2.2.6. Processing hall :- A two line processing facility with all separate processing amenities upto the post freezing stage is suggested due to the following advantages.

1. This helps in continous production just like in a product line layout eventhough production is in batches. The current practice is processing in a single line facility. Here once a batch is loaded in the freezer/s (one or two numbers usually) the workers get lots of leisure due to the forced idleness for want of freezer facilities for the next batch of in-process materials till the first batch is unloaded from the freezer/s.(Detailed description of the production processes are decribed under chapter on 'Work Measurement') This completely disturbs the discipline of the production unit. Sometimes the workers may be asked to do other jobs like pre-processing, cleaning of the premises, etc. This will affect the morale of the workers. Moreover, frequent break in production results in increased outward and inward movement of the workers in the processing plant. This leads to contamination of the in-process materials as well as utensils and premises.

2. The two line system helps to reduce the workers strength in the pre-freezing stage by about one half. This is achieved by a 100% increase in workers utilization. In the present set up with single line, the processors employ more workers and related facilities in the hope of increasing their turnover. But when handling large quantities of different raw materials the tables and the premises have to be washed and cleaned very frequently forcing the production to be suspended for short intervals whereas if there are two separate lines the workers can schedule their work as follows:

To begin with, the workers can start processing in Section I (Line: I) of the processing hall. Once the first load (or batch) is loaded in the Freezer No. I, the entire workers in the pre-freezing and freezing stages can move to the Section No. II to continue their operations on second batch of raw material. Meanwhile the Section No. I can be washed and cleaned and kept ready for the next batch of production. Once the second batch is loaded in Freezer No. II, the workers can again go back to the Section I for processing third batch. By the time the third batch is ready for loading into the Freezer No.I, the first batch which is already in the freezer will be ready for unloading.

Since 'Ninety Minutes Freezer' is suggested instead of the existing 'One Hundred and Eighty Minutes Freezer'(Ninety and one hundred and eighty minutes refer to the normal time required by the two types of freezers for freezing the material) the turnover is doubled with the same processing facilities. Since the extra cost of installing a 'Ninety Minutes Freezer' is only marginal, this is of great advantage in reducing the process cycle time. This balances the processing line to a great extent as this is the longest activity in the processing line.(It is estimated that about 75% to 77% of the total process cycle time for producing a frozen product is consumed by freezing stage alone, if One hundred and eighty minutes freezer is used.) This facilitates continous production as well as full utilisation of workers' time. (A model production schedule is developed and is given in the chapter on

'Scheduling and Production Control'.)

Since, instead of pooling the facilities together at one place as practiced now, if the facilities are split into two separate lines, there will not be much extra space or additional facilities required in the processing hall. Hence,the additional investment required is only marginal.

As per the Government of India's guidelines, as well as due to the quality problems, no two raw materials must be processed in a line at a time. For this reason, either we have to construct separate processing halls for different raw materials or we have to thoroughly wash and clean the premises after every batch of production. This guide line is due to the reason that different fish items have different microbial flora and the pathogenic organisms vary in intensity and variety from fish to fish. This leads to cross contamination if we process these materials together in a line. Hence, a two line system is the best suitable proposition.

Raw material landing is irregular and unpredictable. So the availability of a single type of raw material sufficient for a day's production is remote and the plant may have to use different available raw materials to run the plant to its full capacity.

Future expansion is easy with little demolition of permanent structures.

The peak landing seasons of most of the commercially important varieties of fishes coincides. The peak season is only for a short period of time. The raw material price will be low during peak season. The two line facility helps to absorb the excess raw material available during peak season by only increasing the workers strength during the period. Workers are freely available in Kerala on short term contract. The only constraint will be the availability of freezers for freezing the excess material. The excess material can be washed and cleaned and directly stored in cold store bypassing the freezing stage temporarily. The frozen material ean be later thawed during lean period and used for processing in the normal way. This is in practice in advanced nations where the raw material is being received from deep sea vessels or factory ships. Here fish will be initially frozen in the ship itself and later taken to the factory at shore for reprocessing. (But this method should not be continued as a regular practice as the quality and yield of the products produced by this method is inferior to that of the regular method. George (1973) compared the quality and shelf-life of Headless Shrimp and Peeled and Deveined Shrimp preserved by 'single freezing and 'double freezing'. It was found that the 'double frozen' products were inferior to those of 'single frozen'ones. The main defects noticed was higher reduction in thawed yield and more black discolouration in double frozen products).

<u>Packaging Section (Post Freezing Stage)</u> :- A single line facility is suggested at this stage as the cycle time at this stage is only about half of that of pre-freezing stage. The present

practice of manual mastercartoning and sealing is tedious, labour intensive and affects the quality of the product due to rough handling, nonuniformity and delay in sealing. If this method is replaced by an automatic master carton sealing machine, the processing time can be reduced considerably. A uniform sealing of the carton is also achieved, which adds to product appeal. The trade delegation sent by Government of India to Japan and other countries also revealed that breakage of inner cartons and their deformation were the defects pointed out by the buyers(Anon., 1982 a). Since the fish once frozen should not be kept at higher or fluctuating temperature for long due to quality reasons, the mechanization at this stage helps to minimize the holding time of frozen blocks at this stage.

A manual feeding type automatic master carton sealer which is available in several countries, if installed, helps in improving the production process at this stage. The existing market price of one of the models is around Rs.70,000/- only. The machine is very compact, easy to handle for even unskilled workers, and moveable.

The machine helps in retaining the shape of the frozen blocks as well as the master cartons. It reduces wastage of straps and requires only little space. The machine is having the maximum capacity of sealing 300 master cartons per hour and this helps in quick movement of the frozen material into the cold store. The machine will replace a worker ie. in a day three workers can be reduced (in three shifts of 8 hours each). The economic benefit of installing a master carton sealer instead of manual operation is worked out as follows: (Yearly basis)

	Rs.	Ps.
The cost of installing the machine @ 18% interest rate	12,600	00
Depreciation of the machine @ 10%	7,000	00
Total salary of the workers who are operating the machine(one employee each per shift @ Rs. 600 per month and a bonus of 8.33%)	23,403	00
Estimated electricity charge/annum	933	00
Total recurring cost per annum	43,936	00

If manual operation is carried out instead of installing a machine, two workers are required for the work. The total recurring cost in this situation is worked out as follows:

	Rs.	Ps.
Cost of hand operated sealing equipments (This needs replacement every year)	500	00
Interest on Investment @ 18%	90	00
Salary of workers who are involved in packaging operations	46,800	00
Total recurring cost per annum	47,390	00

The cost benefit of Rs.3454/- is estimated every year in case we resort to mechanization of the packaging activities

The packaging section is placed between the two ante-rooms of the cold stores. This position has the natural advantage of low temperature due to the diffusion of cold air from the cold stores while loading and unloading from the cold stores. In addition to this, handling and transportation of the materials are also considerably reduced by this layout.

Cold Stores (Frozen Stores) :- The frozen store must be maintained between $-18^{\circ}C$ and $-23^{\circ}C$ with minimum fluctuation in temperature throughout the storage period. Two separate cold stores of 100 Mtons capacity each is suggested for a ten Mton (daily capacity) processing plant. As per the study on the turnover of stock in cold store in processing plants, it is found that on an average, every two weeks the stored material is completely shipped. The regular shipping facilities available in Cochin Harbour helps to prevent the finished products inventory from piling in the cold stores of plants in Kerala. This is not the situation in other places like Porbander, Veraval, etc. where frequency of shipment is on an average once in a month. The regular shipping facility in Cochin helps rapid replenishment of stock in the cold stores of plants in Kerala.

With the recommended two hundred Mtons storage capacity, 20 days production can be stocked without any shipment. This capacity is more than sufficient for continous and smooth production in plants. In case during peak season, if more products have to be stored (usually a rare phenomenon) the product which is waiting shipment first can be taken to the frozen storage facility available in Cochin Port. This helps in saving unnecessary investment and working capital on large capacity cold stores.

The existing frozen stores in the processing plants are provided with big doors for the movement of the stock. This, while opening for stocking or unloading the products leads to considerable loss of coolness in the stores. The loading and unloading of the products in the cold stores is a continous process and this situation necessitates the cold store door to be in open condition for a long time and ultimately leads to raise in the cold storage temperature to untollerable limits. A temperature rise of upto -10°C is noticed in some of the plants. This will hamper the quality of the products. To prevent temperature rising while stocking and shipment a new model door for the cold store is suggested. The design of the door is given in Fig.2. The new design has a 'mini door' fixed at the centre of the main door. Once the workers enter the store through the main door, it can be closed and for the movement of the material the 'mini door' can be opened. This helps in preventing the cold air from diffusing out of the store and minimizes the temperature fluctuation.

The cold stores are provided with separate ante-rooms and the stored materials can be taken out directly from the anteroom to the outside through separate door provided for this purpose. This helps to reduce handling of the frozen products during shipment.

3.2.2.7. Movement of material/in-process material in the processing plant :-

The raw material enters the plant at the purchase section. The raw material should not be allowed to enter the processing plant through any other passage or entry point. After inspection and weighment, the material is stored in the raw material store. Later it is taken to the pre-processing hall for pre-processing. The thoroughly washed, cleaned and sorted material is either taken to the chill room for temporary storage or to the processing hall directly depending upon the availability of processing facilities as well as the priority rule suggested.

In chill room the material is mixed with crushed ice and stored there till its turn comes for processing. The material is taken to the processing hall when needed for processing. In the processing hall the material moves to different stations as shown in the figure 1. Once the material is checked for quality, weighed and packed in freezer trays, it is taken to the freezer for freezing. After freezing the material is immediately taken to the master cartoning section where the frozen slabs are packed in master cartons and sealed. The sealed master cartons are immediately stored in the cold store. The freezer is maintained at -40°C and the cold stores at -18°C - -23°C.

In this improved layout, no where in the production process the in-process material is reverse in movement. The material is received on one side of the plant and the product is taken out for shipment from the opposite side. This completely eliminates the chance of cross contamination.

3.2.3. Acceptability of the improved layout

The results of the test carried out for comparing the acceptability of the improved layout with that of the existing ones are given in Tables 1 and 2. The improved layout scored maximum for all the factors considered for comparing the acceptability of the layouts. The scores for factors like 'minimum holding time and handling of the materials' , 'shortest process cycle time' and 'better man power utilization' were very high for the improved layout.

TABLE: 1.

AVERAGE SCORES GIVEN BY THE TEST PANEL FOR DIFFERENT FACTORS CONSIDERED FOR TESTING THE ACCEPTABILITY OF LAYOUTS

Factors	Improved layout	Layout of existing factories							
		1	2	3	4	5	6	7	8
Minimum holding time and handling of materials	10	3	6	6	8	6	5	4	2
Shortest process cycle time	12	7	4	5	6	5	4	5	2
Better man power utilisation	15	3	4	4	6	5	5	4	4
Minimum possibility of cross contamination & quality problems	10	4	4	7	7	5	4	5	4
Minimum cost of production and wastage	8	4	3	7	6	6	5	4	7
Better utilisation of facilities	9	6	6	5	5	5	5	5	4

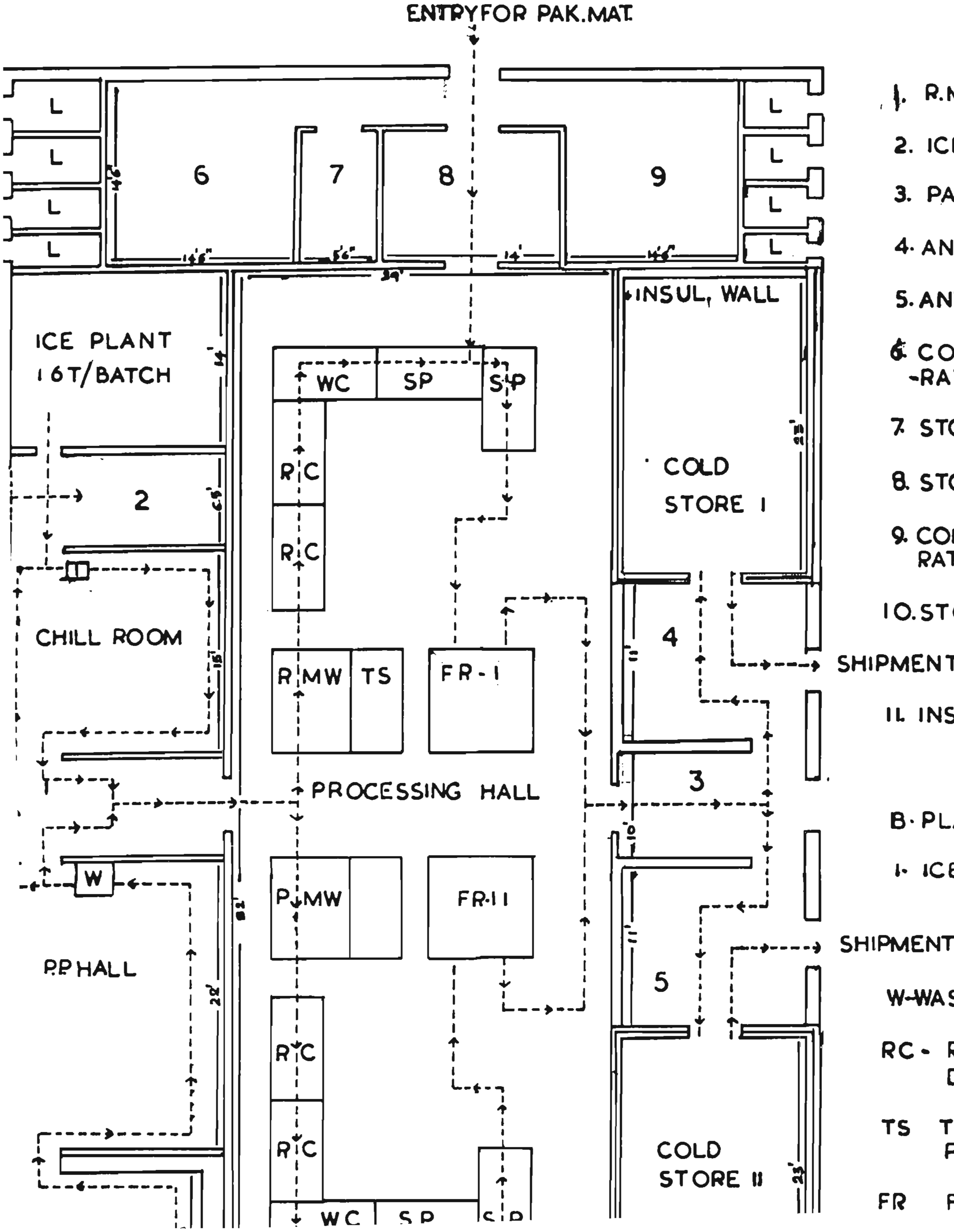
TABLE: 2.

THE RATED VALUES OF THE AVERAGE SCORES FOR DIFFERENT FACTORS CONSIDERED FOR TESTING.THE ACCEPTABILITY OF LAYOUTS

Factors	Improved layout	Layout of existing factories							
		1	2	3	4	5	6	7	8
Minimum holding time & handling of materials	250	75	150	150	200	150	125	100	50
Shortest process cycle time	300	175	100	125	150	125	100	125	50
Better man power utilisation	300	60	80	80	120	100	100	80	80
Minimum possibility of cross contamination & quality problems	150	60	60	105	105	75	60	75	60
Minimum cost of production and wastage	80	40	30	70	60	60	50	40	70
Better utilisation of facilities	45	30	30	25	25	25	25	25	20
Total rated score	1125	440	450	555	660	535	460	445	330

IMPROVED LAYOUT FOR A FISH PROCESSING (FREEZING) PLA

(SHOWING THE MOVEMENT OF RAW MATERIAL IN THE PLANT)

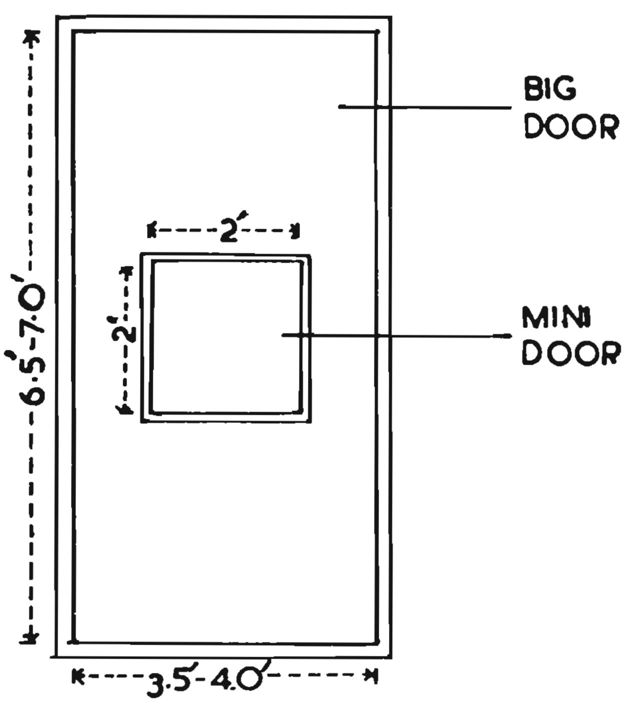


1. R.M.STORE.
2. ICE STORE.
3. PACKAGING S
4. ANTEROOM. I.
5. ANTEROOM. II.
6. COMPRESSOR/ -RATOR ROOM.
7. STORE FOR O
8. STORE FOR P
9. COMPRESSOR/ RATOR ROOM.
10. STORE FOR P
11. INSPECTION R

B. PLATFORM BAL
I. ICE CRUSHER.
W-WASHING MACHI
RC - R.M.CHECKING DRAINING ST
TS TEMPORARY S PLACE.
FR FREEZER

FIG.2.

IMPROVED DESIGN OF COLD STORE DOOR



PRODUCTIVITY STUDY IN SEAFOOD PROCESSING INDUSTRY

1. INTRODUCTION

"The productivity is the path, the only path for everyone's prosperity". Productivity Management in India is a very complex problem due to the various problems like politically conscious labour force, individualistic management, out dated technology, Government policies, etc. Improvement of productivity is a pre-condition of economic progress for us because it alone has the employment potential, it alone can produce the goods that will be purchased by the people as their income multiply; it accounts for the major portion of the Government's revenue; it has the capacity to earn valuable foreign exchange because of its export potential. Higher productivity is required for the survival of the Industry. Productivity for the business would mean cutting down costs and hence giving higher profits (Gupta, 1985).

Freezing is one of the most important methods of processing fish and fishery products. On an average (1981-1985) 86.4% of the total exports of marine products from India is in this form (Anon.,1985 c). Freezing was introduced for the first time in India in 1953 (Govindan, 1972). The first freezing plant was set up in Cochin and the export in 1953 was to the tune of 13.3M.tons worth Rs. 57,740/-. At present Kerala, the pioneer state has 104 freezing factories out of the total 275 factories in India (Iyer, et al., 1981). This,on the whole, shows the importance of this method of preservation in the industry. It is comparatively cheaper when compared to canning or other sophisticated methods like freeze drying. Shelf-lifes of frozen products are high and depends on the inherent nature of the species and the initial quality of the fish. The following list gives the shelf-life of different frozen products stored at -18°C.

Product	Shelf-life (months)	Reference
Frozen crab meat	8	Anon. (1968)
Frozen clam meat	9	Anon. (1969)
Frozen seer and tuna chunks	8	Anon. (1971)
Frozen hilsa	5	Anon. (1975)
Frozen squid	5	Anon. (1976)
Indian salmon (frozen)	6	,, ,,
Sail fish fillet ,,	5	Anon. (1977)
Thread fins ,,	6	Anon. (1978)
Pellona ,,	6	,, ,,
Frozen chirocentrus	6	,, ,,
Ribbon fish fillet (frozen)	6	,, ,,
Cat fish fillet ,,	4-5	,, ,,
Frozen milk fish (Chanos chanos)	5-6	Anon. (1979)
Frozen pearl spot (Etroplus spp.)	10	Anon. ,,
Frozen skinless fillet of perch	8-10	,, ,,
Thread fin bream(frozen)	,,	,, ,,
Jew fish (frozen)	,,	,, ,,
Frozen shark fillets	8	Anon. (1980)
Frozen sole fish	5	Anon. (1982)
Mackerel (frozen)	8	Anon. (1983)

By freezing and cold storage, the main agents of spoilage -

enzymes, bacteria and physical damage are arrested. The process does not require great skill for the wokkers, like that required for canning, smoking or freeze drying. The production cycle time is shorter and quicker than that of any other modern methods.

No previous study has been conducted on the productivity of seafood processing industry in India. Published data on the subject related to seafood industry is scanty.

Iyer, et al (1981; 1982; 1985) have surveyed the fish processing(freezing) plants of the West and East Coasts of India to estimate the capacity utilisation of fish processing plants. Their study was confined to the capacity utilisation of installed freeing capacity alone. They have not studied the capacity utilisation at different stages of processing or utilisation of labour force. As per their study, during 1978-1979 period, the capacity utilisation of plants in Kerala was only 17%.

Mahajan and Chaudhary (1984) conducted a study on the productivity of the pasteurisation section in the beer manufacturing factory. They have analysed the present method of beer bottling, monthly percentage loss of time due to failure in power, water, steam, air supply or due to break down. He also worked out the present pasteurisation cycle time of beer processing and proposed improvements in productivity by modifying the arrangement of the internal facilities ofthe plant.

Khan (1984) suggested improvement of produc/tivity in Foundries through Management Information System. He pointed out that in a developing economy where non-availability of resources is a commom phenomenon, we cannot afford to indulge in the luxury of injudicious use of those that are available. We have to learn to conserve our wealth, invest it wisely and ensure its best utilisation. In his study he explores the reason for low productivity in Foundries and suggests improvements through the introduction of various reports pertaining to production like daily production report, Idle time Analysis, Leave/Absenteeism Analysis, Report of Productivity of machine equipments etc.

1.1. Importance of fish purchasing :-

Purchase is one of the important functions in the seafood processing plants. The main constraint faced by all the processors in the seafood industry is the inadequate and irregular supply of raw materials. Unlike in other industries, the raw materials cannot be purchased and stored for long term use due to its very short shelf-life. Fishes start spoiling within 5 - 6 hours after catch if no preservative is used. Even with the common preservative ie. ice, the quality cannot be retained much longer. So the seafood industry has to resort to daily purchase of raw materials. This situation along with the wide fluctuation in fish landings and severe competition keeps purchasing the most critical function in the seafood industry. This shows the importance of the purchase decisions on the success of the firm. Any mistake or delay in the purchase of raw materials will lead to loss of quality due to spoilage.

The present state of performance of many freezing plants in Kerala and elsewhere in India are not satisfactory. Every year some of the firms are becoming extinct and more and more firms are becoming sick. Till date no attempt was made to conduct a study on the various aspects of productivity in the seafood processing industry in India. Hence the study was carried out to understand the degree of productivity in seafood processing (freezing) industry in Kerala. Measures to improve the same are suggested for the better economic benefit of the individual processor and the industry.

2. DATA AND METHODOLOGY

The methodology of sampling of the processing plants and sample size selected for the study are decribed under the chapter on 'Data Source and Methodology'. The primary and secondary data required were collected as described in that chapter.

For a detailed study on the raw material arrival pattern in processing plants, four plants in Cochin region were selected at random. The data on the quantity of raw materials arrived in these plants on 5th,10th,15th, 20th, 25th and 30th of every month were collected for a period of two years (1983 and 1984).

Data on the monthwise production and export (quantity and value) of various products produced in the plants selected for the study were collected from the concerned documents for a period of two years. The cold storage holdings of five randomly selected plants in Cochin region were observed on 15th and 30th of every month during 1983 and 1984.

The fluctuations in the process cycle time (Time taken between raw material entry into the processing hall and the loading of the finished products made out of it in the cold store) of Frozen Headless Shrimp and Frozen Peeled and Undeveined Shrimp were observed at random using a stop watch. The average, range and standard deviation were calculated as described by Dixon and Massey (1983).

3. OBSERVATIONS, RESULTS AND DISCUSSION

3.1. Organisational set up :- The organisational set up of the processing plants varies depending on the size of the processing plants. Most of the processing factories are partnership concerns and some are limited companies. The overall control of the factory rests with the partners or board of directors as the case may be. In most of the plants one of the partners/ board of directors work as full time Managing Director. The managing director is assisted by a factory manager. Factory manager is assisted by a production manager to look after the various activities of production. Under production manager there are technologists and supervisors to carry out the day to day functions in the purchase and production departments. The actual processing work is carried out by skilled workers who are either staff of the factory or are working on contract. The laboratory of the processing factory is headed by a chief technologist who is reporting to the factory manager. The chief technologist is assisted by one or more assistant technologists.

3.2. Source of raw materials

Each factory in the industry has some quantity of reliable supply. No supplier or landing centre can supply the required raw materials in sufficient quantities. So plants have to procure the raw materials from various landing and pre-processing centres. The major part of the raw materials received by the plants are in pre-processed form. For example in the case of prawns, the beheading, peeling and deveining are done at the peeling sheds which are located close to the landing centres. In the case of lobsters, the cooking is usually done at the landing centre itself to avoid spoilage. But in some factories pre-processing of shrimp and other materials are done in their own peeling sheds. The important supply centres for the factories in Kerala are:

Ambalapuzha, Neendakara-Shakthikulangara, Aroor, Cochin Fishing Harbour, Kalikavillai, Kozhikode, Vizhinjam, Colechal, Vypeen, Tuticorin, Mangalore, Thirichandur, Kanyakumari, Cannanore, Kannamaly, and numerous other minor centres

(Details regarding the mode and means of procurement of raw materials have already been discussed under the chapter on 'Location of seafood industry'.)

3.2.1. Raw materials:- The important fish items used by fish processing plants in Kerala for the production of various products are:

1. Prawns:- The important species used are *Penaeus indicus* (Naran), *P. monodon* (Tiger), *P. semisulcatus* (Flower), for the production of Frozen Headless Shell-on Shrimps; *Metapenaeus dobsoni* (Poovalan), *M. affinis* (Choodan), *M. monoceros* and *Parapenaeopsis stylifera* (Karikadi) for the production of Frozen Peeled and Deveined Shrimps and Frozen Peeled and Undeveined Shrimp.

2. Squids :- *Loligo duvaucelli* is the common species available in South West Coast of India. This is used for the production of Frozen whole squid and Frozen Squid tubes.

3. Cuttle fishes :- The major species used/available is *Sepia pharaonis* while some quantity of *Sepioteuthis spp.* are also available in Kerala for the production of cuttle fish products like Frozen Whole Cuttle Fish and Frozen Cuttle Fish Fillets.

4. Frogs :- Frogleg was one of the important items exported from India. The important species which contributed to this trade was *Rana hexadactyla*. But recently frogleg export has been banned completely due to the inclusion of frogs under Wild Life Protection Act. Parliament of India also made

legislation to this effect in 1987.

5. Lobsters :- *Panulirus homarus* and *P. ornatus* are the spiny lobsters available in the South West Coast of India. This along with *Thenus spp.* (Sand lobster) are being used for the production of Frozen Whole Cooked Lobster and Frozen Lobster Tail.

6. Clams :- *Katelaysia opima* and *Villorita cyprinoides* are the main species used. The other species available in Kerala are *Meritrix meritrix*, *M. lusaria*, *M. casta*, *Marmorata sp.* and *Paphia malabarica* .

3.2.2. Grades of raw materials and purchase price :- The grades and average purchase price (1984) of raw materials are summarised below :

1. Prawns

Peeled and Deveined Shrimp (PD)

Grades (per lbs.)	Purchase price (Rs./Kg.)
91 - 110	59.50
110 - 130	49.00
130 - 200	42.50
200 - 300	32.50
300 - 500	26.50

Peeled and Undeveined Shrimp (PUD)

80 - 120	48.50
100 - 200	37.50
200 - 300	31.75
300 - 500	25.50
Broken	9.00

Headless Shell-on Shrimp (White)

Grades	Purchase price (Rs./Kg.)
16 - 20	112.50
21 - 25	108.00
26 - 30	87.50
31 - 35	59.00
36 - 40	57.00
41 - 50	48.00
51 - 60	39.50
61 - 70	29.50

Headless Shell-on Shrimp (Brown)

16 - 20	88.00
21 - 25	83.50
26 - 30	69.50
31 - 35	64.00
36 - 40	64.00
41 - 50	52.50
51 - 60	49.50
61 - 70	46.50
71 - 90	35.50

2. Cuttle fish (unsorted)	3.50
3. Squid ,,	4.00

4. Lobster tail

Count	
U/1	9.00
1/2	32.00
2/4	65.00
4/6	70.00

6. Whole Cooked Lobster

Count	
U/80,80/100,100/150,150/200,	85.00
200/250, 250/300, 300/350,	,,
350/400	,,

	Rs. Ps.
6. Clam meat	2. 50
7. Ribbon fish	1. 50

3.2.3. Other raw materials used in the processing division

The other inputs in the production process and its average unit purchase price (1984) are given below:

Sl.No	Item	Unit purchaseprice (Rs.)
1.	Master carton (shrimp)	8.00/Carton
2.	Master carton for Lobster tails	10.00/ ,,
3.	Master carton for fish items	8.00/ ,,
4.	Master carton for Cuttle fish/ Squid	8.00/ ,,
5.	Baby carton for Lobster (10 lbs.)	4.50/ ,,
6.	Waxed carton	1.00/ ,,
7.	Polythene sheets	38.00/ Kg.
8.	High Density Polythene for lobster packing	45.00/ Kg.
9.	Gar strap/Polythene strap	90.00/1000 M
10.	Clip for master carton sealing	30.00/1000 Nos.
11.	Chlorine	2.00/Litre
12.	Teepol	7.00 ,,
13.	Marker	5.00/piece

3.2.4. Raw material Procurement pattern :-

Purchasing is done sometimes at the various landing and pre-processing centres and after agreeing upon the rates, the raw material is taken to the plant. The supervisor or technologist or any other person authorised by the company assess the organoleptic quality of the raw material before purchasing. (Only organoleptic evaluation is done at this stage) It is then washed, any ice particles removed and allowed to drain in wire baskets or plastic net type baskets. From this random sampling of one kilogram is taken out of every 250 kilograms or part there of. The weighment is done and the weighed material is taken to the chill room for storing till the processing facilities are available. If the processing facilities are already available, the raw material goes directly to the processing hall for further processing.

The local peelers/pre-processors who are handling small quantities of raw materials, sell their pre-processed material directly to the nearby processing plants. Some times long queue of such suppliers are seen in front of the purchase section of the processing plants. The plants publish the price list every day in the purchase section and those who are satisfied with the price sell their commodity to the plant.

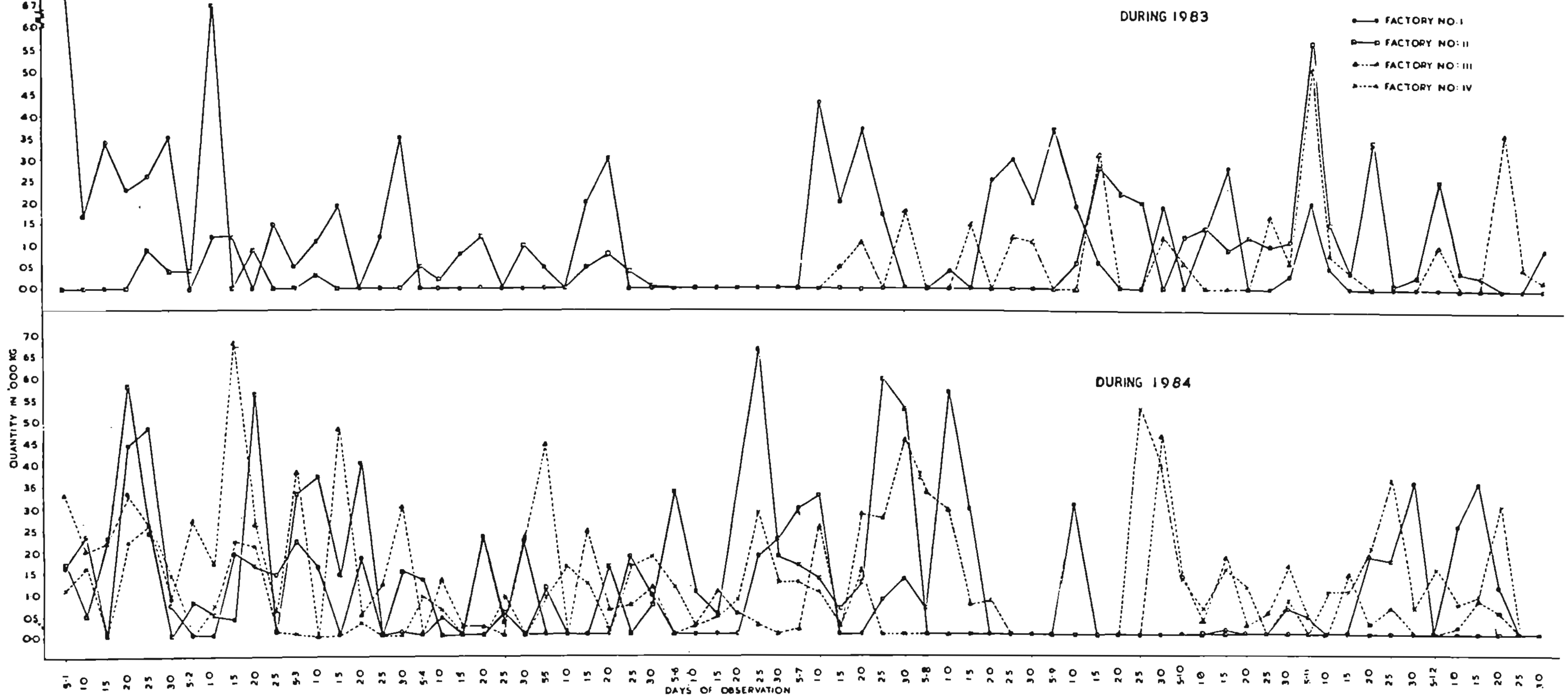
About 80% of the plants studied procured their raw materials only after obtaining the purchase order from the buyers abroad.

At times, some companies used to buy raw materials directly from the landing centre in lots which are peeled at their own peeling sheds or at peeling sheds arranged on lease or rent.

3.3. IN-DEPTH STUDY OF THE PURCHASE PATTERN

The two years study (1983 and 1984) shows that there are wide fluctuations in the daily purchase quantity of different raw materials in all the plants studied. The daily purchase pattern of raw materials in the plants are given in Figure 1. The most important observation is that when a plant was having

FIG.1. RAWMATERIAL PURCHASE PATTERN IN FOUR SEAFOOD PROCESSING PLANT IN COCHIN REGION DURING 1983-84



peak arrival(purchase) of raw material on a particular day, some other plants in the same locality had no arrivals at all. In all the plants, the main item of purchase was confined to shrimp. In all the plants,the raw material purchased was found to be far below the daily requirements. In plant No. 1, out of the total working days, only 0.72% of the days it received sufficient quantity of raw materials for the full utilisation of the capacity(freezer capacity) whereas in plant No.4, it was found to be 4.4%. In the remaining plants, the raw material purchase on all days was far below the requirement. The table 1 gives the percentage frequency distribution of days when no purchase was noticed. In plant No.1, on 52.11 and 42.65% of the days the plant was found to have nil purchase during 1983 and 1984 respectively. The combined cumulative average of 39.16 % of the days the plants made no purchase. This shows the shortage of raw materials and competition prevailing in the field.

3.4. EXPENDITURE ON VARIOUS INPUTS OF PRODUCTION

The details of the annual expenditure incurred on various inputs are given in Table 2.

3.4.1. Fish purchase :- The expenditure on the purchase of fish items is the single largest component of operational costs. The data from five fish processing plants shows that about 76.5 % of the total operational costs goes for fish purchase alone, the range observed being 57 to 89 %. This wide range of expenditure on fish purchase was due to the selectivity of the processors in the purchase of fish items. Some plants concentrate

TABLE: 1.

NUMBER OF DAYS IN 1983 and 1984 WHEN NIL PURCHASE WAS OBSERVED IN FISH PROCESSING PLANTS IN COCHIN REGION

Factory No.	No. of observation		No. of days when nil purchase was observed		Percentage No. of days when nil purchase was observed		Combined Average %
	1983	1984	1983	1984	1983	1984	
1.	71	68	37	29	52.11	42.65	47.38
2.	71	68	34	29	47.89	42.65	45.27
3.	36	68	18	13	50.00	19.12	34.56
4.	-	68	-	20	--	29.41	29.41
Cumulative average for all the plants during 1983 and 1984							39.16

TABLE : 2

PATTERN OF EXPENDITURE ON VARIOUS INPUTS IN FIVE SEAFOOD PROCESSING (FREEZING) PLANTS IN KERALA DURING 1983-84

Sr. No.	Item	FAC I Rs./%	FAC II Rs/%	FAC III Rs/%	FAC IV Rs/%	FAC V Rs/%	Combined Average %	Range %	STD Deviation.
1.a.	Cost of Raw Fish	1,28,10,600	1,04,00,250	5,32,00,000	3,00,01,325	6,24,00,000	76.47	56.52-88 90	12.86
b.	Percentage share on operational cost (O.C)	77.35	56.52	87.05	77.51	88.90			
2.a.	Cost of polythene	72,000	-	-	1,73,050	2,49,600	0.41	0.36- 0.45	0.05
b.	% Share on OC	0.43	-	-	0.45	0.36			
3.a.	Cost of straps & clips	13,000	-	-	35,420	74,400	0.09	0.08- 0.106	0.013
b.	% Share on OC	0.08			0.09	0.106			
4.a.	Cost of duplex cartons	1,82,000	-	-	2,15,000	8,72,000	0.97	0.56- 1.24	0.359
b.	% Share on OC	1.10			0.56	1.24			
5.a.	Cost of Master Cartons	1,93,000	-	-	3,48,280	9,98,400	1.16	0.90- 1.42	0.260
b.	% Share on OC	1.16			0.90	1.42			
6.a.	Total cost of packing materials (items 2-5)	4,60,000	3,99,750	15,00,000	7,71,750	21,94,400	2.51	3.13	0.452
b.	% Share on OC	2.78	2.20	2.45	2.00	3.13			
7.a.	Cost of chemicals	3,737	-	-	-	-			
b.	% Share on OC	0.024							
8.a.	Cost of Refrigerants	3,923	8,000	1,00,000	25,000	-	0.07	0.024- 0.16	0.06
b.	% Share of OC	0.024	0.043	0.16	0.065	-			
9.a.	Cost of salt	6,768	-		-		-		
b.	% Share on OC	0.041							
10.a.	Cost of Electricity	43,038	1,20,000	2,50,000	1,49,590	1,99,680	0.40	0.26- 0.65	0.155
b.	% Share on OC	0.26	0.65	0.41	0.39	0.28			
11.a.	Inspection fee and cess	32,000	20,000	1,00,000	75,620	1,04,400	0.16	0.11- 0.19	0.033
b.	% Share on OC	0.19		0.11	0.16	0.19	0.15		
12.a.	Wages of processing staff	84,000	59,600	4,00,000	3,55,875	3,74,400	0.59	0.32- 0.92	0.221
b.	% Share on OC	0.51	0.32	0.65	0.92	0.53			
13. a.	Cost of Ice	1,56,000	60,000	-	1,10,382	-	0.52	0.29- 0.94	0.364
b.	% Share on OC	0.94	0.33	-	0.29				
14.	Other Items	25,00,962	73,33,170	55,6[illegible],500	64,45,499	27,23,480			
15.	Total Operational Cost	1,65,61,028	1,84,00,870	6,11,17,500	3,87,06,191	70,190,760			

their purchase and production on high value materials like Headless Shell-on Shrimp, Lobster etc. whereas certain other plants are interested only in low cost raw materials like Peeled and Undeveined Shrimp, Squid, Fish items etc. The share of these raw materials in the total purchase decides the quantum of consumption of financial resources(operational expenditure). The studies conducted by the Indian Institute of Foreign Trade in the later part of 1960's also show similar results. As per their study, the average raw material cost accounted for 77% of the ex-factory costs in the case of freezing and 56% in the case of canning. This is mainly due to the high purchase rate of raw materials prevailing in our country. Increases in the price of raw materials are however, not peculiar to India alone. Even in countries like U.S.A., the prices of raw materials are very high. The prices of raw materials in U.S.A. have registered an increase of 40 to 70% between 1966 and 1969 (Anon., 1970). The average unit purchase prices of various fish items used in fish processing plants are already given above.

3.4.2. Packaging costs :- The packaging costs are constituted by the cost of various packaging materials used for the packaging of products. The various packaging materials used are polythene sheets of different gauges, polythene bags, duplex cartons, master cartons, gar straps or plastic straps, clips, markers etc. The packaging cost constitutes about 2.28% of the total operational cost of the factory. The range was found to be between 2.0 and 4.98% depending upon the packaging style and type of packaging adopted by the plant.

3.4.3. Expenditure on refrigerants :- The main refrigerants used in fish processing plants are Freon-12 and Liquid Ammonia. The expenditure on these inputs was found to be 0.523% of the total operational cost.

3.4.4. Electricity charges :- The electricity power is one of the important inputs in fish processing. It is required at every stage of production. The annual expenditure on electricity was found to be 0.4% of the total operational cost.

3.4.5. Marine Products Cess and Inspection Fee :- The expenditure on Marine Products Cess and Inspection fee are other variable costs involved. It is about 0.43 % of the total operational costs.

3.4.6. Wages of processing staff :- The wages of processing staff (processing workers) was found to be only 0.59% of the total operational expenditure. The range was between 0.32 and 0.92%. The wide variation in the share of expenditure on wages among the factories are mainly due to the difference in employment pattern and variation in labour utilisation. The variation in the raw materials purchase also accounts for it.

3.4.7. Expenditure on ice :- The expenditure on this input was found to be 0.52% of the total operational costs.

3.5. PRODUCTION/PROCESSING SECTION

The general method of freezing followed by the processing plants in Kerala is broadly classified into three stages - 1. Pre-freezing, 2. Freezing, and 3. Post freezing stages.

3.5.1.1. Pre-freezing stage :- This starts with the raw material arrival in the factory. The raw material is washed, dressed and packed in the required manner and set in freezer trays for loading into the freezer.

3.5.1.2. Freezing stage :- The materials set in the freezer trays are loaded into the freezer and frozen at -40°C for three hours in the plate freezer (3 hours is the normal time required for freezing for most of the freezers available in the processing plants in Kerala. But recently a quick freezing contact plate freezer has been introduced by some firms which reduces the freezing time to 90 minutes.)

3.5.1.3. Post freezing stage :- At this stage, the frozen material is unloaded from the freezer and packed in the required packaging material like waxed duplex carton,and then into master cartons and sealed. The sealed master cartons are then stored at-18°C to -23°C in the cold store.

3.5.2. Processing facilities

3.5.2.1. Pre-freezing facilities :- The internal arrangements are oriented for the manual operation of the processes. All the processing plants surveyed have processing tables made of galvanised iron or plastic tubs and cement tanks for storing the raw material in ice. Plastic trays are used for grading and sorting the raw materials. Trolleys are used in some plants to transport the material from various work centres. In other plants, it is being done manually. The entire processing activities are done manually except for washing of P.D. Shrimp in some plants. 66.67% of the plants use washing machine for washing P.D. Shrimp.(But most of the time, even the P.D. Shrimp was found to be washed manually) There is a strict instruction from Government of India that all Peeled and Deveined materials used for Frozen P.D. Shrimp for export to U.S.A. have to be washed in washing machine to avoid problems of filth contamination (Anon., 1984 a). In one of the plants, grading of shrimp was being done in a grading machine. The reason for non-adoption of washing and grading machines in all the other plants is found to be due to the low turnover of the process compared to the otherwise, cheap and speedy manual operations.

3.5.2.2. Freezing facilities := All the processing plants have contact plate freezer/s for quick freezing of the products. 15.4 % of the plants have blast freezers in addition to contact plate freezers. The capacity of the freezers vary with the processing plants. 90.0% of the processing plants have two or more freezers. Galvanised iron trays are used for freezing the materials. The refrigerants used in the freezers and cold stores are either Freon-12 or Liquid Ammonia. 15.4% of the plants have already installed the new type of freezer ('90 minutes freezer'). The temperature during freezing is maintained at -40°C.

3.5.2.3. Post freezing facilities :- Here also the entire facilities are oriented for manual operations. The master cartoning is done on tables. The equipments involved are simple hand tightners, sealers and cutters. The products produced are immediately stored in the cold store. The cold store capacity of the plants vary from 50 to 300 tons. The entire operations of master cartoning, sealing and loading into the cold store are done manually in all the plants.

3.6. CAPACITY AVAILABLE AND CAPACITY UTILISED

The capacity available at the different stages of processing and its utilisation by the plants selected for the study is presented in Table 3. A wide gap is found in the capacities provided at different stages of processing. The freezing stage has low capacity in almost all the plants. But the pre-freezing stage has excess capacity in almost all the plants. This may be mainly due to the bad planning of the line of production. Due to difference in the capacities provided at different stages of production, flow of processing cannot be smoothened. This shows that none of the plants have a balanced layout. Due to the excess capacity at the pre-freezing stage, the material usually accumulates at the end of this stage for want of freezer facilities for further processing. This temporary delay at this stage will seriously affect the quality of the product because the in-process material at this stage will be at room temperature. The higher temperature will affect the multiplication of microorganisms and induce enzymatic spoilage. Curran, et al.(1980) studied the shelf-life of gold-lined sea bream(Rhabdosargus sarba) at 0°C (in ice) and 10°C and found out that at 10°C the rate of spoilage is approximately five times greater than at 0°C. Curran, et al. (1981) studied the shelf-life of thread fin bream (Nemipterus - japonicus) stored at 0°C (in ice), 5°C and 10°C. They found that

TABLE : 3

TABLE SHOWING THE CAPACITY AVAILABLE AND CAPACITY UTILISED AT DIFFERENT STAGES OF PROCESSING IN SEAFOOD PROCESSING PLANTS SELECTED FOR THE STUDY DURING 1984 AND 1985.

PRODUCTION AND CAPACITY IN TONS/DAY

Factory No:	Pre-freezing capacity (X)	Freezing Capacity	Post freezing capacity (XX)	AV.Daily Production in 1984	AV.Daily PDN.in 1985	Combin- AV. (1984+ 1985)	Percentage Capacity Utilization Pre-Freezing stage	Freezing stage	Post freezing stage
01	9.72	3.50	7.10	1.03	0.62	0.82	8.43	23.54	11.55
02	9.72	5.00	7.10	1.00	1.24	1.12	11.52	22.50	15.77
03	12.15	7.50	7.10	1.85	1.56	1.71	14.07	22.50	24.08
04	24.30	10.00	14.10	0.88	0.72	0.80	3.29	8.01	5.71
05	14.58	7.00	7.07	0.86	0.52	0.69	4.73	9.98	9.75
06	6.00	2.50	7.07	0.002	0.00	0.001	0.0002	0.04	0.0014
07	6.00	6.00	7.07	0.93	0.96	0.94	15.67	15.73	13.30
08	29.16	27.00	14.10	0.00	0.00	0.00	0.00	0.00	0.00
09	24.30	13.00	14.10	-	-	-	-	-	-
10	21.00	20.00	21.10	3.78	2.90	3.34	15.90	16.70	15.82
11	22.00	11.50	14.10	5.98	4.43	5.20	23.64	45.24	36.88
12	-	6.00	-	-	-	-	-	-	-
13	-	15.02	21.10	5.46	5.85	5.66	-	38.83	26.92

(X) Pre-freezing capacity is worked out as follows:- As per the work study the average turnover per processing worker is worked out to be 0.2025 tons per shift. Hence the total available worker space on the processing plants (maximum number of workers which can be accomodated) is multiplied with 0.2025 to get the capacity of pre-freezing facility on one shift. Two shifts capacity is considered as per day capacity.

(XX) The post freezing capacity is worked out as follows:- The turnover of two workers with a Single Master Carton line is worked out to be 1555.2 slabs/shift. Hence for two shifts turnover is 3110.4 slabs. The average R.M. requirement for producing 3110.4 slabs is about 7.07 tons. This figure is taken to calculate capacity at the post freezing stage.

thread fin bream spoiled twice as fast at 5°C and 4 times as faster at 10°C compared to 0°C. In fish processing, the longest and the most critical activity is the freezing process. Normally it takes 3 hours to freeze the product whereas the pre-freezing stage requires only 25 to 45 minutes and post freezing stage even lesser time than that required for the pre-freezing stage.

No work study or work measurement has been carried out so far in the seafood processing industry in Kerala. This was the main reason for providing an unbalanced line of facilities in most of the plants. The private entreprenurs developed the facilities based on their experience and knowledge in the field

3.7. MONTHWISE PRODUCTION IN SELECTED PLANTS

The factories do not show consistency in production. There are wide fluctuations in production even within a short period. Plants showing peak production in a particular month do not show the same trend the following year. This is mainly due to the shift in the fishing season or fish landings.

The monthwise average daily production of factory No.1 during 1984 and 1985 are presented in Fig.2. This plant showed peak production in July, 1984 with an average daily production 2,344 Kg. whereas in July, 1985 the production was just half the quantity of that in the previous year. In January, 1984, the factory showed a daily average production of 1,887 Kg whereas in 1985 during the same period production was nil. The existing freezing capacity of the plant during the study period was 3.5 tonnes/day.

Fig. 3 gives the monthwise average daily production of plant No.2 during 1984 and 1985. The maximum average daily production of 1,531 Kg. was obtained in October, 1985. But the corresponding production in the previous year was only 406 Kg. In May the plant produced the minimum in both the years. The freezing capacity of the plant during the period was 5 tonnes/day.

Fig. 4. gives the monthwise average daily production of plant No. 3. This factory had a peak production in August, 1984 and in June, 1985. The production being 3,866 and 3,404 Kg. respectively. In December, 1985 the production was nil. The freezing capacity of the plant was 7.5 tonnes/day.

Fig. 5. shows the monthwise average daily production of plant No.4. This factory showed an overall low productivity throughout the study period. The most productive period for the factory was April, 1985. The average daily production was 2,996 Kg. In November, 1984 there was no production and in December it was negligible. The capacity of the freezer during the study period was 10 tonnes.

The monthwise average daily production of factory No.5 is presented in Fig.6 . This factory also had very low productivity throughout the study period. In September and October, 1984 and in March, 1985 there was no production in the factory. The freezing capacity of the plant during the study period was 7 tonnes/day.

The factory No. 6 was remaining idle most of the time during the study period . In 1984 there was only negligible

FIG.3.

MONTHWISE AVERAGE DAILY PRODUCTION DURING 1984-85

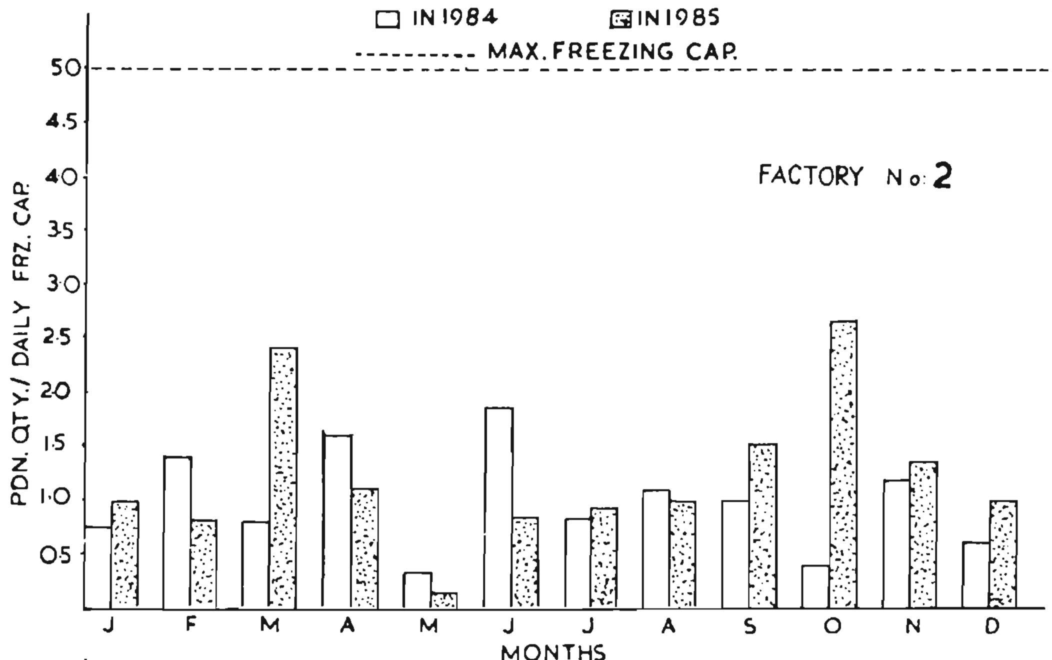


FIG.2.

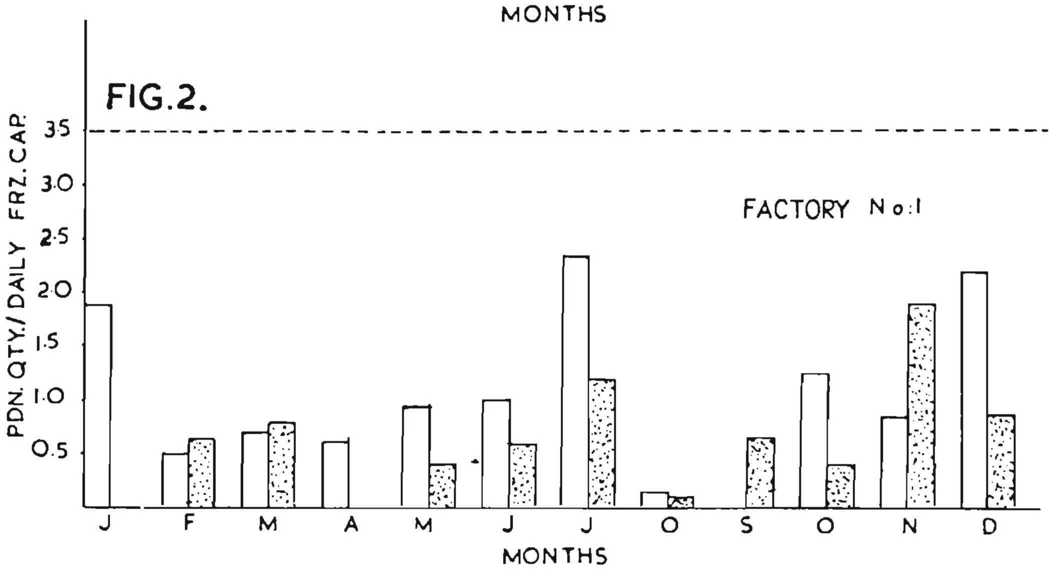


FIG. 5.

MONTHWISE AVERAGE DAILY PRODUCTION DURING 1984 85

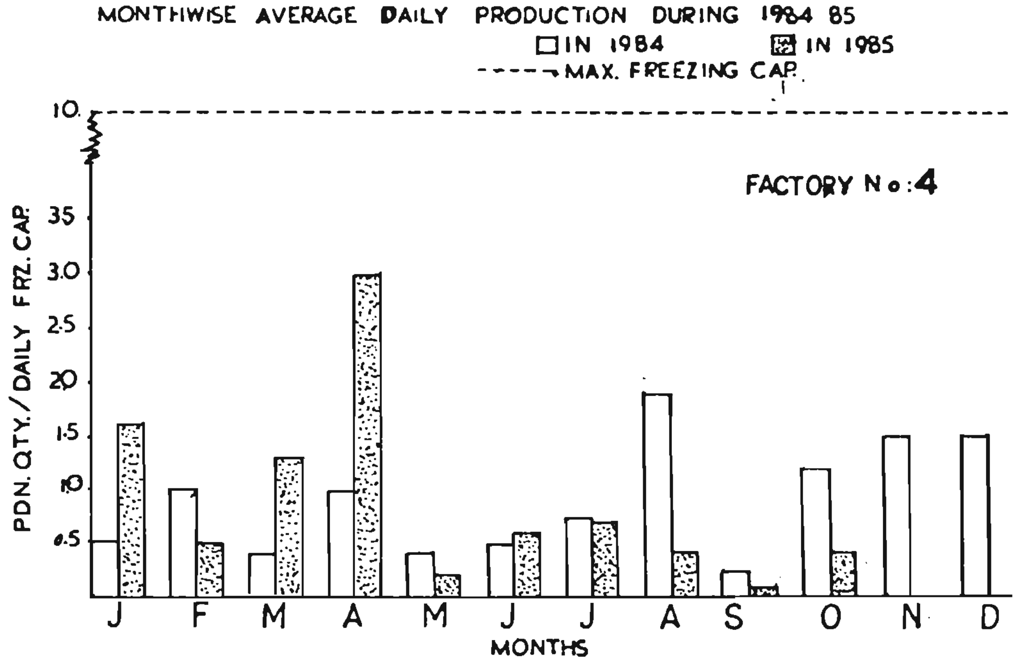
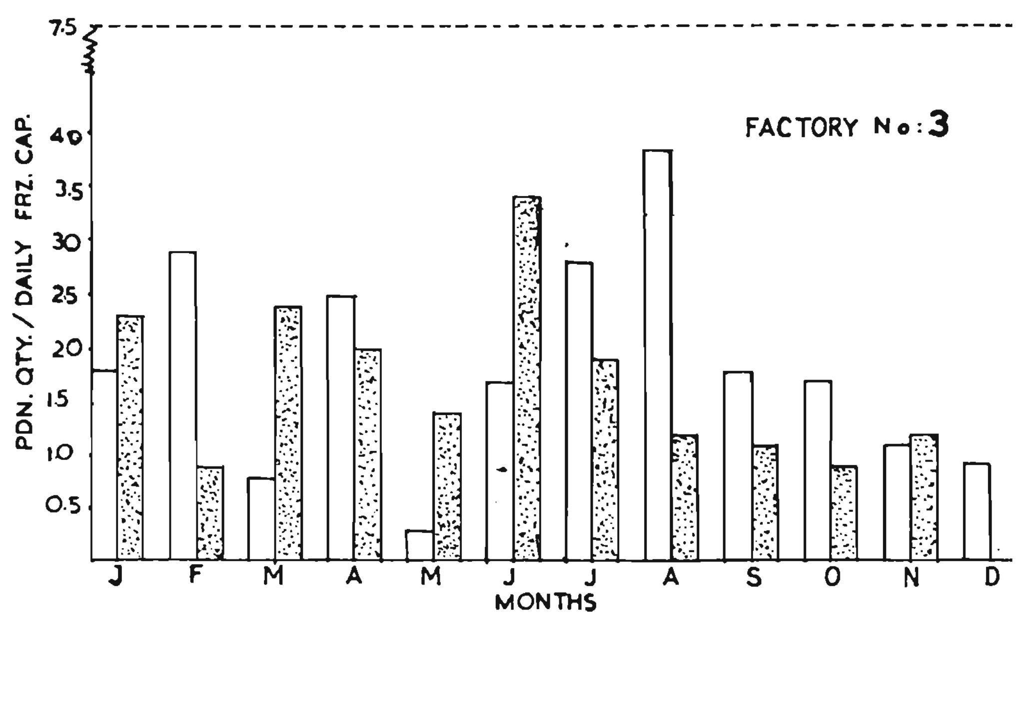


FIG.4.



production and in 1985, the plant was completely idle. The freezing capacity of the plant was 2.5 tonnes / day.

The monthwise average daily production of factory No.7 is presented in Fig. 7. The annual daily average production of the factory during 1984 and 1985 were 927 and 961 Kg. respectively. The peak production was in June,1985 with a daily average production of 2,124.36 Kg. and low production was noticed in September, 1984 with only 172.2 Kg. of average daily production. The freezing capacity of the plant was 6 tonnes per day.

Plant No.8 was lying idle during the entire two year period due to administrative and financial problems.

The plant No. 9 was active till 1983 and thereafter remained closed due to shortage of raw materials, stiff competition and administrative problems.

Fig. 8 gives the monthwise average daily production of plant No.10 during 1984 and 1985. This plant had better production and capacity utilisation than other plants studied. A peak average daily production of 9,324 and 6,037 Kg. were noticed in October,1984 and 1985 respectively. Wide fluctuation in production was noticed in July,1984 and 1985, the average daily production being 5,306.44 and 454 kg respectively. The annual daily average during 1984 and 1985 were 3,781 and 2,895 Kg. respectively.

Fig. 9 shows the monthwise average daily production of plant No.11. The factory showed better management of production

FIG.7

MONTHWISE AVERAGE DAILY PRODUCTION DURING 1984-85

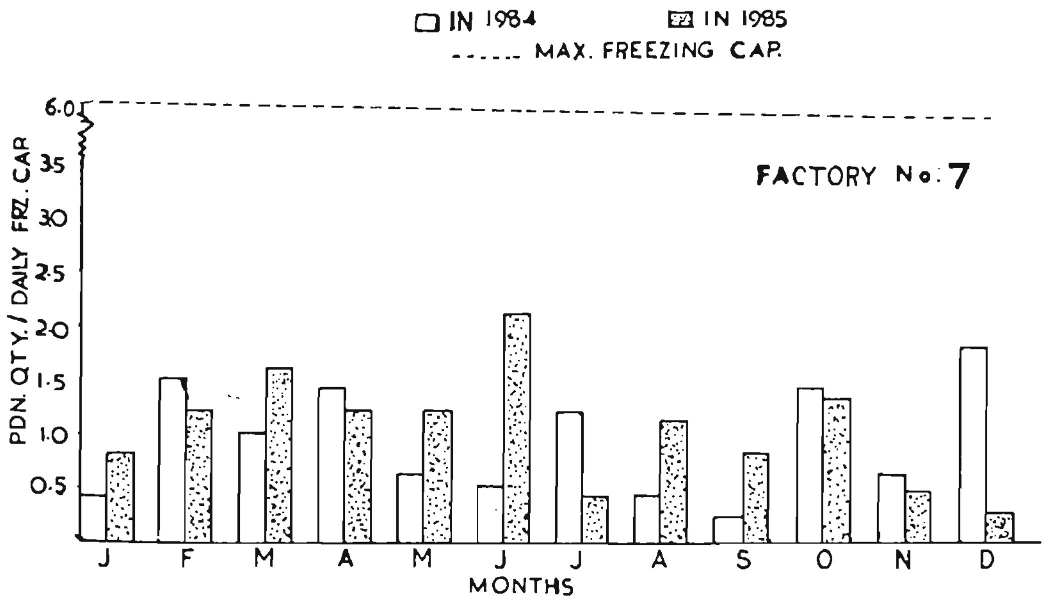


FIG.6.

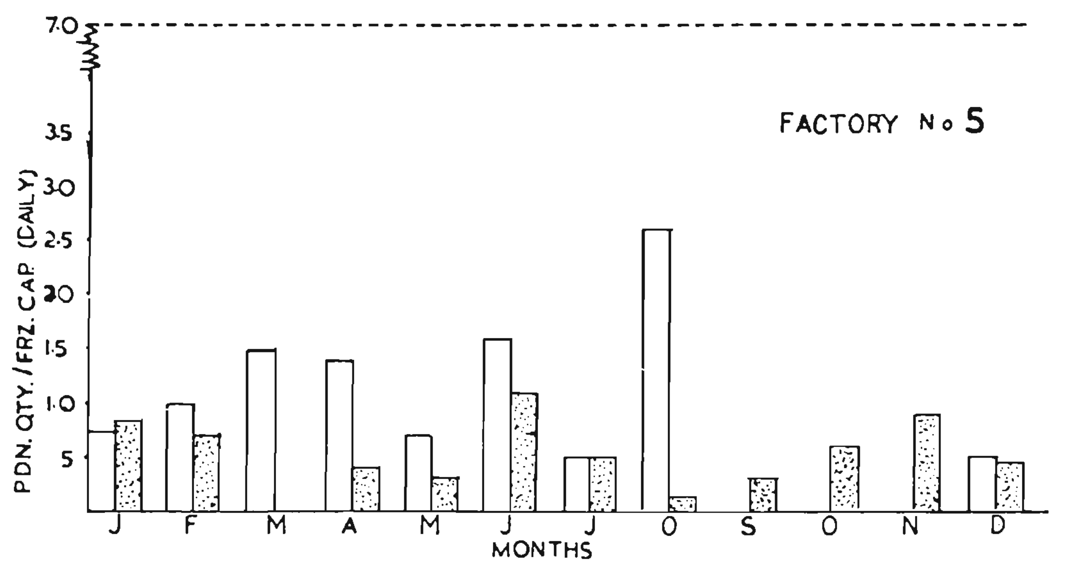
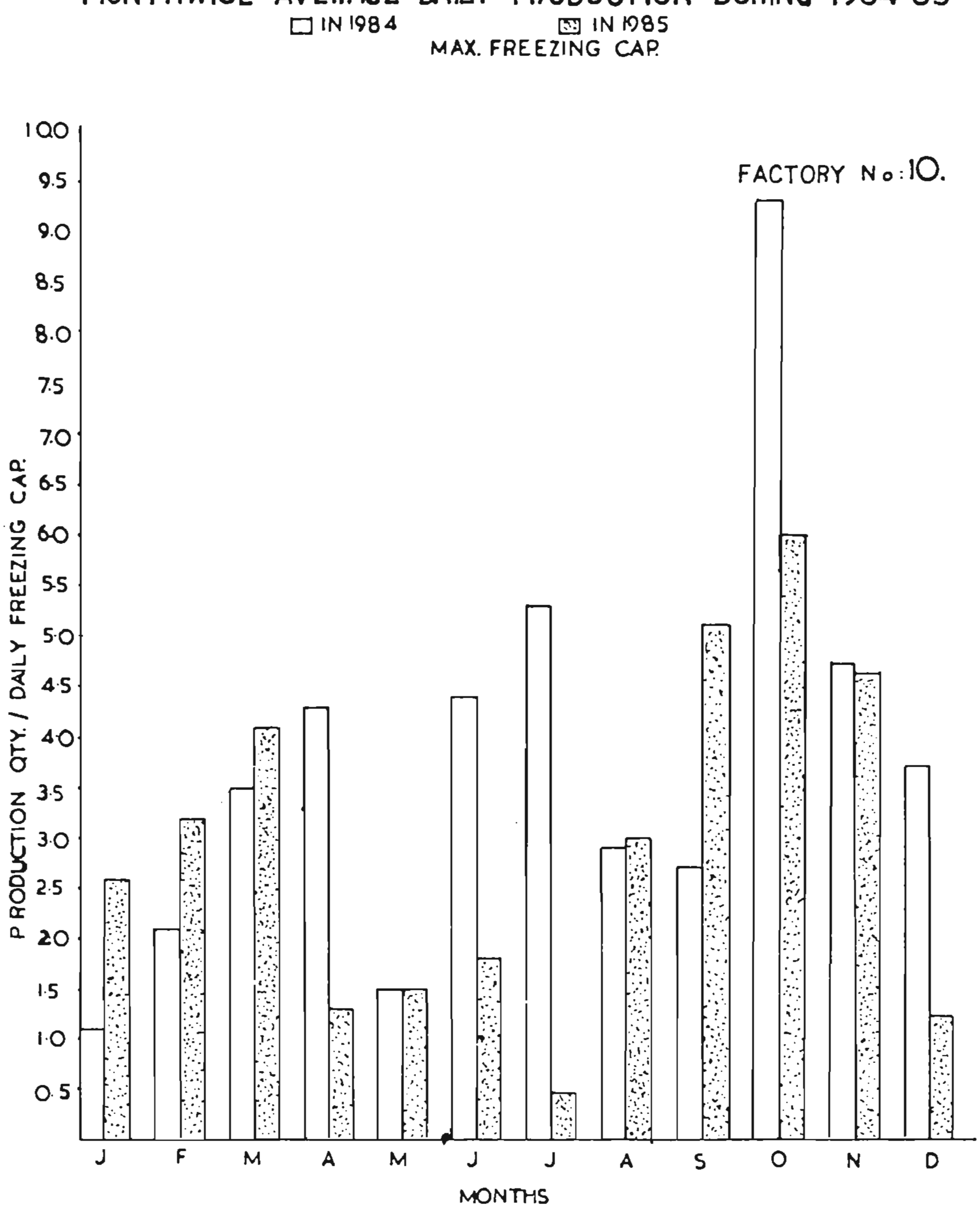


FIG. 8.

MONTHWISE AVERAGE DAILY PRODUCTION DURING 1984-85



with an annual daily average production of 5975 and 4430 Kg. in 1984 and 1985 respectively. The peak production was noticed in April,1984 with an average daily production of 9684 Kg. The daily freezing capacity of the plant during the period was 11.5 tonnes / day.

The Factory No. 12 was completely idle during the study period.

Factory No.13 had a satisfactory level of production throughout the period except for November,1985. The monthwise average daily production during the study period is given in Fig.10. In January and March,1984 and March and June,1985 peak production was noticed, the average daily production being 11,191 Kg, 10,048 Kg., 9,215 Kg. and 10,210 Kg.respectively. The production in January, 1984 for this factory was the record production for the entire factories studied during the two year period. The factory was maintaining a high annual average daily production of 5,460 and 5,850 Kg. during 1984 and 1985 respectively.

The plants in Cochin region (Fig. 2 to 7) are less productive than plants in Quilon (Fig. 8 and 9) and Calicut regions (Fig. 10) due to the following reasons:

1. Lack of product diversification - 92.12% of the total quantity produced during 1984 and 1985 in the plants in Cochin region were shrimp based products alone whereas it was only 87% in plants in Quilon region during the same

FIG. 9.

MONTHWISE AVERAGE DAILY PRODUCTION DURING 1984-85

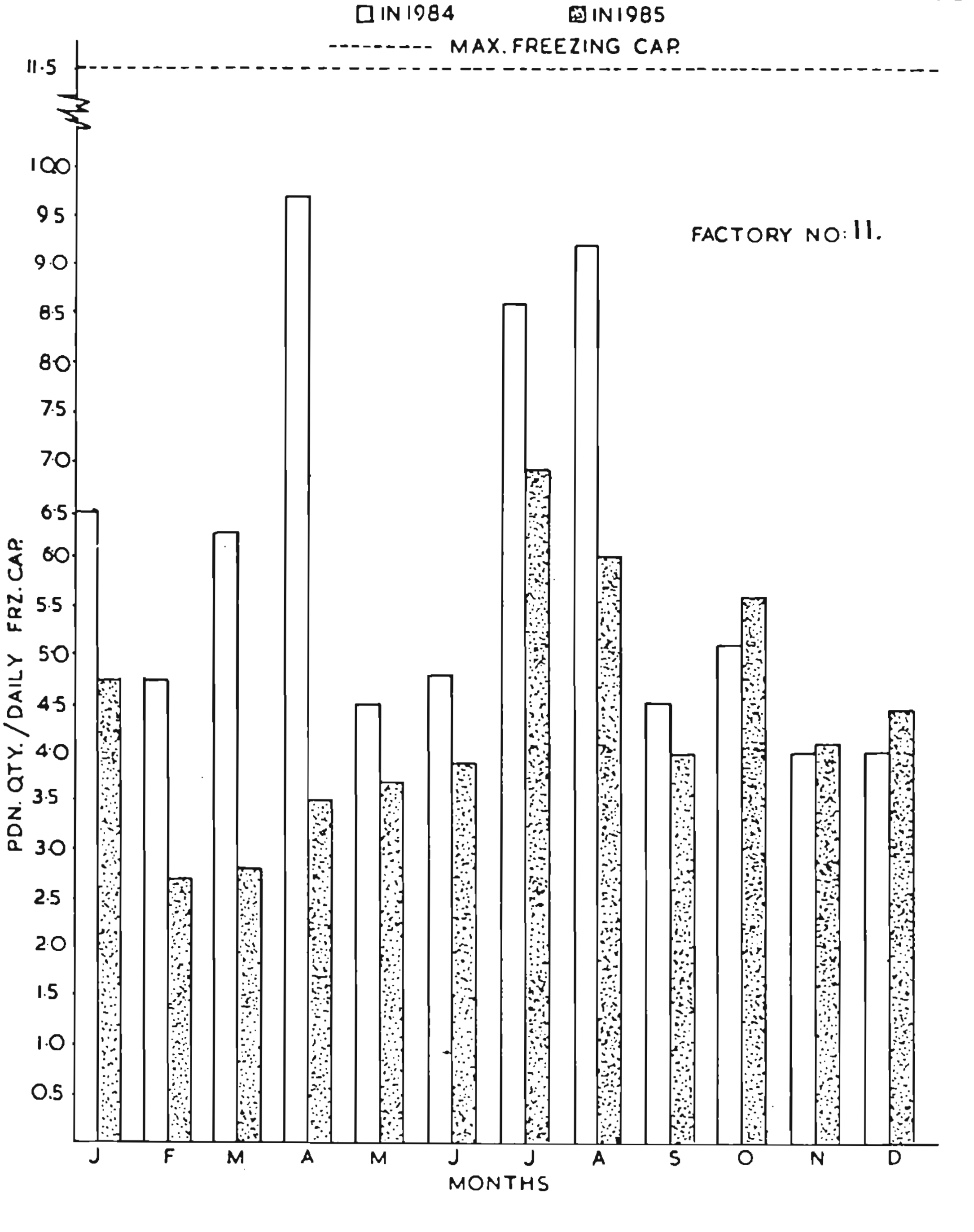
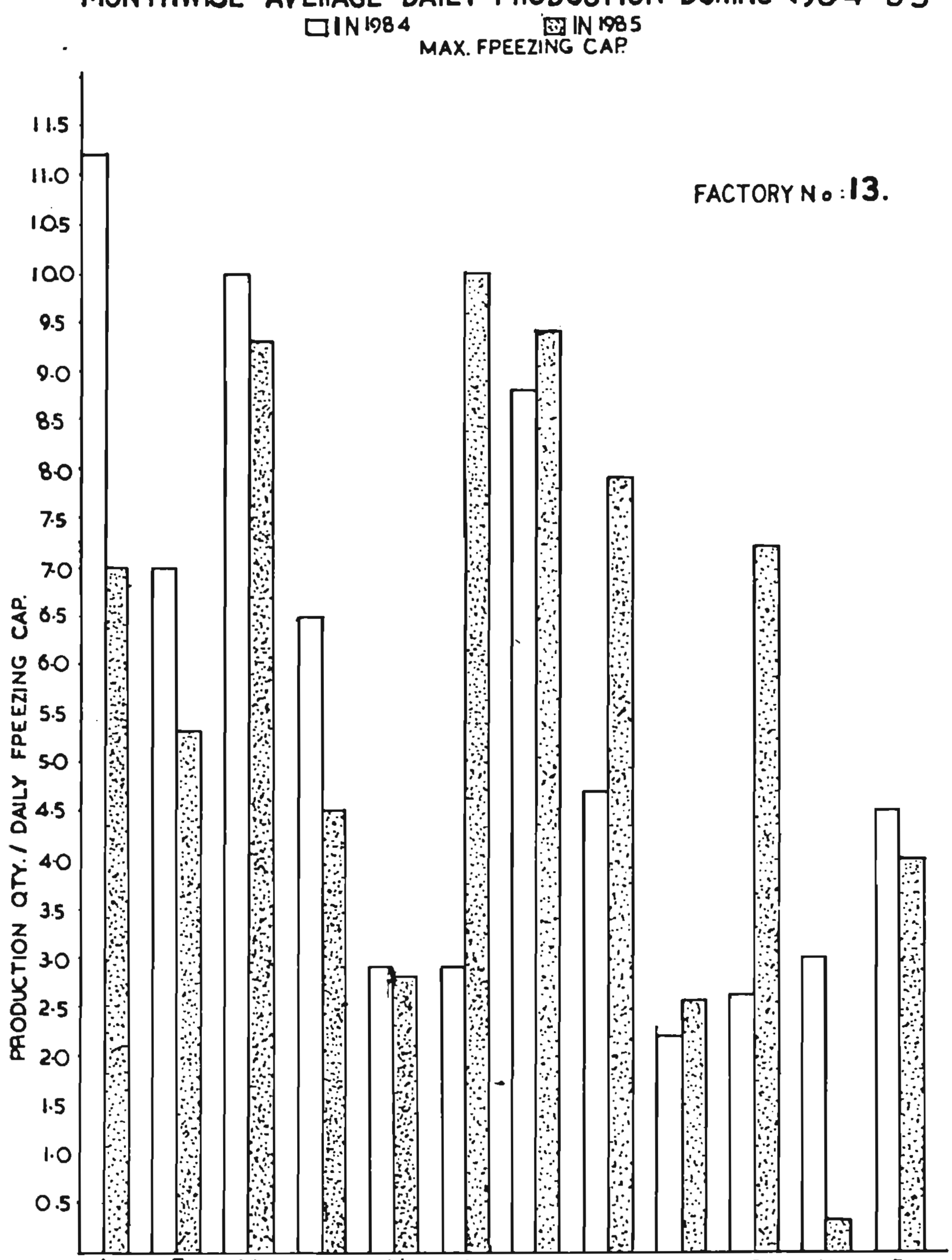


FIG.10.

MONTHWISE AVERAGE DAILY PRODUCTION DURING 1984-85



period. Rest is constituted by products like Frozen Cuttle fish fillets, Frozen Squid, Frozen Cuttle Fish Whole, Frozen Clam meat, Frozen Lobster tail, Frozen Fish items and Frozen Crab meat.

2. Severe competition for raw materials in the region - 60% of the total processing (freezing) plants in Kerala are located in Cochin region and there is a stiff competition for shrimp and other raw materials among the 54 processing plants in this region. In Quilon region the number of processing plants are comparatively less and the raw material availability is better. In Calicut region only one plant was functioning during the study period and as such they get a reliable supply of raw materials from the region itself apart from bringing the raw materials from distant places in the factory's fleet of insulated trucks.

3. Lack of proper purchasing network like purchase depots at important landing centres in the S.W.Coast of India as most of the plants in Quilon have.

3.8. COLD STORE HOLDINGS

The cold store stocks of the plants studied during 1983 and 1984 are presented in Fig. 11 and 12 respectively. The cold storage stock showed rapid replenishment in all the plants due to continous shipment from Cochin Port. On an average, every 15th day, there was one shipment from the plants. So there was no piling of inventory in the cold store. This is also due to the fact that the processing plants in Kerala

FIG.11.

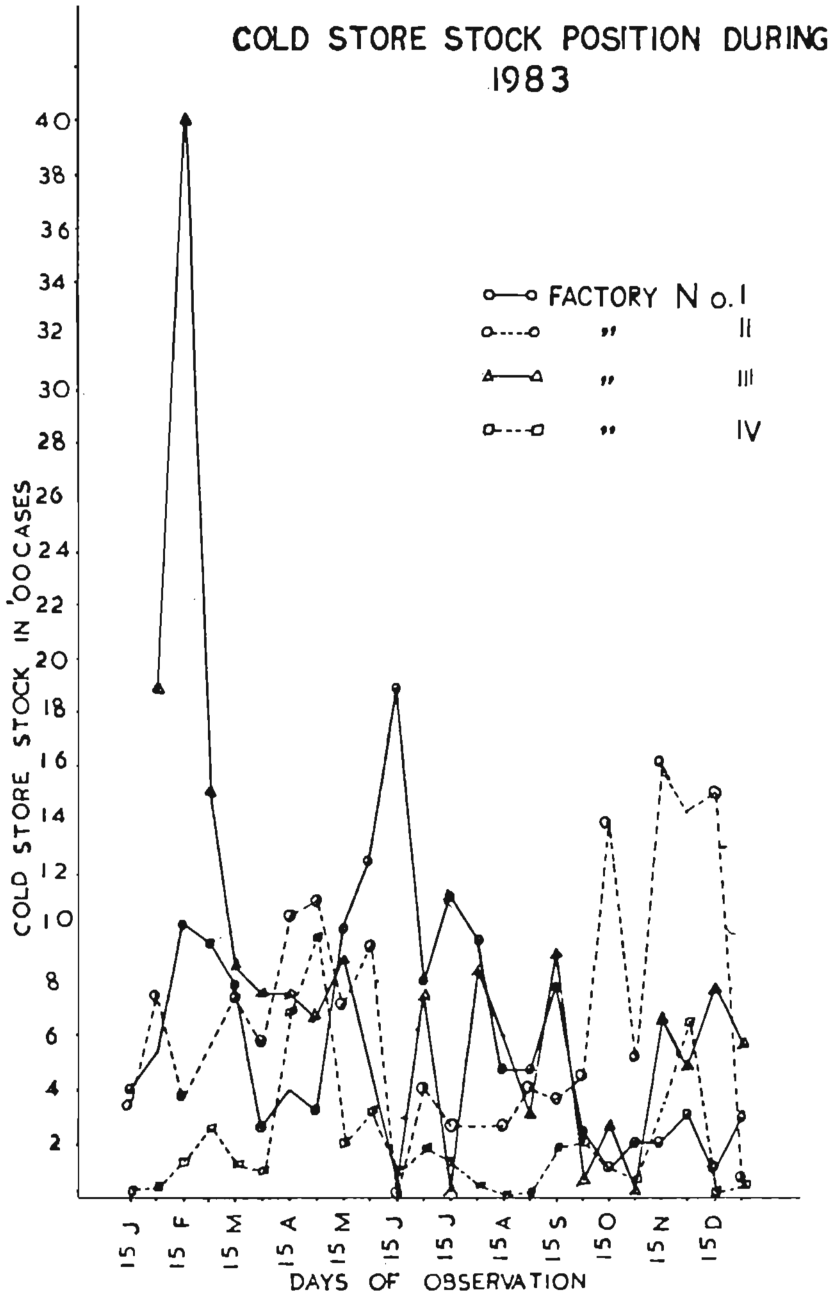
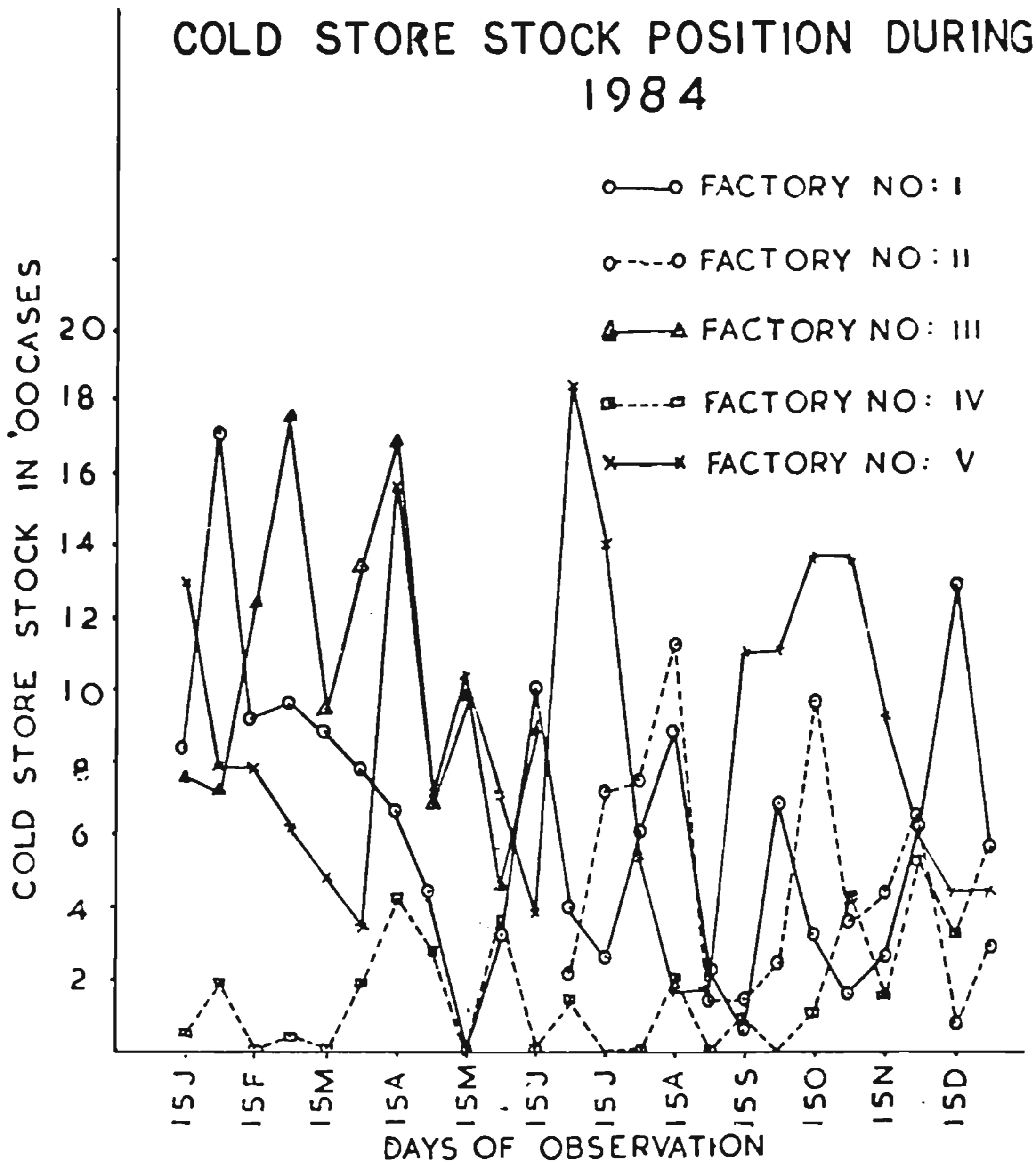

COLD STORE STOCK POSITION DURING
1983
FACTORY No.1
" II
" III
" IV
COLD STORE STOCK IN '00 CASES
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
15 J
15 F
15 M
15 A
15 M
15 J
15 J
15 A
15 S
15 O
15 N
15 D
DAYS OF OBSERVATION

FIG.12.


COLD STORE STOCK POSITION DURING 1984
FACTORY NO: I
FACTORY NO: II
FACTORY NO: III
FACTORY NO: IV
FACTORY NO: V
COLD STORE STOCK IN '00CASES
20
18
16
14
12
10
8
6
4
2
15J
15F
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DAYS OF OBSERVATION

mainly process the products only after obtaining a prior purchase order from a foreign buyer.

In plant No.1, the range of stock noticed during the two year period was between 0.14M.tons (May,1984) and 37.6M.tons (June 1983). The average stock during the period was only 12.7M.tons. The capacity of the cold store was 75M.tons.

In plant No.2 the stock range was between 0.0 (June,1983) and 31.9M.tons (November,1983). The average stock during the period was 11.87M.tons only. The capacity of the cold store was 150M.tons.

In plant No.3 the cold storage holdings ranged between 0.04 and 79.82M.tons. The peak stock was found to be in February, 1983. The average stock during the period was 17.59M.tons. The capacity of the cold store was 50M.tons.

The variation in the cold store holdings in plant No. 4 was between 0.04M.tons (July,1983) and 19.56M.tons (April, 1983), the average stock during the period being 3.74M.tons. This plant was having a cold storage capacity of 300M.tons.

In plant No.5, the cold store stock was between 3.13 and 31.34M.tons. The average stock during the period was 16.75M.tons only but the capacity of the cold store was 75M.tons.

The capacity utilisation of the cold stores during 1983 and 1984 was very low for all the plants and the range of capcacity utilisation being between 1.25% and 22.33% . The average utilisation was 13% only. This is due to the low production maintained in the processing plants.

3.9.SHARE OF PRODUCTION OF DIFFERENT PRODUCTS

Monthwise share of the quantity of different products produced, the export earnings obtained and their percentage share over total production of the plants selected for the study are summarised in Tables 4 to 11. The cumulative share of different products produced by all the plants combined together is presented in Table 12.

In all the plants, the main share of production was shrimp based products. 32.5% of the plants in 1984 produced only shrimp products and the situation in 1985 was also more or less similar with negligible share of production of other products. The share of shrimp production during the period (1984 and 1985) ranged between 38.9 and 100% among the plants. The value of shrimp export during the same period ranged between 53.49 and 100%. The combined average production of shrimp based products by all the plants worked out to be 92.25% (Quantity) and 94.52% (Value) in 1984. In 1985, the share was 80.20% and 86.91% respectively.

The second product which was produced in large quantity was Frozen cuttle fish fillet (C.F.F.). Its share of export quantity varied between 0.0% and 21.0% in 1984 and 0.0% and 36.5% in 1985.

The other products produced in lesser quantities during the period were Frozen Cuttle Fish Whole, Frozen Squid, Frozen Clam, Frozen Lobster Tail, Frozen Fish items and Frozen Crab.

TABLE : 4

SHARE OF DIFFERENT PRODUCTS PRODUCED & EXPORTED BY THE PLANTS SELECTED FOR THE STUDY IN 1984

(Plant No. 1,2, and 3)

Qty in Kg. and Value in Rupees.

Month		Plant No.1.		Plant No.2.					Plant No.3.			
		Fr.Shrimp %	Total Qty/ Value	Fr.shrimp %	Fr.Squid %	Fr.C. fish %	Fr.C. F.F. %	Total Qty./ Value	Fr.shrimp %	F.C. fish %	Fr. lob. tail %	Total Qty./ Value
Jan	Q	100	12,607	100	0.0	0.0	0.0	18,840	100	0.0	0.0	45,855
	V		2,62,353					5,08,970				10,21,103
Feb	Q	100	24,700	100	0.0	0.0	0.0	34,825	100	0.0	0.0	72,721
	V		8,48,581					15,12,701				30,00,977
Mar.	Q	100	9,140	100	0.0	0.0	0.0	20,487	100	0.0	0.0	20,785
	V		11,66,252					8,57,971				13,51,230
Apl.	Q	100	21,247	100	0.0	0.0	0.0	40,173	100	0.0	0.0	62,163
	V		4,65,672					25,86,625				35,48,421
May	Q	100	10,000	100	0.0	0.0	0.0	8,557	100	0.0	0.0	7,105
	V		3,43,632					2,92,757				2,99,738
June	Q	100	11,740	100	0.0	0.0	0.0	46,332	100	0.0	0.0	42,872
	V		4,67,535					21,72,159				19,52,162
July	Q	100	18,465	100	0.0	0.0	0.0	20,733	100	0.0	0.0	70,789
	V		8,76,682					11,48,427				44,14,244
Aug.	Q	100	48,730	100	0.0	0.0	0.0	27,724	100	0.0	0.0	96,655
	V		18,71,806					12,23,136				13,39,231
Sep.	Q	100	5,540	100	0.0	0.0	0.0	26,265	100	0.0	0.0	43,276
	V		1,48,355					8,75,827				1,75,190
Oct.	Q	100	28,847	0.0	100	0.0	0.0	10,000	92.0	8.0	0.0	43,276
	V		11,45,330					1,62,721	92.0	8.0		1,55,190
Nov.	Q	100	37,267	0.0	0.0	70.41	29.61	30,100	88.0	6.7	5.3	29,787
	V		16,28,009			68.7	31.3	6,36,675	72.2	1.7	26.1	19,10,955
Dec.	Q	100	36,816	100	0.0	0.0	0.0	15,605	100	0.0	0.0	22,840
	V		16,31,772					1,08,966				6,29,161
Annual share	Q	100	2,65,099	86.60	3.3	7.1	3.0	2,99,661	98.7	1.0	0.3	5,62,343
	V	100	1,08,55,979	93.91	1.2	3.3	1.6	1,30,67,065	97.0	2.2	0.8	2,15,96,733

TABLE : 5

SHARE OF DIFFERENT PRODUCTS PRODUCED AND EXPORTED BY THE PLANTS SELECTED FOR STUDY IN 1985

(PLANT NO: 1,2 and 3)

Qty in Kgs and Value in Rupees

Month		PLANT NO. 1			PLANT NO.2					PLANT NO.3					
		Fr,shrimp %	Fr.Sqd. %	Total Qty/ Value	Fr.shrimp %	Fr.Sqd %	Fr.C-Fish %	Fr.C. F.F.%	Total Qty/ Value	Fr.Shrimp %	Fr.C. fish %	Fr.C. F.F. %	Fr.Sqd %	Fr.Frog legs	Total Qty/Value
Jan.	Q	-	-	-	100	0.0	0.0	0.0	25,126	76.5	0.0	0.0	23.5	0.0	76,076
	V								11,28,344	93.8			6.2		39,94,326
Feb.	Q	100	0.0	15,913	100	0.0	0.0	0.0	20,914	100	0.0	0.0	0.0	0;0	22,000
	V			6,79,584					6,07,817						3,82,674
Mar.	Q	100	0.0	19,522	100	0.0	0.0	0.0	60,686	100	0.0	0.0	0.0	0.0	60,315
	V			9,10,986					19,13,570						24,30,157
Apl.	Q	-	-	-	100	0.0	0.0	0.0	27,860	100	0.0	0.0	0.0	0.0	51,183
	V								9,74,988						25,86,752
May	Q	100	0.0	9,693	100	0.0	0.0	0.0	3,660	100	0.0	0.0	0.0	0.0	35,540
	V			4,72,207					1,99,017						14,68,016
June	Q	100	0.0	14,548	100	0.0	0.0	0.0	20,910	100	0.0	0.0	0.0	0.0	85,100
	V			6,34,681					8,11,004						40,65,819
July	Q	100	0.0	29,200	100	0.0	0.0	0.0	23,039	100	0.0	0.0	0.0	0.0	45,258
	V			9,64,278					10,63,367						20,15,265
Aug.	Q	100	0.0	2,815	100	0.0	0.0	0.0	25,535	57.0	43.0	0.0	0.0	0.0	51,780
	V			1,38,569					10,68,469	59.3	40.7				16,22,789
Sept.	Q	0.0	100	16,000	13.9	86.1	0.0	0.0	38,280	80.4	19.6	0.0	0.0	0.0	33,534
	V			1,68,389	40.9	59.1			6,18,103	63.1	36.9				14,69,405
Oct.	Q	72.33	27.7	34,554	0.0	8.0	23,9	68.1	66,960	24.6	25.6	33.5	16.3	0.0	88,040
	V	85.7	4.30	9,93,397		7.2	19.7	73.1	9,96,000	29.4	31.7	28.9	10.0		20,76,284
Nov.	Q	100	0.0	47,028	0.0	0.0	100	0.0	34,416	86.5	10.3	0.0	0.0	3.2	58,394
	V			15,73,940					6,64,674	70.1	22.3			7.6	10,30,399
Dec.	Q	96.9	3.1	22,057	0.0	23.4	65.4	11.2	25,680	-	-	-	-	-	-
	V	99.3	0.7	9,23,220		17.6	68.3	14.2	4,63,086						
Annual	Q	87.6	12.4	2,11,330	57.1	11.9	18.0	13.0	3,73,068	80.2	9.4	5.1	5.3		6,10,223
Share	V	95.8	4.2	74,59,251	76.3	4.9	3.0	15.8	10,50,84,889	87.7	7.4	2.9	2.0		2,31,41,886

- = Nil Shipment, Sqd = Squid, C.Fish = Cuttlefish, C.F.F. = Cuttle Fish Fillet.

TABLE : 6

SHARE OF DIFFERENT PRODUCTS PRODUCED AND EXPORTED BY THE PLANTS SELECTED FOR THE STUDY IN 1984 (PLANT NOS: 4,5,6 & 7)

QTY IN KGS AND VALUE IN RUPEES

Month	Q/V	Plant No:4 FR.Shrimp %	Plant No:4 Total Qty/ Value	Plant No:5 FR.Shrimp %	Plant No:5 Total Qty./ Value	Plant No:6 FR.Shrimp %	Plant No:6 Total Qty./ Value	Plant No:7 FR.Shrimp %	Plant No:7 FR.Squid %	Plant No:7 FR.C.F.F. %	Total Qty/ Qty/Value
JAN	Q	100	12,607	100	18,523	-	-	66.4	33.6	0.6	10,227
	V		2,62,353		4,79,927			72.1	27.9		2,85,765
FEB	Q	100	24,700	100	24,096	-	-	100.0	0.0	0.0	38,105
	V		8,48,581		5,48,470						15,05,702
MAR	Q	100	9,140	100	37,908	-	-	100.0	0.0	0.0	25,004
	V		11,66,252		11,21,440						6,14,567
APL	Q	100	21,247	100	34,527	-	-	100.0	0.0	0.0	36,061
	V		4,65,672		7,46,216						14,14,956
MAY	Q	100	10,000	100	16,457	100	12,000	100.0	0.0	0.0	14,010
	V	.	3,43,632		5,79,275		6,81,913				5,22,129
JUNE	Q	100	11,740	100	39,722	-	-	100.0	0.0	0.0	11,794
	V		4,67,535		1,46,449						4,84,913
JULY	Q	100	18,465	100	13,052	-	-	100.0	0.0	0.0	30,577
	V		8,76,682		5,69,163						13,99,471
AUG	Q	100	48,730	100	64,807	-	-	100.0	0.0	0.0	21,271
	V		18,71,806		24,72,642						9,74,394
SEPT	Q	100	5,540	-	-	100	9,080	100.0	0.0	0.0	4,280
	V		1,48,355				6,48,594				1,85,014
OCT	Q	100	28,847	-	-	100	602	92.8	0.0	7.2	85,234
	V		11,45,330				10,822	95.6		4.4	18,98,322
NOV	Q	100	37,267	100	.11	-	-	100.0	0.0	0.0	16,825
	V		16,28,009		275						6,56,814
DEC	Q	100	36,816	100	13,529	-	-	100.0	0.0	0.0	46,184
	V		16,31,772		4,32,728						22,49,785
ANNUAL SHARE	Q	100	2,65,099	100	2,62,632	100	21,682	97.9	1.19	0.91	2 ,89,572
	V		1,08,55,979		84,14,585		13,41,329	98.66	0.65	0.69	1,21,91,832

Q = Quantity, V= Value, C.C.F.=Cuttle Fish Fillet, - Nil Production.

TABLE : 7

SHARE OF DIFFERENT PRODUCTS PRODUCED AND EXPORTED BY THE PLANTS SELECTED FOR THE STUDY IN 1985 (PLANT NOS: 4,5,6 & 7)

QTY IN KG. AND VALUE IN RUPEES

Month	Q/V	Plant No.4 FR.Shrimp	Plant No.4 Total Qty/ value	Plant No.5 FR.Shrimp	Plant No.5 Total Qty./ Value	Plant No.6 Products	Plant No.6 TTL Qty./ Value.	Plant No,7 FR.Shrimp	Plant No,7 FR.Squid	Plant No,7 FR.C.F.F.	Plant No,7 Total Qty/ Value
JAN	Q	100	39,117	100	21,042	-	-	100	0.0	0.0	19,304
	V		16,78,978		8,81,159						8,65,711
FEB	Q	100	12,560	100	18,000	-	-	62.7	37.3	0.0	29,995
	V		4,13,239		8,55,611			83.1	16.9		9,18,664
MAR	Q	100	32,340	-	-	-	-	100	0.0	0.0	40,842
	V		18,88,784								11,24,406
APL	Q	100	74,010	100	9,624	-	-	100	0.0	0.0	30,030
	V		30,44,033		5,10,433						11,25,981
MAY	Q	100	4,680	100	8,490	-	-	100	0.0	0.0	29,365
	V		1,71,411		3,43,542						16,97,616
JUNE	Q	100	14,122	100	28,230	-	-	100	0.0	0.0	53,109
	V		5,14,790		10,19,986						20,21,791
JULY	Q	100	16,698	100	13,461	-	-	100	0.0	0.0	8,923
	V		5,97,725		5,33,001						2,88,086
AUG	Q	100	10,060	100	3,592	-	-	100	0.0	0.0	27,600
	V		3,03,499		84,879						9,60,223
SEPT	Q	100	2,120	100	6,829	-	-	53.8	0.0	46.2	19,240
	V		74,926		1,33,270			53.2		46.8	5,35,833
OCT	Q	100	9,029	100	14,276	-	-	26.0	30.0	56.0	31,988
	V		1,40,207		5,37,674			35.0	12.9	52.1	8,68,960
NOV	Q		-	100	21,794	-	-	23.8	0.0	76.2	11,053
	V				6,56,950			17.1		82.9	3,01,906
DEC	Q	100	749	100	11,143	-	-	29.2	51.7	19.1	6,070
	V		46,949		3,41,587			56.4	16.3	27.3	1,26,628
ANNUAL	Q	100	2,15,485	100	1,56,481	-	-	81.63	7.78	10.59	3,07,519
	V		88,74,541		58,98,092			88.20	2.69	10.11	1,08,65,805

Q = QUANTITY, V = VALUE, C.F.F. = CUTTLE FISH FILLETS, - NIL PRODUCTION

TABLE : 8

SHARE OF DIFFERENT PRODUCTS PRODUCED AND EXPORTED BY PLANT NO: 10 IN 1984

QTY IN KG. AND VALUE IN RUPEES

Month	Q/V	FR-Shrimp %	FR-Lobster Tail %	FR-Fish %	FR-Clam %	FR-C.F.F. %	Total Qty/Value
JAN	Q	51.7	12.3	14.6	21.4	0.0	27,051
	V	59.7	21.7	12.2	6.4	-	11,31,859
FEB	Q	51.2	16.5	0.0	28.5	3.8	51,554
	V	69.1	20.2	-	8.7	2.0	26,09,985
MAR	Q	55.9	15.2	0.0	23.9	5.0	87,633
	V	75.6	16.4	-	5.9	2.3	49,31,122
APL	Q	59.5	13.3	0.0	27.2	0.0	1,06,659
	V	77.1	16.3	-	6.6	-	62,74,179
MAY	Q	54.3	7.5	0.0	38.2	0.0	36,682
	V	79.6	11.4	-	9.0	-	19,98,530
JUNE	Q	56.4	4.9	0.0	38.7	0.0	1,10,593
	V	85.8	2.2	-	12.0	-	54,30,007
JULY	Q	66.5	6.1	0.0	24.4	3.0	1,32,661
	V	82.1	8.2	-	7 .10	9.6	62,48,682
AUG	Q	85.1	14.9	0.0	0.0	0.0	71,977
	V	84.1	15.9	-	-	-	50,53,650
SEPT	Q	31.5	25.2	0.0	0.0	43.3	67,969
	V	40.4	33.0	-	-	26.6	36,20,087
OCT	Q	26.6	10.3	0.0	11.7	51.9	2,33,098
	V	34.3	16.3	-	3.6	45.3	1,02,59,371
NOV	Q	51.1	8.6	0.0	0.0	40.3	1,16,811
	V	54.5	12.5	-	-	33.0	51,78,774
DEC	Q	60.9	1.4	0.0	0.0	37.7	91,340
	V	57.9	10.8	-	-	31.3	41,67,688
ANNUAL	Q	51.3	10.6	0.3	16.8	21.0	11,34,028
	V	64.8	14.6	0.2	4.6	15.8	5,69,63,936

TABLE : 9

SHARE OF DIFFERENT PRODUCTS PRODUCED AND EXPORTED BY PLANT NO: 10 IN 1985

QTY IN KG AND VALUE IN RUPEES

Month	Q/V	FR.Shrimp %	FR.Lobster Tail %	FR.Squid %	FR.Clam meat %	FR.C.F.F. %	FR.Crab meat %	FR.Fresh fish %	Total Qty/Value
JAN	Q	77.0	15.4	0.0	0.0	7.67	0.0	0.0	65,103
	V	80.2	15.9						37,50,879
FEB	Q	75.0	0.0	0.0	0.0	25.0	0.0	0.0	79,898
	V	89.1				10.9			33,15,251
MAR	Q	74.0	9.3	0.0	16.7	0.0	0.0	0.0	1,02,011
	V	84.4	11.4		4.2				63,02,767
APL	Q	43.7	35.7	0.0	20.6	0.0	0.0	0.0	31,575
	V	68.7	26.6						16,27,800
MAY	Q	88.6	5.7	0.0	5.7	0.0	0.0	0.0	36,696
	V	91.3	7.5		1.2				20,55,813
JUNE	Q	94.0	0.0	0.0	0.0	6.0	0.0	0.0	44,369
	V	96.9				3.1			21,74,942
JULY	Q	48.8	20.4	0.0	0.0	0.0	30.8	0.0	11,351
	V	37.7	53.2				9.1		4,91,576
AUG	Q	35.3	1.7	48.0	6.9	8.0	0.0	0.0	74,598
	V	42.2	10.2	31.1	5.3	11.2			12,34,059
SEPT	Q	12.1	1.5	23.1	15.2	48.1	0.0	0.0	1,26,610
	V	15.2	3.3	7.4	1.4	72.7			44,56,236
OCT	Q	1.9	0.0	29.0	6.6	62.5	0.0	0.0	1,50,918
	V	1.8		8.2	9.1	80.9			50,53,465
NOV	Q	9.3	0.0	0.0	0.0	89.3	0.0	8.8	1,15,745
	V	15.1				84.5		0.4	26,51,374
DEC	Q	14.1	2.9	0.0	0.0	83.0	0.0	0.0	29,561
	V	12.4	6.0			81.6			13,91,089
ANNUAL	Q	38.9	4.5	12.5	6.9	36.5	0.40	0.20	8,68,436
	V	53.5	7.3	3.2	2.8	33.1	0.13	0.03	3,44,50,641

Q = Quantity, V = Value, C.F.F. = Cuttle Fish Fillet

TABLE : 10

SHARE OF DIFFERENT PRODUCTS PRODUCED AND EXPORTED BY THE PLANTS SELECTED FOR THE STUDY IN 1984

(PLANT NOS: 11 AND 13)

Qty in Kgs and Value in Rupees

Month		Plant No.11							Plant No.13				
		Fr.Shrimp %	Fr.Lob. tail %	Fr.clam meat %	Fr.fish %	Fr.CFF %	Fr.C. fish %	Total Qty	Fr.Shri-mps %	Fr.Lob-tail %	Fr.C. FF %	Fr.Sq. %	Total Qty/
JAN	Q	94.8	5.2	0.0	0.0	0.0	0.0	1,61,030	100	0.0	0.0	0.0	2,79,780
	V	95.8	4.2					1,14,82,016					1,28,45,797
FEB	Q	96.5	3.5	0.0	0.0	0.0	0.0	1,18,224	95.0	2.6	2.4	0.0	1,74,246
	V	97.5	2.5					1,00,07,232	98.6	0.8	0.6		1,39,48,571
MAR.	Q	95.2	4.8	0.0	0.0	0.0	0.0	1,55,420	100	0.0	0.0	0.0	2,51,204
	V	96.4	3.6					1,29,44,365					1,33,15,327
APL	Q	99.4	0.6	0.0	0.0	0.0	0.0	2,42,097	99.4	0.6	0.0	0.0	1,63,288
	V	99.3	0.7					13,301,009	98.8	1.2			1,05,65,434
MAY	Q	100	0.0	0;0	0.0	0.0	0.0	1,12,534	75.8	3.2	0.0	21.0	71,330
	V							70,38,441	88.0	7.2		4.8	41,23,595
JUNE	Q	72.8	0.0	26.6	0.6	0.0	0.0	1,20,249	100	0.0	0.0	0.0	55,860
	V	92.3		7.1	0.6			67,02,886					23,57,819
JULY	Q	100	0.0	0.0	0.0	0.0	0.0	2,15,290	100	0.0	0.0	0.0	2,20,300
	V							1,69,55,413					1,45,47,547
AUG	Q	97.2	2.8	6.0	0.0	0.0	0.0	2,29,500	100	0.0	0.0	0.0	1,16,340
	V	97.7	2.3					1,47,28,909					75,70,027
SEPT	Q	64.0	27.0	0.0	0.0	9.0	0.0	1,12,130	100	0.0	0.0	0.0	55,500
	V	63.4	32.1			4.5		95,66,119					29,59,129
OCT	Q	74.1	10.2	0.0	0.0	15.7	0.0	1,27,120	100	0.0	0.0	0.0	64,780
	V	78.6	11.1			10.3		81,63,100					28,91,421
NOV	Q	75.4	14.9	0.0	0.0	0.0	0.0	98,470	85.0	15.0	0.0	0.0	74,645
	V	86.5	7.6					68,56,156	73.4	26.6			31,22,256
DEC	Q	89.2	9.9	0.0	0.0	0.0	0.0	1,00,420	96.3	3.7	0.0	0.0	1,12,360
	V	91.4	8.2					72,92,419	98.0	2.0	2.0		45,89,722
Annual share	Q	90.6	5.37	1.8	0.04	1.7	0.46	17,92,484	97.4	1.40	0.26	0.94	16,39,633
	V	92.8	5.38	0.38	0.04	1.04	0.31	12,48,38,065	98.0	1.67	0.10	0.23	9.28.36.645

TABLE : 11

SHARE OF DIFFERENT PRODUCTS PRODUCED AND EXPORTED BY THE PLANTS SELECTED FOR THE STUDY IN 1985
(Plant Nos 11 & 13)

Quantity in Kg. and Value in Rupees.

Month		PLANT NO. 11 Fr.shrimp %	Fr.lobster tail %	Fr.Clam meat %	Fr.Squid %	Fr.C.F.F.%	Fr.C.F %	Total Qty/ Value	PLANT NO. 13 Fr.Shrimp %	Fr.lobster tail %	Fr.C.F.F. %	Fr.Sq. %	Total Qty/ Value
Jan.	Q	100	0.0	0.0	0.0	0.0	0.0	1,17,708	97.7	2.3	0.0	0.0	1,74,270
	V							76,04,439	95.8	4.2			1,28,89,388
Feb.	Q	89.9	15.1	0.0	0.0	0.0	0.0	66,960	92.5	7.5	0.0	0.0	1,33,680
	V	84.3	15.7					51,38,140	92.9	7.1			86,74,900
Mar.	Q	81.6	18.4	0.0	0.0	0.0	0.0	68,970	85.7	7.1	3.5	3.7	2,31,622
	V	79.9	27.1					43,56,647	89.6	8.2	1.1	1.1	1,36,26,511
Apl.	Q	89.5	10.5	0.0	0.0	0.0	0.0	86,650	76.5	4.1	0.0	19.4	1,12,640
	V	89.7	10.3					62,43,938	90.7	4.7		4.6	78,18,528
May	Q	86.5	13.5	0.0	0.0	0.0	0.0	93,242	100	0.0	0.0	0.0	68,780
	V	78.4	21.7					67,56,545					49,36,919
June	Q	100	0.0	0.0	0.0	0.0	0.0	97,020	92.5	0.0	0.0	7.5	2,55,240
	V							73,76,392	98.6			1.4	1,65,94,196
July	Q	92.4	7.6	0.0	0.0	0.0	0.0	1,73,277	99.4	0.6	0.0	0.0	2,34,670
	V	90.5	9.5					1,34,48,087	99.2	0.8			1,45,57,459
Aug.	Q	100	0.0	0.0	0.0	0.0	0.0	1,50,405	97.9	2.1	0.0	0.0	1,97,652
	V							1,42,41,872	95.2	4.8			1,34,21,178
Sep.	Q	59.6	10.2	0.0	0.0	30.2	0.0	99,516	95.7	4.3	0.0	0.0	57,680
	V	71.2	12.9			15.9		17,14,555	92.3	7.7			29,39,372
Oct.	Q	47.1	13.8	0.0	6.9	32.2	0.0	1,39,722	89.2	4.1	0.2	6.5	1,80,100
	V	63.4	19.2		1.6	15.8		98,81,381	92.7	5.7	0.1	1.5	1,22,52,216
Nov.	Q	81.1	8.0	0.0	0.0	0.0	10.9	1,01,566	38.7	61.3	0.0	0.0	8,150
	V	78.5	10.3				11.2	71,72,493	38.9	61.1			7,73,534
Dec.	Q	78.7	19.7	0.0	0.0	5.8	0.0	1,33,930	100	0.0	0.0	0.0	1,00,600
	V	83.6	15.7			2.74		1,13,04,636					47,43,651
Annual share	Q	83.49	9.15	0.0	0.73	5.80	0.83	13,28,966	92.86	3.16	0.64	3.34	17,55,084
	V	85.97	10.67		0.10	2.74	0.52	10,05,38,825	94.80	4.25	0.20	0.75	11,32,27,852

TABLE : 12

PERCENTAGE SHARE OF VARIOUS PRODUCTS PRODUCED AND EXPORTED BY THE PLANTS SELECTED FOR STUDY DURING 1984 AND 1985.

Factory Code	Q / V	Fr.Shrimp % 1984	Fr.Shrimp % 1985	Fr.clam % 1984	Fr.clam % 1985	Fr.Cuttle fish % 1984	Fr.Cuttle fish % 1985	Fr.Lobster tail % 1984	Fr.Lobster tail % 1985	Fr.Cuttle fillets % 1984	Fr.Cuttle fillets % 1985	Fr. Squid % 1984	Fr. Squid % 1985	Fr.Crab Meat % 1984	Fr.Crab Meat % 1985	Fr.Fish % 1984	Fr.Fish % 1985
1	Q	100	87.58	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.42	0.0	0.0	0.0	0.0
	V	100	95.76	-	-	-	-	-	-	-	-	-	4.24	-	-	-	-
2	Q	86.6	57.1	0.0	0.0	7.1	13.0	0.0	0.0	3.0	18.0	3.3	11.9	0.0	0.0	0.0	0.0
	V	93.9	76.3	-	-	3.3	15.8	-	-	1.6	3.0	1.2	4.9	-	-	-	-
3	Q	98.7	80.2	0.0	0.0	1.0	5.1	0.3	0.0	0.0	9.4	0.0	5.3	0.0	0.0	0.0	0.0
	V	97.0	87.7	-	-	2.2	2.9	0.8	-	-	7.4	-	2.0	-	-	-	-
4	Q	100	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	V	100	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	Q	100	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	V	100	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	Q	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	V	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	Q	97.9	81.63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.59	1.19	7.78	0.0	0.0	0.0	0.0
	V	98.66	88.20	-	-	-	-	-	-	-	10.11	0.65	2.69	-	-	-	-
8	Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	V	-	-	-	-	[illegible]	-	-	-	-	-	-	-	-	-	-	-
10	Q	51.3	38.9	16.86	6.9	0.3	0.0	10.6	4.5	21.0	36.5	0.0	12.5	0.0	0.40	0.0	0.19
	V	64.8	53.49	4.6	2.78	0.2	-	14.6	7.3	15.8	33.1	-	3.2	-	0.13	-	0.03
11	Q	90.6	83.49	1.80	0.0	0.46	0.83	5.37	9.15	1.70	5.80	0.0	0.73	0.0	0.0	0.0	0.0
	V	92.8	85.97	0.38	-	0.31	0.52	5.38	10.67	1.04	2.74	-	0.10	-	-	-	-
12	Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	Q	97.4	92.86	0.0	0.0	0.0	0.0	1.40	3.16	0.26	0.64	0.94	3.34	0.0	0.0	0.0	0.0
	V	98.0	94.80	-	-	-	-	1.67	4.25	0.10	0.20	0.23	0.75	-	-	-	-
Cumulative average/share of plants except non-working plant (percentage)	Q	92.25	80.20	1.86	0.77	0.89	2.10	1.77	1.87	2.69	8.99	0.54	6.0	0.0	0.014	0.0	0.02
	V	94.52	86.91	0.50	0.31	0.67	2.14	2.49	2.22	1.92	6.28	0.21	1.99	-	0.014	-	0.003

Q= QUANTITY, V= VALUE

The study shows that the plants in Kerala are mainly dependent on the shrimp based products and little effort is taken to diversify their production. A large number of products can be produced with the existing facilities in the plants from the available fishery resources in Kerala and nearby places.

3.10. SHIPMENT PATTERN

The shipment pattern of the plants studied during 1984 and 1985 are presented in Fig.13 to 22. The shipment pattern reflects the quantity produced during a particular month. The plants in Kerala ship their products very frequently, sometimes 3 or 4 times in a month. The study shows that on an average, once in every two weeks there is a shipment. This is facilitated by the frequent liner facilities available from Cochin Port to all important destinations (markets) like Japan, U.S.A., West European countries etc. This helps the plants to rapidly replenish their stock produced. This high turnover of the finished products helps the processors to avoid piling of finished products inventory in the cold store. Actually the shipment orders received by the processors from the buyers will have instructions to send the products in installments before a particular date. This arrangement is to take into account the seasonality and wide fluctuations in species-wise landings. The job of the processors is to wait for the sufficient cold store stock of a particular product to be despatched to the destinations. (Sometimes the processors may withhold the stock for a short period of time when price falls in the international market

FIG.14

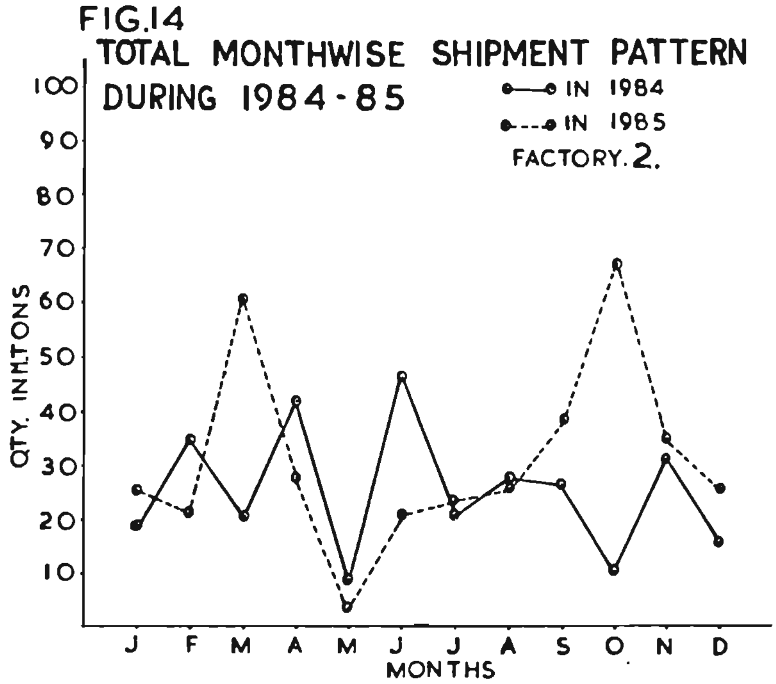

TOTAL MONTHWISE SHIPMENT PATTERN
DURING 1984-85
IN 1984
IN 1985
FACTORY. 2.
QTY. IN M.TONS
100
90
80
70
60
50
40
30
20
10
J F M A M J J A S O N D
MONTHS

FIG.13.

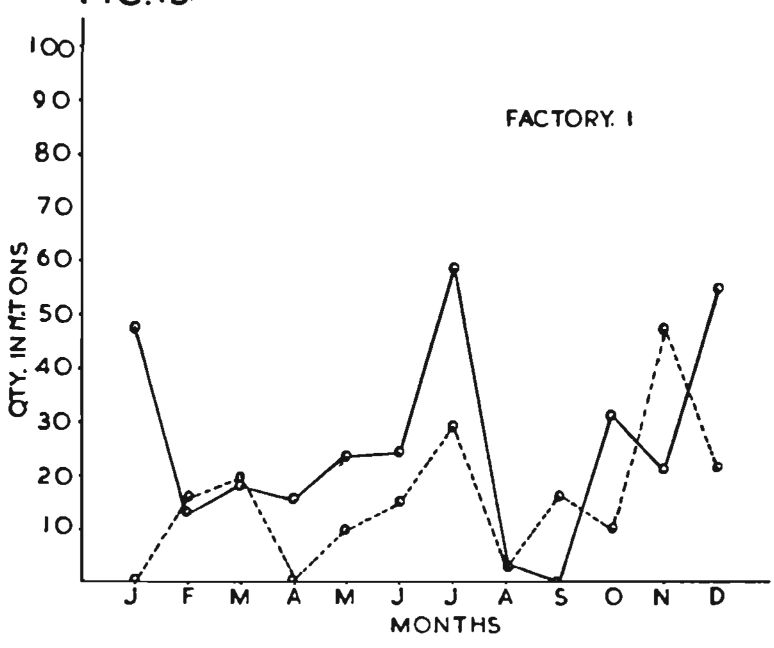

FACTORY. 1
QTY. IN M.TONS
100
90
80
70
60
50
40
30
20
10
J F M A M J J A S O N D
MONTHS

FIG.16.

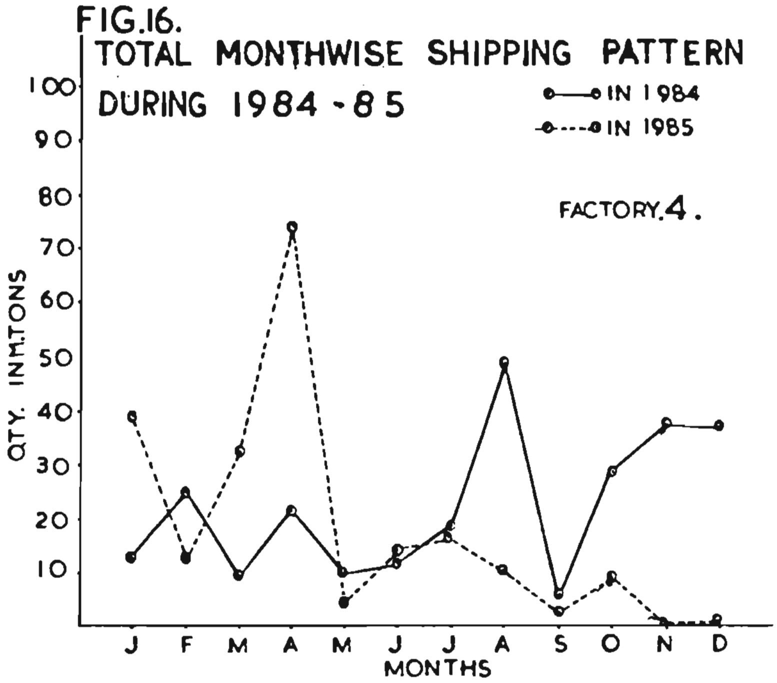

TOTAL MONTHWISE SHIPPING PATTERN
DURING 1984 - 85
IN 1984
IN 1985
FACTORY.4.
QTY. IN M.TONS
100
90
80
70
60
50
40
30
20
10
J F M A M J J A S O N D
MONTHS

FIG.15.

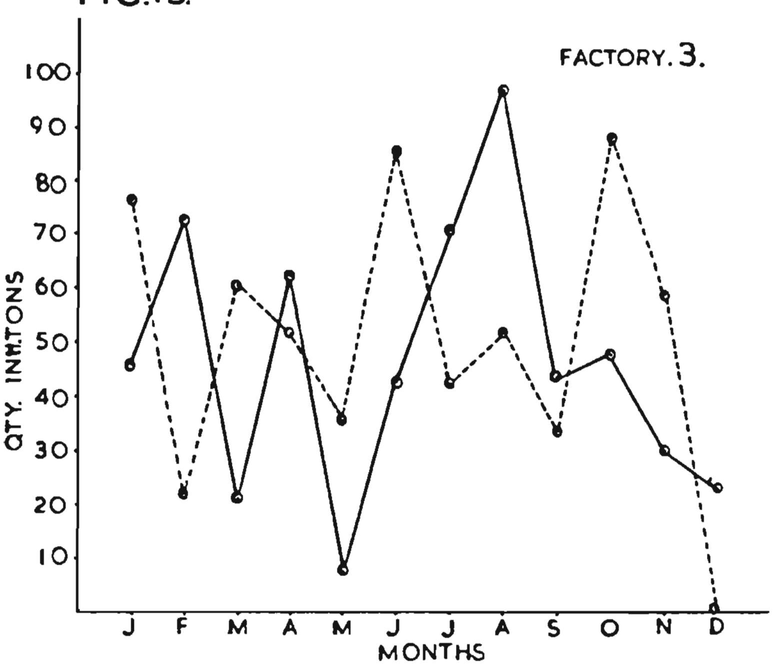

FACTORY. 3.
QTY. IN M.TONS
100
90
80
70
60
50
40
30
20
10
J F M A M J J A S O N D
MONTHS

FIG.18.

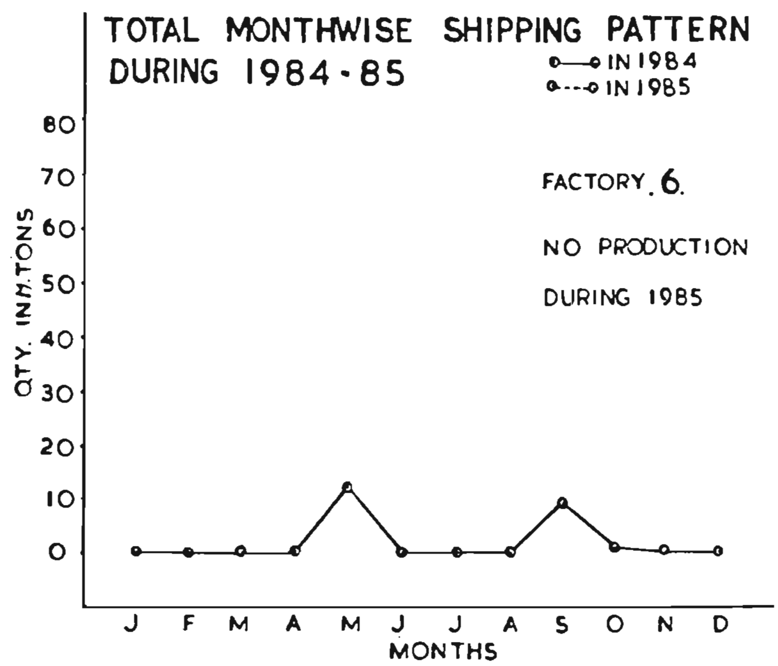

TOTAL MONTHWISE SHIPPING PATTERN
DURING 1984-85
IN 1984
IN 1985
FACTORY. 6.
NO PRODUCTION
DURING 1985
QTY. IN M.TONS
80
70
60
50
40
30
20
10
0
J F M A M J J A S O N D
MONTHS

FIG.17


FACTORY. 5.
QTY. IN M.TONS
80
70
60
50
40
30
20
10
J F M A M J J A S O N D
MONTHS

FIG.19.

TOTAL MONTHWISE SHIPMENT PATTERN DURING 1984 - 85

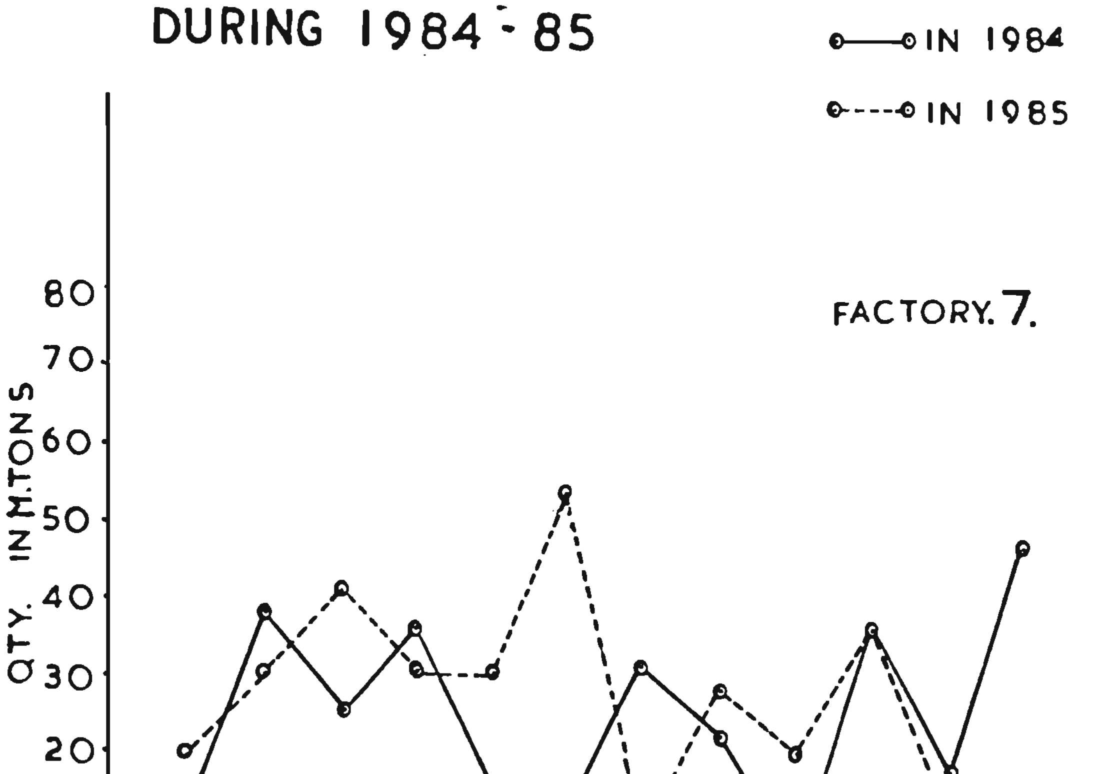


FIG. 20.

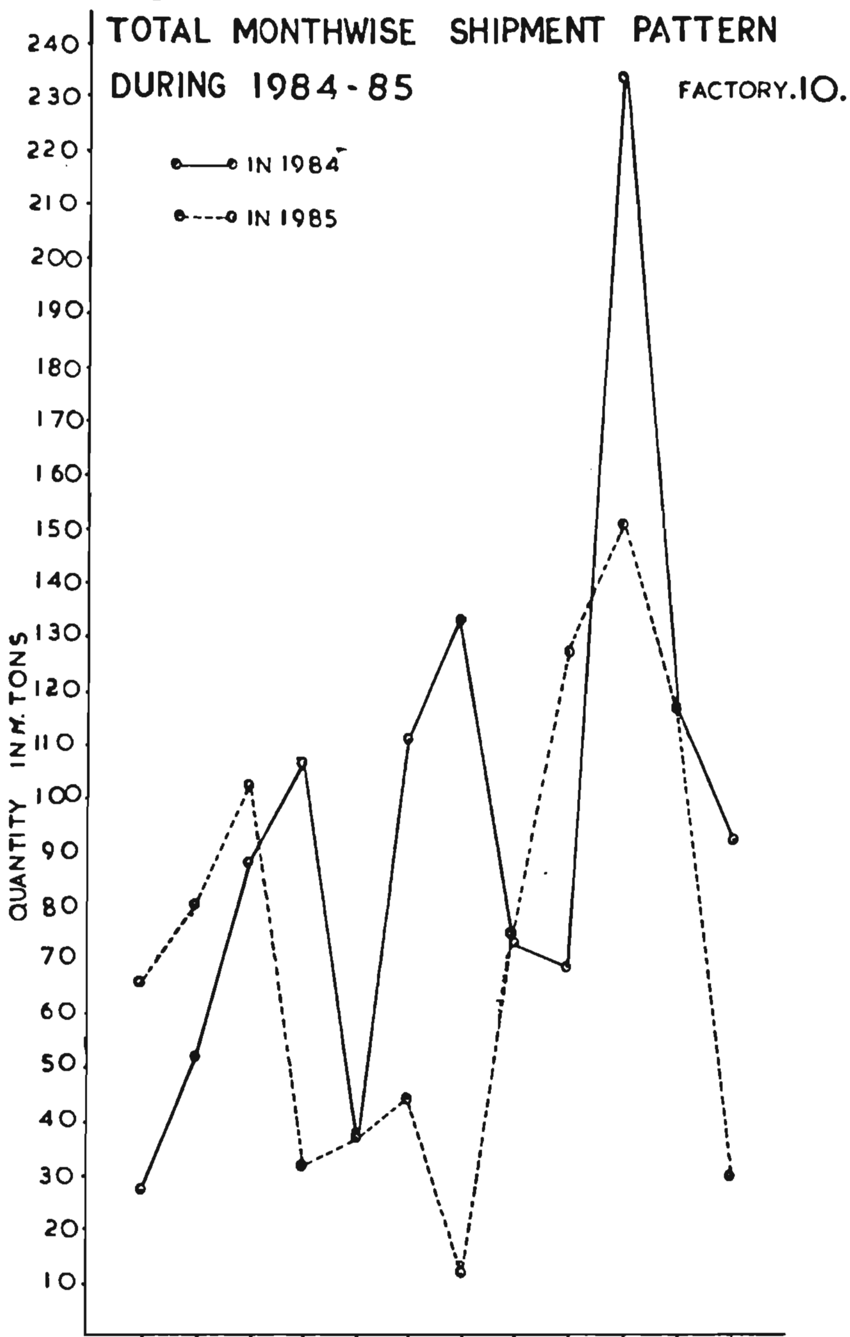

TOTAL MONTHWISE SHIPMENT PATTERN
DURING 1984-85
FACTORY.10.
IN 1984
IN 1985
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
QUANTITY IN M. TONS
J
F
M
A
M
J
J
A
S
O
N
D
MONTHS

FIG.21.

TOTAL MONTHWISE SHIPMENT PATTERN DURING 1984 - 85

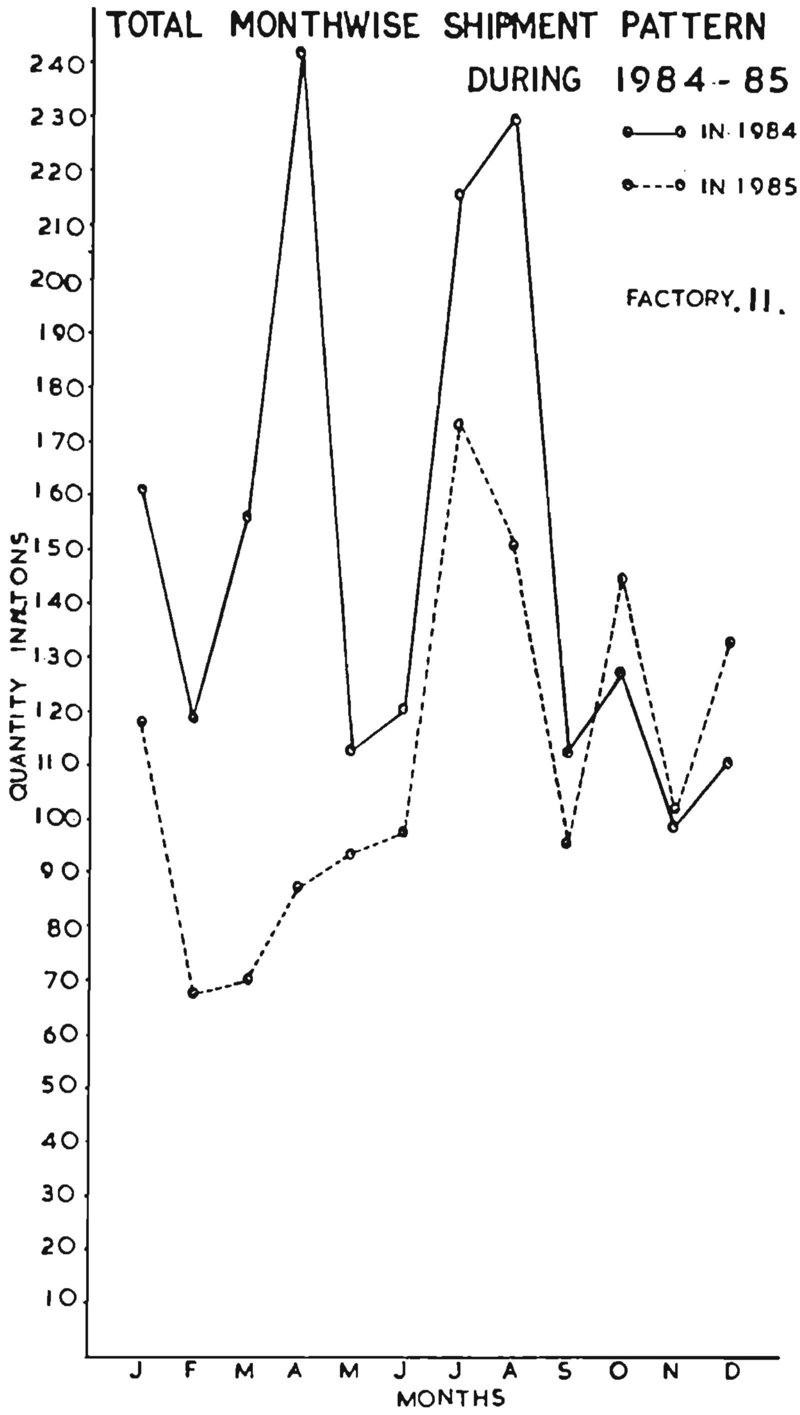
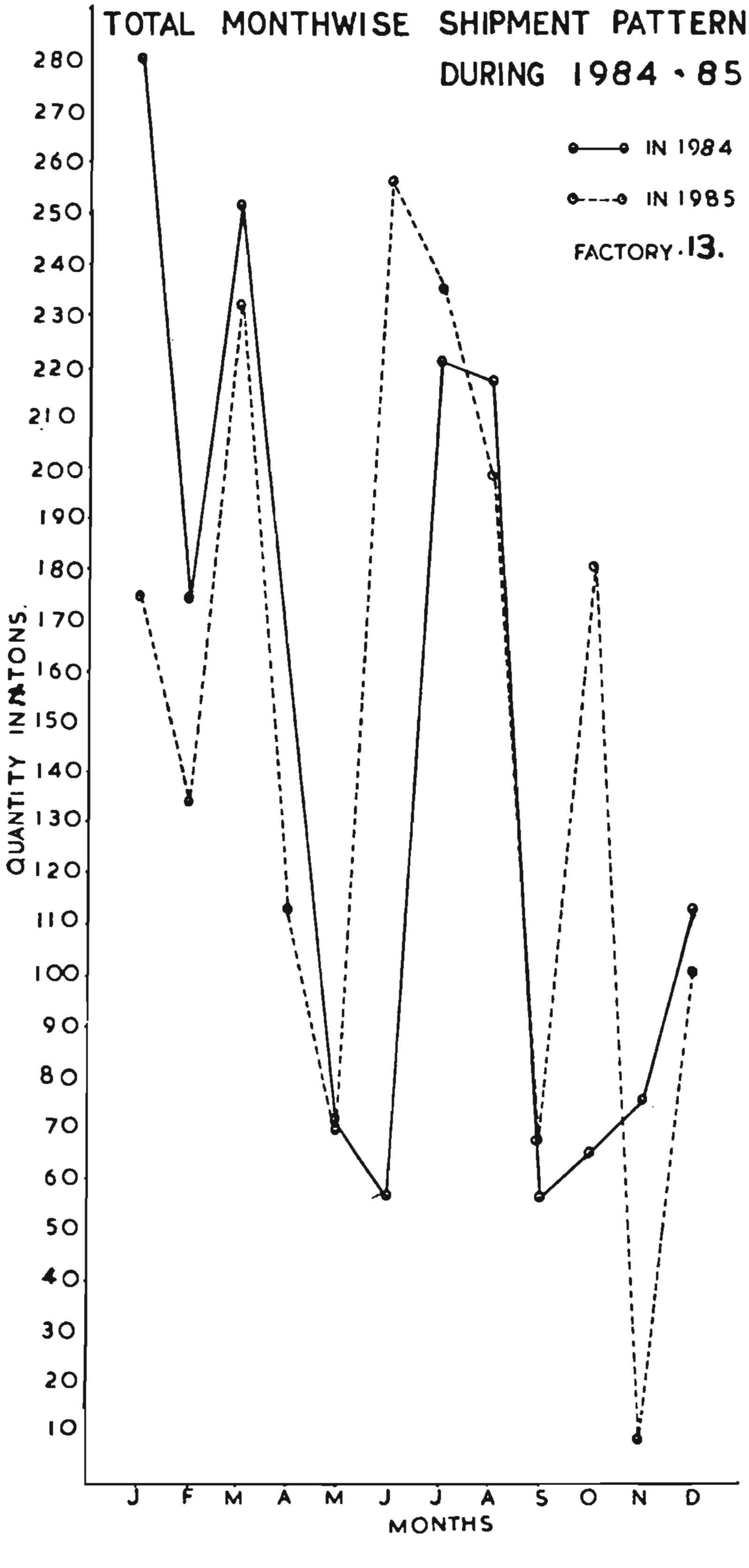


FIG.22.


TOTAL MONTHWISE SHIPMENT PATTERN
DURING 1984 - 85
IN 1984
IN 1985
FACTORY - 13.
QUANTITY IN TONS.
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
J F M A M J J A S O N D
MONTHS

and will dispose of it at a later period expecting higher price.)

3.11. PROCESS CYCLE TIME

A wide fluctuation in the process cycle time was noticed in all the plants on random observations on the production of Frozen Headless Shell-on Shrimp and Frozen Peeled and Undeveined Shrimp. The results of the observations are given below:

PRODUCT	No. of obser-vations	PROCESS CYCLE TIME IN MINUTES		
		Average	Range	Standard Dev-iation
Frozen Headless-Shell-on Shrimp	14	363.36	310 - 420	39.07
Frozen Peeled & Undeveined Shrimp	14	323.78	290 - 370	27.21

The process cycle time shows wide fluctuations. This is due to the following reasons:

1. Lack of standard production methods adopted by the processors.

2. Poor scheduling - This is due to the lack of a proper production schedule in the processing plants. The production is carried out as per the wish of the shift technologists/supervisors. This variation in the sequence of production of different products during different times results in fluctuating quality levels and production turnovers.

3. Shortage of raw materials of a particular variety sufficient for a full load in the freezer. This results in keeping the semi-processed material at the end of the pre-freezing stage.

4. Variation in the workers skill from plant to plant and from time to time in a particular plant due to changes in the workers* during the season. So the workers commitment to work and productivity is at a low level.

5. Variation in the quality of the raw materials used for the process.

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* The processing workers are usually arranged for a short period on contract basis. So a particular batch of workers may not be available for a factory throughout the period as they seek employment in other plants when a contract is over.

WORK MEASUREMENT IN SEAFOOD INDUSTRY

1. INTRODUCTION

Evaluating worker performance is a necessary function of management. It is conveniant to evaluate worker performance by comparing the actual time taken against a standard time. This form is especially useful when there are a variety of outputs with different time standards for each. Worker performance in this case can be defined as:

$$\frac{\text{Standard time}}{\text{Actual time}} \text{ X } 100$$

For the standard and actual time to be comparable, this standard time must reflect not only normal productive time but also a fair and equitable allowance for non working time, ie., rest breaks, delays in receipt of work and other unavoidable delays.

The Standard time can be defined as the expected amount of time needed by a typical, qualified worker using the proper work method and layout and performing at a pace which can be maintained throughout the day without undue fatigue (Levin, et al., 1972)

Without reliable and appropriate time estimates, it would be impossible to improve existing methods or effectively plan new ones. It would be difficult to compare 'make or buy' alternatives, select processing and material handling equipment, decide on layout and routing considerations, and design work methods. Moreover, without proper time data, the efficiency of production schedule, labour requirements planning etc will be imperfect.

1.1. WORK MEASUREMENT IN SEAFOOD PROCESSING INDUSTRY

It was observed that in fish processing plants in Kerala the production is carried out in a manner which requires excess work content and man hours. As fishery products are highly perishable, any delay or excess handling will seriously affect the quality of the product.

No work has been done so far in this direction and hence work measurement of important products were carried out to understand the basic work content and the normal time required for the processing of different products. This will inturn help to standardise the production method by eliminating unwanted excess work and handling and to reduce the rate of spoilage of the products.

1.2. TIME STUDY

Time study is a formal work measurement technique. Time study utilises direct observation of activities to develop normal times for those activities. It is defined by Keith, et al.(1983) as "the technique to establish the time required for a qualified worker to carry out a specified job at a defined level of performance". This method is applied to study the required time for the production of different products in seafood processing plants in Kerala.

The excess work content in the fish processing plants were observed to be due to the following reasons:

1. Lack of standardisation of processing methods resulting in fluctuations in the production process which in turn leads to the production of the same product with variation in quality.

2. Inefficient methods of production process due to the use of wrong production facilities.

3. Bad layout causing wasted movements.

4. Bad planning of work and orders adding idle time of men and machine and spoilage of raw materials.

5. Shortage of raw materials due to bad planning which ultimately leads to idle time of men and machines.

6. Inefficiency of freezers and cold storages due to poor maintenance resulting in the consumption of excess time and energy for processing and also to the spoilage of raw material.

Short commings due to the special nature of the industry:-

1. Fluctuations in raw material landings resulting in increasing the idle capacity of the production facilities

2. Uncertain landings of a particular variety of raw material resulting in developing a highly flexible system

for processing which in turn results in employing excess staff and production facilities to absorb the fluctuations in the raw material availability.

3. Fluctuation of purchase rate very frequently resulting in difficulty in fixing the production cost.

4. Difficulty in procuring raw materials from distant places due to high perishability of the raw materials.

Hence the work measurement of the processing activities in processing plant is to achieve the following objectives:

1. A basis for comparison of alternate methods.
2. For developing a standard method of processing.
3. For realistic layout planning.
4. To reduce production cost due to wastage and spoilage.
5. For setting a planned production schedule.
6. To utilise the plant to the optimum level of capacity.
7. To decide the capacity of the facilities and equipments.
8. Processing and operation planning.
9. To develop the most economic method of scheduling by evaluating the possibilities for concurrent operations, multiple machine operations etc.
10. To have a better material handling system.
11. To plan man power requirements.

2. MATERIALS AND METHODS

The processing of the following products which constitute the major portion of the production in the processing plants in Kerala were selected for the study.

1. Frozen Headless Shell-on Shrimp. (2 Kg. block)
2. Frozen Peeled and Undeveined Shrimp. (2 Kg. block)
3. Frozen Peeled and Deveined Shrimp. (2.27 Kg. block)
4. Frozen Squid Whole. (2 Kg. block)
5. Frozen Cuttle Fish Whole. (2 Kg. block)
6. Frozen Squid tube. (2 Kg. block)
7. Canned Shrimp (128 gms pack).

The study was carried out as described by Levin, et al. (1972). Information regarding the methods of processing, facilities required, etc were collected by detailed observations of the processing activities of the above mentioned products from processing plants selected for the study. Flow charts were then prepared to have the best sequence of production in the plant.

Measurable elements of activities were then sorted out from the processing activities for further study. The measurements were taken for each element to the required number of cycles. The number of observations required for a 95% confidence level and confidence limits (precision) of ± 5% were worked out using the formula:

$$N^1 = \left[\frac{40\, N}{\Sigma X} \sqrt{\frac{\Sigma X^2 - (\Sigma X)^2 / N}{N - 1}} \right]^2$$

Where N^1 = Number of readings required for the stated confidence.

X = Element readings.

ΣX = Sum of items.

N = Number of readings actually taken

Stop watch time study was employed to measure the work (element) in the processing plants.

Allowances and Time standard :-

The following types of allowances were taken into account while computing the standard time. This is based on the special nature of the processing conditions at different stages of processing.

1. Personal allowance (%)
2. Standing and fatigue allowance (%)
3. Process and other allowances (%)

(The allowances given for different activities are shown in the respective tables of time study under different products)

3. RESULTS AND DISCUSSION

3.1. Frozen Headless Shell-on Shrimp (2 Kg block)

The following are the raw materials used for the production of Headless Shell-on Shrimp blocks :

Scientific name	Commercial name
Penaeus indicus	Naran/White shrimp
Penaeus monodon	Kara/Tiger shrimp
Penaeus canaliculatus	Flower shrimp
Metapenaeus affinis	Kazhanthan

The raw materials are purchased in the headless form itself by the purchase section of the factories. The removal of the head immediately after the catch by fishermen themselves or other agents is to help to improve the quality.

The raw material is stored in the chilled room with proper icing. Usually the material on reaching the processing factory is to be immediately processed and packed to avoid shell loosening and blackening. The Headless varieties are more costly, and so great care has to be given by the processors.

The raw material is then washed thoroughly in sufficiently chlorinated (5 to 10 ppm) potable water and is rechecked for quality and grades. In this process, shell particles, vein bits, fibres etc are removed. The drained and quality checked prawns are then weighed (2 Kg + additional weight of 100 to 200 gms for compensating the drip loss)

Methods of packing :- Two methods of packing are employed in processing plants. Some plants pack the material directly on the freezer trays with polythene sheets (without duplex carton) and then send it for freezing. The duplex cartoning is done only at the end when master cartoning is done to store the product. In the second method, the material is directly packed in duplex cartons with polythene lining before freezing (freezing with duplex carton).

The second method is found to be better as the shape and appearance of the block is better in this case. Moreover, freezer burn can be minimized to the maximum extent as the material is not in direct contact with the plates of the freezer.

Another advantage is that the master cartoning time can be reduced to some extent which helps in minimising the temperature raise of the frozen blocks. For the time study, the second method is adopted as this is beneficial for the processors.

After weighing, the material is layered in duplex carton (coded) and glazed with potable water to get uniform shape and to prevent spoilage. The layered material is then arranged in freezer trays and is then loaded into the freezer maintained at -40°C.

<u>Freezing</u> :- Two types of freezers are now employed in fish processing plants. The commonly available one which uses Freon as the cooling medium requires three hours for the freezing process. But recently developed and introduced 'Ammonia Freezer' with the ability to freeze in 90 minutes are installed in some plants. This will reduce the freezing time to almost half the time required in the earlier method.

The frozen blocks are then packed in master carton (10 blocks in one master carton)and is sealed and stored at -18°C- to -23°C in the cold store till shipment.

The standardized flow chart of the processing of Frozen Headless Shell-on shrimp is given in flow chart No.1. The time study observation and the result of the study is given in table 1. The study starts with raw material transportation from chill room and ends with the storage of the processed

FLOW CHART - 1

FROZEN HEADLESS SHELL-ON SHRIMP

Raw material transportation from chill room to processing hall

↓

Washing and draining

↓

Rechecking of quality and grades

↓

Weighing

↓

Initial preparation of Waxed carton & polythene → Coding of material and duplex cartoning

↓

Layering of shrimp in duplex carton

↓

Glazing

↓

Setting in freezer trays

↓

Loading in trolleys

↓

Loading into the freezer

↓

Freezing at -40°C

↓

Unloading from the freezer

↓

Master cartoning

↓

Storing at -23°C

TABLE: 1.

TIME STUDY - TABLE SHOWING THE ACTIVITIES, START AND END EVENTS, TURNOVER QUANTITY AND THE NORMAL TIME OF THE ELEMENTS IN THE PROCESSING OF HEADLESS SHELL-ON SHRIMP

Activity No.	Name of the activity (element)	Start event	End event	Turn over qty.	No. of workers invoLed	Normal time (Min)	Range of observations (Min.)	No. of observations taken
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.	R.M. transportation from chill room to weighing station	Started keeping tubs ready for loading	Unloading the R.M. at the washing stn. completed	100 Kg.	2 M	4.670	3.17-6.20	23
2.	Washing & Draining	Washing of the R.M. started	Workers ready for washing the next lot of R.M.	25 Kg.	2 F	0.940	0.50-1.93	24
3.	Checking of quality, grades & draining	Rechecking & grading started	Worker ready for rechecking & grading the next lot	25 Kg.	1 F	4.638	3.90-5.10	8
4.	Weighing	Material scooping for weighing started	Worker ready for scooping the next lot.	2 Kg. + E.Wt.	1 F	0.128	0.067-0.20	37

CONTINUATION OF TABLE: 1.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
5.	Coding of the material & duplex carton.	Coding of duplex carton started.	Worker ready for coding next carton	1 No.	1 F	0.128	0.067-0.200	37
6.	Distribution of weighed & coded material to respective layering site.	Started the distribution of the material which is weighed & coded.	Worker ready for distributing the next lot.	1 No.	1 F	0.128	0.067-0.200	37
7. a.	One side layering (single side layering)	Started keeping ready the materials & trays for layering.	Worker ready for receiving next lot of weighed & coded material.	1 slab	1 F	0.744	0.602-0.764	30
7. b.	Double side layering	,,	,,	,,	,,	1.650	0.500-2.660	28
8.	Glazing	Started picking the cup for taking glaze water.	Worker ready for filling glaze water in the next lot.	25 slabs	1 F	4.882	4.580-5.100	14
9.	Setting in trays	Started setting in trays	Worker ready for setting next lot.	,,	1 F	4.882	4.580-5.100	14
10.	Loading in trolley & transporting to freezer.	Loading in trolleys started	Worker ready for loading the next lot	,,	1 M	4.882	4.580-5.100	14

CONTINUATION OF TABLE: 1.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
11.	Loading into the freezer	Picking the first tray for loading started.	completed closing the freezer door after loading	220 slabs	1 M	5.190	4.900-5.500	10
12.*	Freezing	Completed closing the freezer door after loading	Opening the freezer door started for unloading.	,,	- -	180.000	-	-
13.	Unloading	Opening the freezer door started for unloading	Unloading the last slab from the last tray completed	,,	same worker who is loading into the freezer	13.000	12.500-13.500	6
14.	Master cartoning	Started keeping ready the M.C.	Workers ready to receive next lot.	1 M.C.	2 M	1.135	0.750-1.417	16
15.	Sealing of M.C.	Started keeping ready the M.C. for sealing.	Workers ready to receive next M.C. for sealing.	,,	2 M	1.135	0.750-1.417	16
16.	Storing	Started loading the sealed M.C. on trolleys.	Worker is ready for loading the next lot.	22 M.C.	1 M	28.950	28.700-29.053	4
17.	Preliminary arrangement for D.C. & polythene	Initial preparation of duplex cartons & polythene sheets started	Completed arranging of Duplex carton & polythene for a batch of production	231 D.C. & poly. sheets	1 F	44.160	-	4

R.M. = Raw Material; F = Female; M = Male; M.C. = Master Carton; D.C. = Duplex Carton

* The Normal Time of the recently introduced freezer is 90 minutes.

product in the cold store. Some activities require more than one person to carry out the job and the number of persons involved for each activity is shown in the table. The freezing is the longest activity in the production process and its normal time is 180 minutes (3 hours). If we install a new type of freezer with shorter freezing time like the one available locally, the normal freezing time can be reduced to 90 minutes. In the case of Headless Shrimp processing, two types of layering are usually done. The common one is single side layering. In this process the headless shrimp on the top of the duplex carton are arranged in layers to get good appearance for the frozen product. But some buyers insist on double side layering where the material is arranged in layers on both sides of the pack. This gives a better appearance and shape for the frozen slabs than the single side layering. The normal time of these two processes are separately given in the table(Activity Nos. 7(a) and 7(b).

Preparation of waxed duplex cartons and polythene for processing (Activity No.17) is a parallel activity and the normal time for setting ready 231 sets (for one batch) of duplex cartons is computed and given in the table.

Allowances, number of workers required, turnover quantity and Standard Time :- The allowances given for different activities, man power requirement, turnover quantity and standard time for different activities are given in table 2. The table gives the above information for the production of

TABLE: 2.

TABLE SHOWING THE NORMAL TIME, ALLOWANCES , STANDARD TIME AND NUMBER OF WORKERS INVOLVED IN VARIOUS ACTIVITIES FOR THE PROCESSING OF FROZEN HEADLESS SHELL-ON SHRIMP (22 MASTER CARTONS OF 10 SLABS EACH)

Act. No.	Name of the activity	Turn-over Qty.	Normal time (Min.)	Personal Allowance %	Personal Allowance time	Standing & fatigue Allowance %	Standing & fatigue Allowance time	Process & other All-owances %	Process & other All-owances time	Std. time (Min.)	No. of work-ers
(1)	(2)	(3)	(4)	(5)		(6)		(7)		(8)	(9)
1.	R.M. transportation from chill room to washing station	500 Kg.	23.35	2	0.467	3	0.701	2	0.467	24.985	2 M
2.	Washing & draining	,,	18.80	5	0.940	10	1.880	17	3.196	24.816	2 F
3.	Rechecking of quality & grades	,,	18.800	5	0.940	10	1.880	17	3.196	24.816	4 F
4.	Weighing	220 slabs	28.16	15	4.224	15	4.224	30	8.448	45.000	1 F
5.	Coding	,,	28.16	15	4.224	15	4.224	30	8.448	45.000	1 F
6.	Distribution of weighed materials to respective layering sites	,,	28.16	15	4.224	15	4.224	30	8.448	45.000	1 F
7. a.	Layering of shrimp (single side)	,,	163.68	2	3.273	3	4.910	4	6.547	178.410	1 F
b.	Double side layering	,,	363.00	2	7.260	3	10.890	4	14.520	395.670	1 F
8.	Glazing	,,	42.96	2	0.860	2.5	1.070	-	-	44.890	1 F
9.	Setting in F.trays	,,	42.96	2	0.860	2.5	1.070	-	-	45.000	1 F
10.	Loading in trolleys & transporting to freezer	,,	42.96	2	0.860	2.5	1.070	-	-	45.000	1 M

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CONTINUATION OF TABLE: 2.

Act. No.	Name of the activity	Turn over Qty.	Normal time (Min)	Personal Allowance		Standing & fatigue Allowance		Process & other Allowances		Std. time (Min)	No. of workers
				%	time	%	time	%	time		
11.	Loading into freezer	220 slabs	5.19	10	0.519	30	1.557	40	2.076	9.342	1 M
12.	Freezing*	,,	180.00	-	-	-	-	16.5	29.70	209.70	-
13.	Unloading	,,	13.00	10	1.300	10	1.300	35	4.55	20.150	**
14.	Master cartoning***	22 MC	24.97	10	1.851	10	1.851	35	6.48	35.152	1 M
15.	M.C sealing	,,	24.97	5	1.250	5	1.250	25	6.24	33.710	2 M
16.	Storing	,,	28.95	5	1.450	5	1.450	20	5.74	37.640	1 M
17.	Initial preparation+ of duplex cartons & polythene sheets.	231 No.	44.16	5	2.210	5	2.210	--	--	48.580	1 F

R.M = Raw Material; M.C. = Master Carton.

* In the new type of freezer employed in some processing plants, the normal time is 90 minutes. Its standard time for freezing is worked out to be 104.85 minutes (105' approximately.

** Unloading of frozen blocks from the freezer is done by the same worker who is loading the material into the freezer.

*** 10 frozen slabs of 2 Kg. each are packed in one Master carton.

\+ 11 numbers of duplex cartons and polythene sheets are taken in excess than required for a batch of 220 slabs to compensate for any loss due to defects or damage during processing.

one batch of Frozen Headless Shrimp (220 slabs of 2 Kg.).

From this information, it is possible to work out a balanced line of production with balanced number of workers at different stations. (Layout of a model plant and production schedules are worked out and is given in separate chapters)

3.2. Peeled and Undeveined Shrimp (Frozen 2 Kg block)

The following are the main raw materials used for the production of Peeled and Undeveined Shrimp (P U D).

Scientific name	Commercial name
Metapenaeus dobsoni	Poovalan/brown shrimp
Parapenaeopsis stylifera	Karikadi shrimp
Penaeus indicus	Naran/white shrimp
Metapenaeus monoceros	Choodan shrimp
Metapenaeus affinis	Kazhandan shrimp

PROCESS DESCRIPTION :-

Activities in the pre-processing centre :- The material received through auction or through other means is directly transported to the peeling shed owned or leased by the the suppliers. Normally unpeeled raw material received in the peeling shed is iced. In practice, it is kept overnight. This sort of packing is called ice packing and is said to be giving more yield than that of immediate peeling. But theoretically, it is better to pre-process the material immediately in order to avoid spoilage.

Pre-processing is usually carried out on a contract basis.

However, it is appreciated that quality consciousness is prevalent among the pre-processors and suppliers in the industry in Kerala in recent times.

Along with peeling, sorting and grading is also carried out in the peeling shed itself.

The above activities are collectively called as pre-processing activities and is being done in the peeling sheds or pre-processing centres. In Kerala, in the fish processing plants, this pre-processed material is the starting raw material where as in other places like Veraval and Porbunder in Gujarat, the processing plant itself is doing the peeling or beheading operation in their factory premises.

Activities in the processing plants :- The meat is brought to the processing plants by the local agents or by direct purchase in insulated vehicles. Shrimp meat is also brought by the local peelers in their containers. The meat is kept in ice. The purchase is done mainly in the morning and in the evening hours. The material so arrived is washed, ice removed and weighed. It is then stored in the chill room for further operations. This raw material is taken to the washing centres for thorough washing and cleaning in big tubs. This operation removes adhering dirt, veins and other foreign matter from the meat. This can also be done with a washing machine.

Draining and rechecking of the quality and grades :- Rechecking of quality and grades are highly essential to keep the product within the prescribed standard limit. The proper draining of the material will help to give the required drained weight of the frozen and thawed product. This is done on a perforated aluminum or steel table. Usually, more care has to be taken to reduce handling from this stage onwards. Upon re-checking and draining, the material is sent for final weighment(2 Kg + Excess weight required) before packing.

Weighing :- The weighment and grade checking have to be done by highly experienced persons. Extra care has to be given at this stage. Excess weight is added to the net weight of the material to compensate the drip loss during freezing and subsequent storage and thawing. The extent of weight loss during processing and thawing depends on the type of the sea-food and the way the material is treated.

Coding of waxed carton and coding of meat :- After weighing, the material is passed on to the respective filling and setting stations. Before this process, simultaneously while weighing, codes are written on the waxed carton and a code slip showing the date of production, grade, factory code etc. is also put in the pack.

Filling in waxed duplex carton :-A duplex carton marked with the specific grade is put on the table and a washed high density polythene sheet is placed in the carton. The material is wrapped in the polythene sheet and packed in the duplex carton.

Glazing :- Immediately after packing, chilled glaze water with 5-10 ppm. available chlorine is added to the pack. The quantity of the glaze water is usually 10% of the weight of the material packed.

Setting in Freezer trays :- After packing, the packed duplex cartons are systematically arranged in metal trays (4 slabs/ tray) which are immediately loaded in trolleys to take it to the plate freezer for freezing at -40°C (Quick freezing). Freezing is done as described for the production of Frozen Headless Shell-on Shrimp.

Master cartoning and storing :- The frozen blocks after unloading from the freezer is packed in master cartons (10 slabs/ master carton) and stored as in the case of the production of Frozen Headless Shell-on Shrimp.

The standardized flow chart of the processing of Frozen Peeled and Undeveined Shrimp is given in flow chart No. 2.

The time study observation and result of the processing of the product is given in table 3. The study started with the peeling of shrimp shell (activity No. 1) in the pre-processing hall. It is followed by grading and sorting of the material into different grades and quality.

Washing is the first activity in the processing plant. Most of the activities for the production are similar to that of the production of Frozen Headless Shell-on Shrimp except setting of the materials. In this case, layering of the material is not done as in the case of Headless Shrimp. This

FLOW CHART - 2.

FROZEN PEELED AND UNDEVEINED SHRIMP

Peeling of raw shrimp
↓
Grading and washing

(Activities at the pre-processing centre.)

↓
Washing
(at processing plant)
↓
Draining & rechecking of quality & grades
↓
Weighing
↓
Filling in duplex carton ← Coding of duplex carton & code slip writing.
↓
Glazing
↓
Setting in freezer trays
↓
Loading into the freezer
↓
Freezing at -40°C in plate freezer
↓
Unloading
↓
Master cartoning
↓
Sealing of master carton
↓
Storing at -23°C

TABLE: 3.

TIME STUDY OBSERVATIONS ON THE PROCESSING OF FROZEN PEELED AND UNDEVEINED SHRIMP IN FISH PROCESSING PLANT

Act. No.	Name of the activity	Start event	End event	Turn-over Qty.	No.of work-ers invo-lved	Normal time (Min.)	Range of observations (Min.)	No. of obser-vat-ions taken
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
PRE-PROCESSING ACTIVITIES								
1.	Peeling of shrimp	Started peel-ing of shrimp	Completed peeling & worker is ready to receive next lot.	5 Kg.	1 F	70.500	65.00-75.00	4
2.	Grading & sorting	Started grad-ing & sorting	Completed grading & sorting & second lot is kept ready.	10 Kg.	5 F	21.000	18.00-24.00	6
PROCESSING ACTIVITIES								
3.	Washing	Started scoo-ping the mat-erial	Workers ready for scooping next lot of R.M.	25 Kg.	3 M	0.856	0.50- 1.00	15
4.	Draining & rechecking	Started re-checking	Worker ready for working on next lot	,,	1 F	4.438	3.90- 5.10	8

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CONTINUATION OF TABLE: 3.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
5.	Weighing	Started scooping the material for weighing	Worker ready for weighing next lot.	1 slab	1 F	0.137	0.116-0.166	17
6.	Coding	Started coding	worker ready for coding next lot	,,	1 F	0.137	0.117-0.167	17
7.	Distribution to respective sites.	Started taking the coded material for distribution	Distribution completed & worker ready to receive next lot.	,,	1 F	0.137	0.117-0.167	17
8.	Filling in D.C.	Started the filling process	Worker ready to receive next lot.	,,	1 F	0.588	0.530-0.610	15
9.	Glazing	Started opening the D.C. for glazing	Carton kept ready for setting in F.T. and worker ready to receive next lot.	50 slabs	1 F	4.882	4.580-5.100	14
10.	Setting in F.T.	Started setting	The trays kept ready for loading in trolley	25 slabs	1 F	4.882	4.580-5.100	14
11.	Loading in trolleys & transporting to freezer	started loading	Material kept ready for loading into freezer & worker ready for loading next lot	,,	1 M	4.882	4.580-5.100	14

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CONTINUATION OF TABLE:3.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
12.	Loading into the freezer	started picking the first tray for loading	completed closing the freezer door for freezing	220 slabs	1 M	5.190	4.900-5.500	10
13.	Freezing	Completed closing the freezer door for freezing	Started opening the freezer door for unloading	,,	-	180.000	Fixed time	-
14.	Unloading	Started opening the freezer door for unloading	Unloading of the last slab from the last tray completed	,,	**	13.000	12.500-13.500	6
15.	M.Cartoning	Started keeping ready the M.C.	Worker ready for receiving next lot for M. cartoning.	1 M.C.	1 M	0.841	0.670- 1.170	23
16.	Sealing of M.C.	Started lifting M.C. for sealing	Completed keeping ready the sealed M.C. ready for storing & workers free to receive next lot.	,,	2 M	1.140	0.750- 1.420	16
17.	Storing	Started loading of sealed M.C. on trolleys.	Completed storing & worker free to receive next lot.	22 M.C.	1 M	28.950	28.700-29.053	4

* Grading and sorting of PUD shrimp into 100-200, 200-300, 300-500 and Broken grades and sorting out foreign particles and spoiled meat.

** For unloading of the frozen blocks from the freezer, the same worker who is loading the material into the freezer is used.

Preparatory activities are the same as that of frozen Headless shell-on shrimp (table:1) reduces the cycle time of production to some extent.

The normal time, allowances, workers requirement, and turnover quantity at different stages of production is worked out and is given in table 4. This is for the production of one batch of product.

3.3. Frozen Peeled and Deveined Shrimp (P D)

The following raw materials are used for the production of Frozen Peeled and Deveined Shrimp.

Scientific name	Commercial name
Metapenaeus dobsoni	Poovalan/brown shrimp
Metapenaeus monoceros	Choodan shrimp
Penaeus indicus	Naran/white shrimp

Method of production:-

The method of production is similar to that of Frozen Peeled and Undeveined Shrimp. The only difference is, instead of peeling alone as in the case of P U D shrimp, deveining also is done to get peeled and deveined product.

Usually it goes in two types of pack - 2.27 Kg pack (5 lbs) and 2 Kg pack. The first one is the popular pack.

The extra time taken for the production of this product is only at the stage of peeling and deveining. Hence time study was conducted to know the time requirement for this activity. The result of the observation is given in table 5.

The normal time, allowances, number of workers required

TABLE: 4.

TABLE SHOWING THE NORMAL TIME, ALLOWANCES, STANDARD TIME AND NUMBER OF WORKERS INVOLVED IN VARIOUS ACTIVITIES FOR THE PROCESSING OF 220 SLABS (ONE BATCH) OF FROZEN PEELED AND UNDEVEINED SHRIMP

(Time in minutes)

Act. No.	Name of the activity	Turn-over Qty.	Normal time (Min.)	Personal Allowance		Standing & fatigue Allowance		Process & other All-owances		Std. time (Min.)	No. of Work-ers
				%	time	%	time	%	time		
(1)	(2)	(3)	(4)		(5)		(6)		(7)	(8)	(9)
1.	Peeling	1,000 Kg.	14,100.00	5	705.00	10	1410.00	5	705.00	16,920.00	1 F
2.	Washing	500 Kg.	17.12	5	0.86	10	1.71	17	2.91	23.00	3 F
3.	Grading & sorting	,,	1,050.00	5	52.50	10	105.00	5	52.50	1,260.00	5 F
4.	Second washing	,,	17.12	5	0.86	10	1.71	17	2.91	23.00	3 F
5.	Draining & rechecking	,,	92.76	5	4.64	10	9.28	17	15.77	122.44	1 F
6.	Weighing	220 slabs	30.14	15	4.52	15	4,52	30	9.04	48.22	1 F
7.	Coding	,,	30.14	15	4.52	15	4.52	30	9.04	48.22	1 F
8.	Distribution to respective work sites	,,	30.14	15	4.52	15	4.52	30	9.04	48.22	1 F
9.	Filling/setting in D.C	,,	129.36	2	2.59	3	3.88	4	5.17	141.01	1 F
10.	Glazing	,,	48.82	2	0.97	3	1.47	4	1.95	53.21	1 F
11.	Setting in Fr. trays	,,	48.82	2	0.97	3	1.47	4	1.95	53.21	1 F
12.	Loading into trolleys & taking to freezer	,,	48.82	2	0.97	3	1.47	4	1.95	53.21	1 M
13.	Loading into freezer	,,	5.19	10	0.52	30	1.56	40	2.08	9.34	1 M

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CONTINUATION OF TABLE: 4.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
14.	Freezing	220 slabs	180.00	-	-	16,5 29.70	209.70	-
15.	Unloading from freezer	,,	13.00	10 1.30	10 1.30	35.0 4.55	20.15	*
16.	Master cartoning	22 M.C.	18.50	10 1.85	10 1.85	35.0 6.48	28.68	1 M
17.	M.C. Sealing	,,	24.97	5 1.25	5 1.25	25.0 6.24	33.71	2 M
18.	Storing	,,	28.95	5 1.45	5 1.45	20.0 5.79	37.64	1 M

* The same worker who is engaged in loading the material into the freezer is engaged in unloading of the frozen material from the freezer.

Note: The initial preparation is the same as that shown in table:2.

turnover quantity and standard time of this activity is worked out and is presented in table 6. The standard time required for one worker to produce peeled and deveined material required for the production of a batch of 220 slabs of 2.27 Kg each (net weight) is worked out to be 24,357.60 minutes (405.96 hours). From this we can calculate the required number of workers at this station to balance the production activities along the entire production line.

3.4. Frozen Squid Whole/Cuttle Fish (2 Kg. pack)

The following are the species of squid and cuttle fish available in South West Coast for the production of various products(Mohan Rajan, 1983).

Squids :-
1. *Loligo duvaucelli* (common species)
2. *Doryteuthis singhalensis*

Cuttle fish:-
1. *Sepia pharaonis*
2. *Sepioteuthis lessoniana*
3. *S. aculeata*
4. *S. eliptica*

The products from squid and cuttle fish are very popular in Japan, Singapore, Hongkong etc. for the last so many years. The following are the important grades used for packing Frozen Squid whole and the excess weight added to compensate drip loss:

Grades (per Kg.)	Excess weight added
Upto 3, 3 -6, 6 - 10	150 gms/2 Kg.pack
10 - 20, 20 - 40	200 ,, ,,

TABLE:5.

TIME STUDY OBSERVATION ON THE PEELING AND DEVEINING PROCESS

Name of the activity	Start event	End event	Turn-over Qty.	No.of workers involved	Normal time (Min.)	Range of observation(Min.)	No.of observations
Peeling & Deveining	Started peeling & deveining operation	Completed the work & worker ready to receive next lot.	5 Kg.	1 F	81.65	71.00-95.5	13

TABLE:6.

TABLE SHOWING THE NORMAL TIME, ALLOWANCES, WORKERS REQUIRED, TURNOVER QUANTITY AND STANDARD TIME FOR PEELING AND DEVEINING OF SHRIMP REQUIRED FOR THE PRODUCTION OF 220 SLABS OF FROZEN PEELED AND DEVEINED SHRIMP

Name of the activity	Turn-over Qty.	Normal time (Min.)	Personal Allowance		Standing & Fatigue Allowances		Process & other Allowances		Standard time (Min.)	No.of workers
			%	time	%	time	%	time		
Peeling & deveining	1,243* Kg.	20,298	5	1,014.9	10	2,029.8	5	1,014.9	24,357	1 F

* 1,243 Kg. of raw material is required to get a final yield of 220 slabs of 2.27 Kg. each with 12% allowance for excess weight added in the pack to compensate drip loss. (The yield of final product from raw material is taken as 45%)

Given below are the grades of pack of cuttle fish Whole.

Count (weight of individual pieces in grammes)

1. 50 - 100, 2. 100 - 170, 3. 170 - 300, 4. 300 - 500, 5. 500 - 700, 6. 700 - 1000.

Squid and cuttle fish are the two most sensitive raw materials to poor handling and higher temperature. These raw materials have to be kept at low temperature in crushed ice and care should be taken to prevent pressing of the material. The external pressure will rupture the ink sac and the whole meat will turn to dark black due to the spreading of the ink over the body and muscles.

The raw material is stored in big galvanized or aluminium or high density plastic tubs with crushed ice.

Washing and cleaning :- The material has to be thoroughly washed and cleaned before packing. This will help in retaining the natural colour of squid/cuttle fish.

Grading:- After washing and cleaning, the material is spread on the table for grading into different grades. The grades used are as given above. It is also noticed that grades vary with the factories. This depends on the buyers instruction to pack the product. The graded material is then kept in separate trays and at this stage the damaged, spoiled and discoloured material is discarded.

Draining and rechecking :- The graded material is immediately drained and again checked for quality. This is done on a perforated table. At this stage the grades are also rechecked.

Weighing :- The weighing is done in a small common balance. The material is packed as 2 Kg. blocks.

Coding :- The coding is done to find out the size grade, date of packing and the name of the exporter. This is done simultaneously with weighing. In the case of whole squid and whole cuttle fish packing, the duplex carton is avoided by most of the processors based on the instruction of the buyers. This helps in reducing the cost of production by Rs. 1.60 per two Kg block. The time study is conducted for the production of these products without duplex carton for packing the material.

Setting in freezer trays and loading in trolleys :- The weighed and coded material is directly packed in freezer trays using polythene sheets. Each tray contains four slabs of 2kg. each. It is then loaded into the trolleys for taking it to the freezer.

Loading into the freezer :- Loading is done after unloading the already loaded frozen material. The capacity of the freezer varies with the make and from factory to factory. The study was conducted with a freezer having a capacity of 220 slabs per batch (Load).

Freezing :- The freezers which are in use in seafood processing plants in Kerala have a normal freezing time of 3 hours or 1½ hours depending on the type of freezer used. After freezing the frozen blocks are unloaded on a table for master cartoning. Ten frozen slabs of 2 kg net weight each are packed in a master carton. It is then sealed and stored at -23°C.

The flow chart for the production of Frozen Squid whole/ Cuttle Fish Whole is shown in Chart No.3. The time study observation and the result of the processing of the products is given in table 7. The study started with the raw material transportation from chill room to washing station in the processing hall. The flow of activities are similar to that of other products discussed earlier. The normal time, allowances, number of workers involved, turnover quantity and standard time required for the production of 220 slabs of frozen products is given in table 8.

3.5. Frozen Squid Tube :-

The same species used for the production of frozen Squid Whole is used for the production of frozen Squid tube also. The grade of packing and the excess weight added under different grades are given below:

Grades (No. of pieces /Kg)	Excess weight added
Upto 10, 10 - 20,	150 gms./2 Kg. pack
20 - 40, 40 - 60	200 ,, ,,
60 - 80, 80 & Up	300 ,, ,,
80 & Up (if not fresh)	350 ,, ,,

Process Description

Only very fresh raw material is to be used for the production of Frozen Squid tube.

FLOW CHART - 3.

FROZEN WHOLE SQUID / CUTTLEFISH

Raw material transportation from chill room to washing station

↓

Washing and cleaning

↓

Grading

↓

Draining and rechecking

↓

Weighing

↓

Coding

↓

Setting in freezer trays and loading in trolleys

↓

Loading into the freezer

↓

Freezing

↓

Unloading

↓

Master cartoning

↓

Sealing of master carton

↓

Storing

TABLE: 7.

TIME STUDY OBSERVATION ON THE PROCESSING OF FROZEN WHOLE CUTTIE FISH/SQUID (2 KG. SLABS WITHOUT DUPLEX CARTONS)

Act. No.	Name of the activity	Start event	End event	Turn-over Qty.	No.of workers involved	Normal time (Min.)	Range (Min.)	No.of observations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.	R.M. transportation from chill room to washing site	Started keeping ready tubs for loading.	Workers ready for working on the next lot.	100 Kg.	2 M	4.670	3.17 - 6.20	23
2.	Washing & cleaning	Started scooping the material for washing & cleaning	Completed loading of cleaned material in tub containing ice & worker is ready to receive next lot.	25 Kg.	1 F	1.943	1.82 - 2.00	4
3.	Grading	Started scooping the material for grading	Completed unloading the graded material for next operation and workers ready to work on next lot.	,,	4 F	1.410	1.16 - 1.67	8

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CONTINUATION OF TABLE: 7.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
4.	Rechecking & Draining	Started taking the material for rechecking	Completed re-checking & draining & material kept ready for next operation. Worker ready to start on next lot	25 Kg.	1 F	0.940	0.90- 1.10	8
5.	Weighing	Started scoop-ing	Completed the process and worker ready to scoop next lot.	1 slab	1 F	0.128	0.67- 0.20	37
6.	Coding	Started taking code slip	Completed the process & wo-rker ready to code next slip	,,	1 F	0.128	0.67- 0.20	37
7.	Filling	Started keeping the trays ready for filling	Completed set-ting of trays in trolleys & workers ready to start next cycle.	4 slabs	2 F	2.040	2.00- 0.24	15
8.	Moving the trolley loaded with material to freezer	Started moving the trolley	Completed kee-ping the mat-erial ready for loading into the free-zer & worker free to hand-le the next lot.	80 slabs	1 M	0.939	0.75- 1.20	9

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CONTINUATION OF TABLE: 7.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
9.	Loading into the freezer	Started picking the first tray for loading	Completed closing the freezer door	220 slabs	1 M	5.19	4.90- 5.50	10
10.	Freezing	Completed closing the freezer door & freezing started	Started opening the freezer door for unloading	,,	-	180.00/* 90.00	- -	-
11.	Unloading	Started opening the freezer door	Completed unloading the last tray.	,,	**	13.00	12.50-13.50	6
12.	Master cartoning	Started keeping ready the M.C.	Completed keeping ready the packed carton for sealing.	1 M.C.	1 M	0.84	0.67- 1.17	22
13.	Sealing of M.C.	Started lifting the M.C for sealing	Completed keeping ready the sealed M.C. for storing.	,,	2 M	1.14	0.75- 1.14	16
14.	Storing	Started loading of M.C. in trolley	Worker completed storing and ready to store the next lot.	22 M.C.	1 M	28.95	28.70-29.05	4

* Freezing time depends on the type of the freezer used.

** For unloading operation, the same worker who is engaged in the loading of the material into the freezer is used.

TABLE SHOWING THE NORMAL TIME, NUMBER OF WORKERS INVOLVED, TURNOVER QUANTITY AND STANDARD TIME FOR PROCESSING OF 220 SLABS OF FROZEN WHOLE CUTTLE FISH/ WHOLE SQUID

Act. No.	Name of the activity	Turn-over Qty.	Normal time (Min.)	Personal Allowance		Standing & Fatigue Allowances		Process & other Allowances		Std. time (Min.)	No. of workers
				%	Time	%	Time	%	Time		
(1)	(2)	(3)	(4)	(5)		(6)		(7)		(8)	(9)
1.	R.M. transportation from the chill room to washing site	500 Kg.	23.35	2	0.467	3	0.701	2	0.467	24.99	2 M
2.	Washing & cleaning	,,	38.86	5	1.943	10.0	3.886	17	6.606	51.30	1 F
3.	Grading	,,	28.20	5	1.410	10.0	2.820	17	4.794	37.22	4 F
4.	Rechecking & draining	,,	18.80	5	0.940	10.0	1.880	17	3.196	24.82	1 F
5.	Weighing	220 slabs	28.16	15	4.224	15.0	4.224	30	8.450	45.06	1 F
6.	Coding	,,	28.16	15	4.224	15.0	4.224	30	8.450	45.06	1 F
7.	Filling, setting in trays glazing and loading in trolleys	,,	112.20	2	2.244	2.5	2.805	10	11.220	128.47	2 F
8.	Transporting the material to the freezer	,,	2.81	2	0.056	2.5	0.070	--	-	2.94	1 M
9.	Loading into the freezer	,,	5.19	10	0.519	30.0	1.557	40	2.076	9.34	1 M
10.	Freezing	,,	180.00/* 90.00	--	-	--	-	16.5	29.700/ 14.850	209.70/ 104.85	-
11.	Unloading	,,	13.00	10	1.300	10.0	1.300	35.0	4.550	20.15	**
12.	Master cartoning	22 M.C.	18.48	10	1.850	10.0	1.850	35.0	6.468	28.64	1 M
13.	Sealing of M.C.	,,	25.12	5	1.254	5.0	1.254	25.0	6.270	33.86	2 M
14.	Storing	,,	28.95	5	1.450	5.0	1.450	20.0	5.790	37.64	1 M

* Freezing time depends on the type of freezers used; ** For unloading the frozen blocks the same worker who is engaged for loading into the freezer is used.

Peeling and cleaning of tube :- The head, skin, squid pen, fins and gut contents are removed. The remaining mandle is washed and cleaned to remove adhering dirt, ink stain, gut portions etc. from both inside and outside the tube.

Final washing and icing :- The squid tube thus prepared is further washed in chlorinated water and temporarily stored in ice.

Trimming of the rim of the mantle :- As per the buyers specification, the brown rim of the squid tube has to be trimmed off. This has to be done by expert workers as the improper cutting reduces the yield of the final product. On an average 5% of yield loss is noticed in this process. This is due to the lack of skill and training of the workers who are engaged in this job. This can be reduced to not more than 3% with proper training and selecting suitable workers for the job. After trimming the material is washed to remove adhering trimmed meat from the tube.

The rest of the activities are similar to that of the processing of Frozen Squid Whole as described earlier. The standardized flow of production is given in the Flow chart No. 4. The time study observation and its result are given in table 9. The normal time, allowances, number of workers required at each stage of processing, turnover quantity and standard time for each activity is given in table 10.

FLOW CHART - 4.

FROZEN SQUID TUBE

Peeling and cleaning
↓
Washing and icing
↓
Trimming of mantle rim
↓
Washing
↓
Grading
↓
Draining and rechecking
↓
Weighing
↓
Coding
↓
Setting in freezer trays and loading in trolleys
↓
Loading into the freezer
↓
Freezing
↓
Unloading
↓
Master cartoning
↓
Sealing of master carton
↓
Storing

TABLE: 9.

TIME STUDY OBSERVATION ON THE PEELING AND CLEANING, TRIMMING AND FINAL WASHING PROCESSES FOR THE PRODUCTION OF FROZEN SQUID TUBES

Name of the activity	Start event	End event	Turn-over Qty.	No. of workers invol-ved	Normal time (Min.)	Range of Observations (Min.)	No.of obse-rvat-ions
Peeling & cleaning	Started peel-ing & clean-ing process	Worker ready for starting work on the next lot of material	25 Kg.	1 F	103.92	98.00-115.00	12
Trimming the rim of the mantle	Started trim-ing process	Worker ready to work on the next lot.	1 Kg.	1 F	1.37	1.23-1.44	26
Final washing	Started wash-ing process	Worker ready to work on the next lot.	25 Kg.	1 F	6.67	6.66-7.08	6

Note: Rest of the activities are similar to that for the processing of frozen whole cuttle fish/squid as given in table: 7.

TABLE: 10.

TABLE SHOWING THE NORMAL TIME, ALLOWANCES, NUMBER OF WORKERS INVOLVED, TURNOVER QUANTITY AND STANDARD TIME REQUIRED FOR THE PROCESSING ACTIVITIES FOR THE PRODUCTION OF 220 SLABS OF FROZEN SQUID TUBES

Name of the activity	Turn-over Qty.	Normal time (Min.)	Personal Allowance		Standing & fatigue Allowance		Process & other Allowances		Standard time (Min.)	No.of work-ers invol-ved
			%	time	%	time	%	time		
Peeling & cleaning*	1,132 Kg.	4,705.04	5	235.25	10	470.50	5	235.25	5,646.00	1 F
Trimming**	610.58 Kg.	838.94	5	41.95	10	83.89	5	41.95	778.37	1 F
Final washing	592.80 Kg.	262.13	5	13.11	10	26.22	5	13.11	314.57	1 F

Note: Rest of the activities are similar to that for the processing of frozen cuttle fish/squid as given in table:8.

* 1,131.89 (1,132 approximately) Kg. of raw material is estimated to be required for obtaining 592.80 Kg. of frozen squid tube ie. 220 slabs of 2 Kg. net drained weight.

** 610.58 Kg. of peeled and cleaned squid tube before trimming yields 220 slabs of frozen squid tubes.

3.6.Canned shrimp

Description of shrimp canning process :-

Small size shrimp is used for canning. The main species used are *Metapenaeus dobsoni*, *Parapenaeopsis stylifera*, *Metapenaeus monoceros*, *Penaeus indicus* etc. Very fresh raw material should be used for canning purpose.

Grades of canned shrimp	No. of pieces/100gms.
1. Supreme Jumbo	Below 8
2. Jumbo	9 - 13
3. Large	14 - 22
4. Medium	23 - 36
5. Small	37 - 63
6. Tiny	64 -102
7. Cocktail	103- & above
8. Broken	

Peeling and deveining :- Raw material after proper washing is manually peeled and deveined to get peeled and deveined material. This is the starting raw material in a shrimp canning plant. During this process, the entire shell covering and intestinal tract are removed and is washed and stored in ice.

Weighing :- The peeled and deveined material is further washed thoroughly to remove the adhering shell, intestinal portions and other foreign particles. This will also improve the appearance of the meat. The meat is then drained and kept ready for pre-cooking operation.

Pre-cooking/blanching :- This is the process by which the raw material is heat treated before filling in cans. The material is immersed in hot brine. Duration of cooking depends on the size and species of shrimp used.Usually it is between 5 to 7 minutes. This is a batch operation and the study is conducted by using steam as the heating agent. After pre-cooking for the desired time, it is drained and kept over a perforated table to cool the material.

Cooling :- The pre-cooked material is spread properly over the perforated steel tables to facilitate quick cooling. A fan is to be provided for quick cooling to avoid over cooking of the meat.

Sieving :- The cooked material is sieved properly to remove the powdered meat and broken pieces. (Broken pieces have no market at present) This is done over a sieving table. The sieved material is then transferred to the grading and sorting tables.

Grading and sorting :- The sieved material is graded as per the count size and unwanted meat, foreign particles and poor quality meat are discarded at this stage.

Filling and weighing :- The can is filled with hot brine and is covered with a lid after the graded and weighed material is taken in the can. It is then kept ready for the exhausting operation.

Exhausting :- The study was carried out with a conveyor exhauster. The exhausting time can be adjusted by adjusting the speed of the conveyor motor. For exhausting, the material is kept at one end and collected at the other end for seaming operation.

Double seaming :- This is done with a semi-automatic seaming maching. This is operated by an operator. The can for the seaming operation is picked up by the operator himself from the final end of the exhaust conveyor. After seaming, it is put in a cooling tank containing water. This prevents overcooking of the meat.

Retorting :- The cooled can after seaming is taken in a retort basket and loaded into the retorter using a crane and pulley arrangement. The retorting is done for 15 minutes at 15 p s i. After retorting the cans are taken out and immediately cooled by dipping in water contained in a tank. The water in the tank is properly chlorinated as per Central Institute of Fisheries Technology recommendation .

Cooling :- For cooling, 30 minutes is more than sufficient. it will vary depending on the size of the can and the bulk. After cooling, the baskets containing the cans are taken out and kept outside for drying the surface . The cooling process is adjusted in such a way that when the cans are taken out of the cooling tank, they will have a temperature of around 40°C. This will help to dry the surface of the can quickly when taken out of the cooling tank.

Wiping :- The cooled can is then wiped with a cloth to remove any adhering water. It is then kept ready for oiling.

Sorting of cans of different grades :- This is done to paste the label of the respective grades and pack the cans in different cartons as per the grades.

Gum coating on labels and Labelling:- The labels to be pasted on the cans are fixed on them using gum. The gum coated labels are fixed on to the cans. The labels carry the brand name, grade of the product, net weight and date of packing.

Master cartoning :- 24 cans of the same grade are packed in a master carton. After the arrangement of cans in the master carton, the carton is moved to the next stage of operation ie. master carton sealing. For sealing the master cartons, gum is coated on the lids of it and is fixed properly. It is then sealed with paper tapes. After this operation, the master carton is ready for storing.

Storing :- Cans are stored in a clean and dry place at room temperature. Storing is done grade wise and date wise.

The flow of production of canned shrimp is given in flow chart No. 5. The result of the time study on the processing of canned shrimp is summarised in table 11. The study started with the peeling and deveining of shrimp. Grading and sorting (including rechecking of quality) is the most labour intensive activity in the canning process apart from peeling and deveining. The standard time and man hour requirement of different activities in the canning process is presented in table 12.

FLOW CHART - 5.

CANNING OF SHRIMP

Peeling & deveining of shrimp
↓
Washing
↓
Pre-cooking (in 4 - 8% brine & .3% citric acid for 5 - 7' depending on size)
↓
Cooling
↓
Seiving
↓
Grading & sorting
↓
Checking of quality and grades
↓
Weighing and filling
↓
Exhausting by conveyor exhausting system
↓
Seaming in semi-automatic machine
↓
Cooling in galvanized drum
↓
Retorting at 15'p s i for 15' in retort by steaming
↓
Cooling
↓
Wiping
↓
Oiling the outside of the can
↓
Sorting of cans for different grades
↓
Gum coating for labels
↓
Labelling of cans
↓
Master cartoning (24 cans per carton)
↓
Master carton pasting
↓
Master carton sealing
↓
Stocking in store at room temperature

TABLE: 11.

TIME STUDY OBSERVATION ON THE PRODUCTION OF CANNED SHRIMP (301 X 203 SIZE CAN- 128 GRAM NET WEIGHT PACK)

Act. No.	Name of the activity	Start event	End event	Turn-over Qty.	No. of work-ers	Normal time (Min.)	Range of observ-ation	No. of obs-erv-ations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.	Peeling & deveining	Kept ready the R.M. for peeling and de-veining.	Worker Comp-leted the peeling & deveining process.	5 Kg.	1 F	81.65	71.00-82.93	13
2.	Washing (final)	Started the washing process	Completed arranging the the next lot of R.M. for washing.	100 Kg.	2 F	60.00	57.00-63.00	4
3.	Precooking*	Kept the boiling brine ready for loading the meat	Unloading of the cooked meat complet-ed	30 Kg.	1 M	9.50	9.00-10.00	5
4.	Cooling of** cooked meat	Started spreading of the cooked meat	Material ready for sieving	,,	X	10.00	- -	-
5.	Sieving	Started sieving	Material kept ready for next operation	10 Kg.	1 F	17.48	17.08-17.93	6
6.	Grading & sorting in-cluding re-checking of quality	Started grading & sorting	Material kept ready for next operation	5 Kg.	1 F	78.98	77.93-80.33	5

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CONTINUATION OF TABLE: 11.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
7.	Filling & weighing	Started picking the first can for filling & weighing	Completed keeping the last can for filling of brine	10 cans	3 F	0.730	0.68-0.83	15
8.	Filling of brine	Started filling the first can	Completed keeping the last can for next operation	,,	1 F	0.371	0.33-0.42	15
9.	Exhausting by conveyor	Started keeping the first can for exhausting	Completed the exhausting operation of the last can	121 cans	1 F	8.000	120 to 123 cans 0.79-0.81	8
10.	Seaming in semi-automatic seaming machine(Cap. 1200 cans/ hour)	Started seaming the first can	Completed seaming the last can	100 cans	1 M	5.884	5.50-6.33	8
11.	Retorting	Started collecting the first can for loading into the retort	Completed unloading the retorted cans	400 cans	1 M	30.590	29.00-30.67	6
12.	Cooling	Started cooling	Kept the cans ready for wiping	,,	XX	30.000	- -	-
13.	Wiping	Started wiping the first can	Kept ready the last can for oiling	75 cans	1 F	4.590	4.17-5.00	5
14.	Oiling	Started oiling the first can	Completed oiling the last can	,,	1 F	4.440	3.99-4.87	5
15.	Grading & sorting	Started grading & sorting	Completed grading & sorting	,,	1 F	1.860	1.67-1.95	10

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CONTINUATION OF TABLE:11.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
16.	Gum pasting on labels	Started arranging the labels	Completed the process	75 labels	1 F	3.990	3.75-4.22	6
17.	Labelling of cans	Started labelling on the first can	Completed the labelling process	,,	1 F	7.990	7.83-8.17	5
18.	Master cartoning(24 cans/M.C.)	Started keeping ready the M.C.	Completed the process	5 M.C.	3 F	2.135	2.00-2.33	10
19.	M.C. sealing by gum pasting	Started pasting gum on the first M.C.	Completed the process	,,	4 F	1.170	1.07-1.28	10
20.	M.C. sealing with adhesive tape	Started keeping ready the tape	Completed the pasting operation	,,	4 F	1.510	1.33-1.78	7
21.	Storing	Started the storing of the first M.C.	Completed the storing process.	20 M.C.	2 F	2.290	2.12-2.33	6
		OTHER CONCURRENT ACTIVITIES REQUIRED FOR CANNING OPERATIONS						
1.	Coding on lids	Started coding	Completed the operation	50 lids	1 F	1.004	0.98-1.07	7
2.	Preparation of brine	Started arranging the utensils	Completed the preparation of brine		1 F	21.700	18.0-25.0	7
3.	Keeping ready the R.M in the canning hall	Started arranging the trolleys for loading the material	Completed the process	500 Kg.	2 F	21.000	20.0-22.0	3

R.M. = Raw material; F = Female; M = Male, M.C. = Master carton;
* = The study was conducted in a precooking tank having a capacity of 30 Kg./load
** = A cooling time of 10 minutes is recommended to maintain uniform yield of product.
X = This activity does not require separate worker as the spreading of meat is done by the worker who is precooking the meat.
XX = The same worker who is engaged in the activity No. 11.

TABLE: 12.

TABLE SHOWING THE NORMAL TIME, ALLOWANCES, NUMBER OF WORKERS INVOLVED, TURNOVER QUANTITY AND STANDARD TIME REQUIRED TO PROCESS 1,000 KILOGRAMMES OF RAW SHRIMP FOR THE PRODUCTION OF CANNED SHRIMP(in 128 gms. net weight pack)

Act. No.	Name of the activity	Turn-over Qty.	Normal time (Min.)	Personal Allowance		Standing & fatigue Allowance		Process & other Allowances		Stand. time (Min.)	No.of work-ers
				%	Time	%	Time	%	Time		
1.	Peeling & deveining	1,000 Kg.	16,330	5	816.5	10	1,633.0	5	816.5	19,596.00	1 F
2.	Washing*	500 Kg.	300	5	15.0	10	30.0	5	15.0	360.00	2 F
3.	Pre-cooking	500 Kg.	158.33	10	15.83	10	15.83	15	23.75	213.74	1 M
4.	Cooling**	300 Kg.	158.33	-	-	-	-	15	23.75	182.08	-
5.	Sieving	,,	524.40	5	26.22	10	52.44	15	78.66	681.72	1 F
6.	Grading & sorting***	275 Kg.	4343.9	5	217.20	10	434.39	5	217.20	5,212.49	1 F
7.	Filling & weighing	1,894 cans	138.26	5	6.91	10	13.83	5	6.91	165.91	3 F
8.	Filling of brine	,,	70.27	5	3.51	10	7.03	5	3.51	84.32	1 F
9.	Exhausting	,,	125.22	-	-	-	-	5	6.26	131.48	1 F
10.	Double seaming	,,	111.44	15	16.72	15	16.72	15	16.72	161.60	1 M
11.	Retorting @ 400 cans/batch	,,	152.93	-	-	10	15.29	10	15.29	183.51	1 M
12.	Cooling @ 400 cans/batch	,,	150.00	-	-	5	7.50	10	15.00	172.50	-
13.	Wiping of can surface	,,	115.79	5	5.79	10	11.58	5	5.79	138.95	1 F
14.	Oiling the can exterior	,,	112.12	5	5.61	10	11.21	5	5.61	134.55	1 F
15.	Grading & sorting of cans	,,	46.92	5	2.35	10	4.69	5	2.35	56.31	1 F

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CONTINUATION OF TABLE: 12.

Act. No.	Name of the activity	Turn-over Qty.	Normal time (Min.)	Personal Allowance		Standing & fatigue Allowance		Process & other Allowances		Standard time (Min.)	No. of workers
				%	Time	%	Time	%	Time		
16.	Gum pasting on labels	1,894 labels	100.69	5	5.03	10	10.07	5	5.03	120.32	1 F
17.	Labelling on cans	1,894 cans	201.72	5	10.09	10	20.17	5	10.09	242.07	1 F
18.	Master cartoning	,, (79 M.C)	33.73	5	1.69	10	2.37	5	1.69	40.48	3 F
19.	Pasting of gum on M.C.	,,	18.50	5	0.93	10	1.85	5	0.93	22.21	4 F
20.	Master carton sealing	,,	23.93	5	1.20	10	2.39	5	1.20	28.72	4 F
21.	Storing	,,	9.03	5	0.45	10	0.90	5	0.45	10.83	2 F

* = After peeling and deveining the material will be reduced to 50 %.

** = After pre-cooking, the cooked yield of the peeled and deveined material will be around 60% of the raw material.

*** After sieving operation the yield is further reduced to 55% of the uncooked peeled and deveined meat.

Note: After grading and sorting also the yield will be further reduced to about 50% of the raw peeled and undeveined meat. This is due to the removal of spoiled, discoloured and broken pieces from the sieved meat. The net weight added per can is 128 gms and an excess weight of 4 gms. per pack is added to compensate the loss in weight during processing and storage.

SCHEDULING AND PRODUCTION CONTROL IN SEAFOOD PROCESSING PLANTS

1. INTRODUCTION

1.1. Master production schedule :- A master production schedule is a list showing how many numbers of each items to be manufactured in each period of time in the future. Once made up, it remains fixed for the immediate future, so that production can progress. Master schedules are usually changed as time moves along in response to changed conditions (Levin, et al., 1972).

The first step in the master scheduling is the sales forecast. It permits the determination of the factors of production which must be on hand if the shipping schedule suggested by the sales forecast is to be met. Once the sales forecast in terms of physical units for various products has been prepared, the next task is to translate this forecast into the demand it generates for various factors of production (Mayer,1968).

One of the major functions of master schedule when manufacturing to stock is to smoothen the difference as much as possible between irregular sales and steady production, largely by using inventories to cushion the differences. This has the effect of 'decoupling' production from sales. But the situation in the seafood industry is just the opposite ie., the production is irregular due to the seasonality of raw material availability, whereas the demand can be considered as steady throughout the year. The demand peak is not that much steep as in other industries. The seafood processing factories usually receive buyer's orders to supply (export) the seafoods for a long period of time in instal - ments. This is based on the seasonality and availability of a particular species of fish. To cite an example, a buyer may ask the processor to export a particular product within 3 months'time. He may allow the processors to despatch the products in small quantities as and when available during the three months period. This helps to smoothen the production in the processing factories. Moreover, this helps to avoid unnecessary accumulation of finished products in the cold store.

1.2. The Production Planning and Control Process :-

The production is the organisation's nervous system. Production control helps the factory to decide what kind of products to make, how much to make and when to make them. Each input and output and each processing step must be controlled day by day to achieve the planned capacity and to do an acceptable job of meeting customer demands. If the capacity available is not scheduled efficiently, men and equipment can be idle as is found in the study, reducing effective capacity. Although scheduling decisions and their implementation are highly detailed and are tactical rather than strategic, they are important to the long run success of the organisation.

As we look at the task of selecting a desired timing and sequencing for operations and activities in the organisations, we will assume that the sequence in which the operations are to be performed on a single customer, customer order, or project has been pre-determined by the designers of the product and process, and that the required order has been established. The job remaining is the priority with which these various products are being prepared within a single facility. The generalizations that can be made out about sequencing and timing procedures centre round two sets of attributes - 1. the process type, that is flow shop, job shop or fixed location and 2. the nature of uncertainities encountered, example, the arrival of tasks, the length of tasks, the flow of tasks and the completion time of tasks. In each case, careful attention has to be given also to the specific criteria by which the choice of a sequence is to be judged. There are a number of managerial and organisational considerations to be taken into account in understanding the content of scheduling and dispatching decisions.

The figure 1 shows the hierarchy of sequence of decisions in an organisation. Long range planning involves the sequencing of events at a higher level of aggregation far into the future. Figure 2 illustrates the much more complex but realistic relationships between sequencing decisions.

In any large operations, there are many persons involved

FIGURE: 1.

SIMPLE HIERARCHY OF SEQUENCING DECISION

LONG RANGE PLANNING

CAPITAL INVESTMENT PROGRAMS

AGGREGATE PRODUCTION SCHEDULING

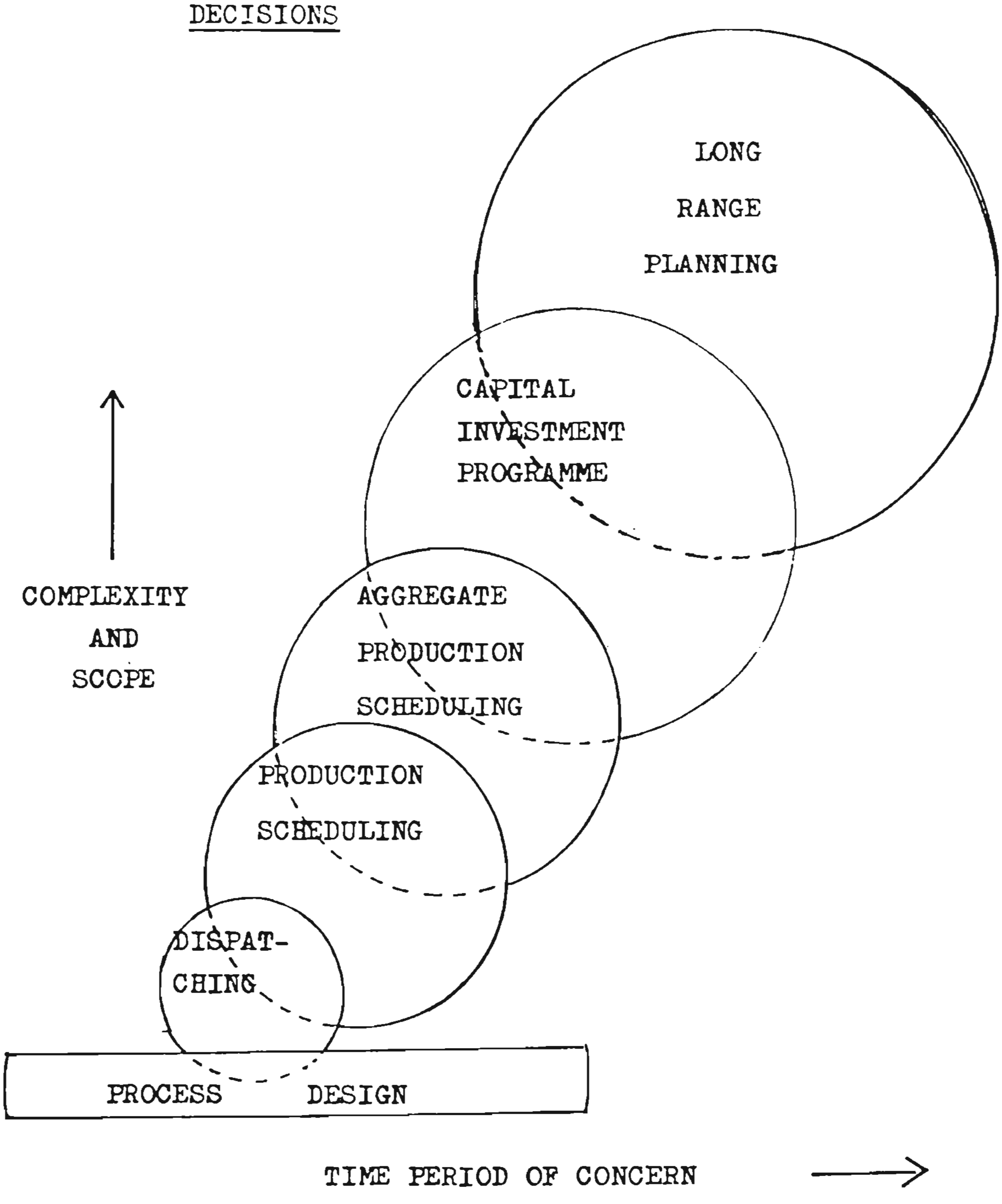
PRODUCTION SCHEDULING

DISPATCHING

PROCESS DESIGN

Source : Production/Operations Management Edted. Richard-
I Levin, et al., Mc. Graw-Hill, Inc., 1972,
New York.

FIGURE: 2. RELATIONSHIPS AMONG AREAS MAKING SEQUENCING DECISIONS



Source : Production/Operation Management, Richard. I. Levin, Mc. Graw-Hill, Inc., 1972, New York.

in controlling various aspects of the production process. Control is an information decision making process which must be operated parallel to the physical or information conversion process to be controlled. In order to meet the needs of the organisation, all these activities, both direct production and indirect control, must be managed smoothly. As techniques for process and product design have gradually enabled management to reduce direct labour and material requirements, managers have begun to look for other ways to compete. Consequently greater importance has been given to labour and equipment utilisation, to reduce volumes of work in progress and finished goods inventory, and to the ability of the system to respond to proliferating product lines and to demands for improved delivery and product quality.

1.3. Situation in the seafood processing industry

Unlike in other industries, the situation in the seafood processing industry is entirely different. As per the study conducted by Marine Products Export Development Authority, Cochin, on the demand pattern of various marine products in a number of fish importing countries, India can export any quantity of Shrimp, lobsters, squid, cuttlefish and other marine products. But our production and export are centred round shrimp product alone. In 1985, 61.64% of the total quantity of 80,585 tonnes exported from India was shrimp based products (Anon., 1985c). But the shrimp resource is limited and its landing is stagnating round 1,16,814 tonnes which gives only 58,407 tonnes (at 50% yield level) as raw material to the processing factories if all the landings are considered available for fish processing plants. With this much quantity of shrimp the industry can utilise only 12.8% of the installed freezing capacity. Moreover, the shrimp landings are highly seasonal (Anon., 1978, Anon., 1978 a, Anon., 1979 a, Anon., 1979 b).

Several workers have reported the depletion of shrimp stock in coastal waters and its overfishing. George, et al. (1980) reported signs of economic overfishing in Shakthikulangara-Neendakara area in Kerala. They pointed out that from the peak fishing in 1973 and 1975, there had been considerable reduction in the total catch as well as catch per unit effort in the subsequent years. There was a shortage of catch per unit effort showing signs of stock depletion.

Reduction in size of fish landed is considered as a sign of depletion. Rao,et al.(1980) established this fact in connection with prawn fishery of Kakinada in Andhra Pradesh. According to them there is a clear difference in prawn fishery from 1977 onwards in respect of prawn production and catch rate, species composition and sizes of the constituent species. The decrease in total catch of prawns as well as catch rate was noticed inspite of increased effort. They cautioned the present situation of drastic reduction in the catch rate of prawns in recent years along with the phenomenal increase in effort and simultaneous deterioration of sizes of exportable varieties of prawns in this area.

The studies conducted by the Central Institute of Fisheries Technology, Cochin during 1978 - 1979 period revealed that about 75% of the total freezing capacity in India was idle (Iyer, et al., 1982). This was reported to be due to the shortage of raw materials. This is because of the fact that most of the plants depend mainly on shrimp as the raw material. But due to stiff competition prevailing in the industry for shrimp in addition to the seasonality in its landing , the individual processor gets only very little raw material for the day to day running of their plants. This results in the following situation :

1. Idleness of men, machine and other facilities.
2. Frequent layoff of the plants resulting in jobless state of the workers.
3. Loss of additional income especially foreign exchange.

Diversification of products and proper selection of product mix is a solution to increase the capacity utilisation of the plants which inturn increases the profitability. Management measures are suggested to improve the productivity of the plants.

1.4. Linear Programming (L P)

The overall productivity of the industry depends on the effective utilisation of scarce resources - Materials, Man power, Machinery, Money and Management (M M M M M). Productivity does not increase by increasing production or profit. It increases only through optimum utilisation of productive resources. The increased productivity finally results in reduction of unit cost of product and also contributes to increased profit to the firm and more benefit to its employer.

Linear Programming is a widely used operations research method which is a member of a family of techniques called mathematical programming. Many problems in the area of production scheduling, financial planning and marketing strategy can be solved by Linear Programming. More and Hendrick (1978) discuss the use of simplex method for selecting product mix to maximize the contribution towards profit and overheads. They describe the entire stages of computer programming by citing an example. Hughes and Grawlog (1973) also describe the use of computer programming to solve product mix problems. Simplex method is a general algorithm that can be used to solve any Linear Programming problem of any size. It consists of arranging the constraint equations in the form of a tableau and systematically generating feasible solutions to the problem. The technique is iterative in nature where each step in the procedure generates a new tableau that represents a feasible solution. The algorithm terminates when a solution is generated that cannot be improved. Many others have also highlighted the use of Linear Programming for production scheduling (Gass, 1975; Kroeber and Forge, 1980; Srinath,1982).

Linear Programming is selected as a method for short term production planning in seafood industry in Kerala. The suitability of Linear Programming for selecting the best product mix in seafood industry is due to the following reasons.

1. In production scheduling of seafood processing plants, the problem consists of finding the combination of products to be produced during the planning period so that total contribution towards profit and overhead is maximized, and at the same time the availability of man and/or machine hours is not exceeded.
2. The production schedule will reduce the total idle time.
3. The objective and the constraints can be expressed as linear or straight line equations.
4. Linear Programming model is basically static, while the problem analysed here is dynamic. Partly to overcome this problem, the Linear Programming model has been designed as a one year multi-period model as suggested by Mikalsen and Vassdal (1981). They have divided the whole year into five equal periods. The objective function of their model was to maximize the net operating surplus during a one year period.

1.5. Gantt Load Chart

The need for developing a proper production schedule in the seafood processing industry was felt when the production process was studied. At present, there is no scientific or standardized production planning and control practised in the industry. The different types of raw materials arriving in the processing plants are being processed to the wish, convenience and interest of the technologist or supervisor. The production process varies with the technologists and hence with the change of shift itself, the production schedule changes. This results in underutilization of men, materials and facilities. It also contributes to accumulation of in-process materials at different work stations. This will affect the quality and yield of the products.

Gantt chart is used for multiple machine scheduling. It is named after Henry Gantt, a pioneer in scientific management, who developed it over fifty years ago. It can take several forms. The simplest form is a loading chart. Load chart does not tell the scheduler what he needs to know about and the date in which an order should be completed .

The criteria and especially the nature ofthe problem becomes more variable as the uncertainities increase, especially those concerning the arrival of orders and their delivery priorities as well as the processing and waiting time applying to change and to obsolescence as actual job completion times vary from the expected times of completion. Because of this many schedulers use a form of Gantt Chart that can be updated regularly to show the current date, the jobs scheduled and where time has been reserved for maintenance, rush orders, training and other things. The technique of controlling the larger, more complex flow shops can be extended to job shop, where the routings are highly variable. These routings also tend to be coupled with higher variability in waiting times, process times and delivery requirements. Here Gantt Charts are used as control devices to follow orders and schedule equipments but one has to rely more and more on the arbitary scheduling rules as uncertainity and complexity increases (Levin, et al., 1972). The preparation and use of Gantt Charts for scheduling of operations are described by various workers (Srinath, 1975; Sambadam (1978); Baumol,1982) etc.

Gantt Chart scheduling is found to be suitable for scheduling the processing in a seafood processing plant due to the several advantages as given below.

1. Ease of adoption by the seafood processors for the day to day production scheduling and control.
2. Frequent changes in the chart is possible with minimum time and cost.
3. Modification in the Gantt Chart can be made by a trained technologist and no other experts are required for the purpose.

1.6. Sequencing and Priority rules

The sequencing problem is the problem of defining the priority or order over a set of jobs (tasks, items etc.) as they proceed from one machine (process to another) to other. Johnson (1954) decribed an optimal two and three stage production schedules with setup times. After Johnson's model, several algorithms have been developed for sequencing 'n' jobs on 'm' machines to minimize make span in the flow-shop. In all these algorithms, several assumptions are made, such as the simultaneous availability of all jobs and the machines, deterministic process times etc. These assumptions are far from real situations especially if we consider sea food processing where everything is uncertain.

But further studies for a solution to the problem of finding an optimal sequence has yielded some results. The techniques (Conway, et al.,1967; Baker,1974) solve the problems in principle, but, in most of the cases, the computation time and the memory required to keep track of the calculations is prohibitive even for small problems. Park (1981) found that the heuristic algorithms, though do not necessarily provide the optimal solution to the problem, are better in efficiency and economy.

Nawaz, et al.(1983) proposes a heuristic algorithm for the 'm' machines, 'n' job flow-shop sequencing problem. This is for a general flow-shop situation, where all the jobs must pass through all the machines in the same order. The proposed algorithm is based on the assumption that a job with more total process time on all the machines should be given higher priority than a job with less total process time .

In the seafood processing plants where a number of different products are to be processed through a single facility, the order with which the fishes are tp be processed is of great significance. Operation researchers have studied the problems of how best to decide the priorities in production units and have used simulation to see which dispatching policy is the best. The important priority rules suggested by them are - first come, first worked on; first come, first worked on but with dollar value classes; choose the one to work on next which has the shortest time for the present operation; or the longest processing time for the present operation; least slack time in the department; least slack time in all remaining departments; least total slack time between remaining operations; later passage through overloaded work centres; later passage through presently idle work centers; importance ofthe customer; and profitability of the item(More and Hendrick, 1978)

Unfortunately none of the above mentioned models or priority rules suit seafood processing plants in Kerala due to the following reasons:

1. The work to be carried out is processing of fish and fishery items. Unlike in any other industry, the raw material cannot be purchased as and when desired by the processor.

2. The raw material landing is irregular and uncertain

3. The raw material cannot be stored even for a few days due to high perishability.

4. Quality problems vary with the species of the fish

5. The shelf-life of fish varies with species as well as pre-process handling.

6. The purchase is in small quantities from different scattered landing and pre-processing centres.

7. The raw material purchase is continous throughout day and night.

8. Everything has to be kept flexible in the production line to absorb any variety of raw material entering the plant.

9. The production cycle time of most of the products have only marginal difference.

Hence a new priority rule specially suited for fish processing plants is developed. This is based on all the above mentioned special aspects of the industry. The new priority rule suggested is simple and easy to adopt and can be handled by the supervisors or technologists of the plants.

2. LITERATURE REVIEW

2.1. Resource Analysis

Analysis of the available fishery resources, which in-turn is the source of raw materials to the fish processing plants, helps in a great way to plan production and procure orders from foreign buyers. Fish landing is highly seasonal and unpredictable. Frequent resource analysis is inevitable due to the peculiar nature of the industry. Here raw material is in the sea and no boat owner is in a position to say that he can supply'this'much quantity of a particular grade or species of fish on a particular day. Available literature on this subject is reviewed and is presented below.

2.1.1. Prawn resources :- India continues to top the list of shrimp producing countries in the world. World Fishery statistics shows that India's shrimp production increased to 2,44,500 tonnes in 1980s. India's share in world shrimp production also rose to 14.5% from 11.7% achieved in the previous year (Anon, 1982 c). The fishery is constituted by Penaeid and Non-penaeid prawns.

Total Catch trend :-

Landings over the past decade and a half shows that there has been steady increase of the total landings in India upto 1973. After this there was a yearly fluctuation, reaching 2,20,000 tonnes in 1975. 34.9% of the catch in Kerala is by trawlers(Anon,1978 a).

Cochin and Neendakara :- They are the most important landing centres in Kerala. Among the five species of prawns contributing to the fishery, Metapenaeus dobsoni (Poovalan) with prominent sizes ranging from 60-80 mm was reported to be the dominant species in January-March. Parapenaeopsis stylifera with modal lengths of 81-95 mm was found to be second in abundance in the first quarter. But in February, Penaeus indicus with prominent sizes of 121-161 mm was the dominant species. The other two species of Metapenaeus, namely M. affinis (Kazhanthan) and M. monoceros (Choodan) were absent in February but present in small quantity in January.

In the second quarter the landings showed a steady increase from 825 tonnes in April to 5,486 tonnes in June. The catch per unit effort also showed a steady increase from 8.3 Kg. in April to 21.2 Kg in June. Both total landings and catch per unit effort are considerably high when compared to the first quarter. M. dobsoni with prominent sizes ranging from 76 mm to 100 mm was dominant in April and May. Karikadi with prominent size ranging from 81 to 110 mm was dominant in April and May. P. indicus of larger sizes was the species next in abundance and it maintained a regular increase in catch from April to June. Among the other two species, M. affinis was more common than M. monoceros.

Third quarter was found to be much more productive than the previous quarter with a total landing of 23,169 tonnes. The peak landing was in July with 16,068 tonnes. However, the landing pertaining to Cochin alone was very poor with a total catch of 50.9 tonnes in July. Rate of catch per unit effort decreased from 86.0 Kg in July to 3.0 Kg. in September. Karikadi was dominating in the catch with sizes ranging between 65 and 97 mm. Metapenaeus dobsoni and P. indicus were next in order of abundance.

Landing in fourth quarter was found to be poor in comparison to other quarters. The maximum catches were 203.1 tonnes in December at Cochin and 244 tonnes in November at Neendakara. M. dobsoni and P. stylifera were the dominating species

Calicut :- The catches were highest in January, thereafter showed a decrease in the first quarter. M. dobsoni with modal length of 78-85 mm was more abundant in both February and March. P. indicus was caught only during the month of March, while P. monodon and M. affinis were landed during all these months.

In the second quarter catch was found to decrease considerably. In May and in June there was no fishery. In April, P. indicus with modal lengths 143 to 183 mm in males and females respectively contributed 64.0% of the catch and P. stylifera was next in abundance in that month. In the third quarter, the fishery was constituted by only P. indicus and in the fourth quarter fishery was almost negligible.

Mangalore :- The landings as well as the catch rate show a steady decrease from January to March. The catches are composed of all the five species available along the Kerala coast. P. stylifera was dominant in the catch during all the months, the prominent size range being 83 - 108 mm. In the second quarter, catch per unit effort decreased considerably. In June there was no fishery. P. stylifera dominated in the catch in this quarter. Appreciable quantities of M. monoceros and P. indicus were also caught in both months. There was no trawl fishery at Mangalore during July and August in 1978. But in September, the catch was better than in the previous year. M. dobsoni was the dominant species.

In the fourth quarter trawl fishing was relatively less active than during the pre-monsoon period and the catches showed a progressive increase from 25 tonnes in October to 85.1 tonnes in December. M. dobsoni was the main species followed by P. stylifera. Some quantities of M. affinis and M. monoceros also contribute to the fishery.

Tuticorin and Mandapam :- The dominant species during the first quarter was P. semisulcatus with modular sizes of 113 - 173 mm. The landings of the species showed a steady decline from January to March. P. indicus was next in abundance at Tuticorin while at Mandapam, M.affinis was next in abundance during February and March. In January, P. merguiensis was second in abundance in the total prawn landings at Mandapam. Small quantities of M. dobsoni were also landed at Tuticorin during the quarter.

In the second quarter, catch was less in June and maximum in April in Tuticorin. The dominant species were P. semisulcatus, P. indicus and the prominent sizes of these species ranged between 128 and 158 mm. Dobsoni was also landed even though at a low level. Contrary to the prawn landings at Tuticorin, the landings at Mandapam showed a regular increase from 12.7 tonnes in April to 40.5 tonnes in June (1978) with corresponding increase in catch per boat days. While P. semisulcatus was the only species contributing to the fishery in April and May, small quantities of M. affinis were also landed in June forming 17.3 % of the catch.

In the third quarter P. indicus and P. semisulcatus are the major species of importance in Tuticorin than in the previous year or quarter. The major species present were P. indicus from October to November. In Mandapam, during the last quarter the main landing was P. semisulcatus (Anon., 1978 a; 1979 a ; 1979 b).

2.1.2. Tuna Resource:-

Tuna is one of the least exploited resources in India. All India landings of tuna is estimated to be 19,322 tonnes in 1976 and 13,005 tonnes and 13,748 tonnes during 1977 and 1978 respectively. The percentage contribution of tuna landings in the All India landings of marine fishes ranged from 0.3 (1970) to 1.42 % (1976). The species contributing to the fishery are:

	Scientific name	Commercial name
1.	Euthynus affinis	(little tunny)
2.	Auxis thazard	(frigate tuna)
3.	A. rochei	(frigate tuna)
4.	Sarda orientalis	(Oriental bonito)
5.	Thunnus tonggol	(Northern blue fin)
6.	T. albacores	(Yellow fin tuna)
7.	T. abesus	(Big eye tuna)
8.	Katsawonus pelamis	(Skipjack tuna)

<u>Tuna landings in Kerala</u> :- Prior to 1977 tuna catches at Cochin were insignificant with occasional catches in the experimental purse seine operations conducted by Integrated Fishery Project and in the artisanal fishery from hook and line and shore seines. In Cochin Fishing Harbour the main species landed are *A. thazard*, *A. rochei*, *T. tonggol*, *T. albacores* and *S. orientalis*. The size ranges and weights of different species observed during 1978 and 1979 are given below:

Species	Fork length (range in cm.)	Weight(range in Kg.)
E. affinis	21 - 71	0.9 - 5.2
A. thazard	31 - 48	0.6 - 2.0
T. tonggol	38 - 64	0.7 - 3.5
T. albacore	63 - 78	4.8 - 7.1
S. orientalis	11 - 52	0.1 - 1.8

In Calicut the tuna catches were estimated at 91.5 tonnes and 69.5 tonnes in 1977 and 1978 respectively. Vizhinjam is another important centre of tuna landing. The landings in 1977 and 1978 being 416.0 and 397.3 tonnes respectively. January and June are the peak periods in Calicut and Vizhinjam respectively. Tamil Nadu is also an important state for tuna landings. Tuticorin is one of the main centres. June is the period when maximum landing was observed here. In Minicoy the total catch of tuna and related species was estimated at 326.6 tonnes (1977) of which skipjack constitutes 67.3 % of the total landings (Anon., 1979 c).

Estimated potential ;- Japanese Fish Agency reported an estimated potential of 2,00,000 to 2,50,000 Mtons of tuna from Indian Ocean (Anon., 1968 a). Studies conducted by Silas, etal. (1976) revealed that most of the species of tuna are highly under-exploited and there is a good possibility of increasing the production. Reports published by Food and Agriculture Organisation (F A O) indicate that the present exploited resources of shelf oriented species amount to 48,752 tonnes (Anon., 1977 b). There is a great potential for expanding the fishery which in turn contributes as a good raw material for the fish processing plants.

2.1.3. Indian Oil Sardine (*Sardinella longiceps*):-

Oil sardine is one of the major pelagic fishery resources of our country. The greatest abundance has been noticed in Kerala and Karnataka coasts, especially between Alleppey and Karwar. The traditional fishery commences by August and continues till March along this region. With the development of purse seine fishing, the season has been extended further upto June. The major landings in the country during the decade came from Kerala. The average catch (1969 to 1978) is worked out to be 1,31,440 tonnes. There is great potential to expand this fishery (Anon., 1979 d).

2.1.4. Anchovy (White bait) resources :-

One of the turning points in marine fisheries development in India is the introduction of purse seine operation in Kerala and nearby states for commercial exploitation of marine fish resources. Mangalore and Cochin are the main landing centres. From 73 tonnes landed by purse seiners during 1978 at Mangalore, the annual white bait catch rose to about 72 tonnes in 1979 and shot upto 4588 tonnes in 1980. The fishing yielded an estimated catch of 2,240 tonnes in 1981. Although the white bait landings at Cochin compared to Mangalore were of lower magnitude, the same trend in the increased production at this centre was evident over the years. The bulk of the landings were found to be between October - December period at both the centres. Peak landing at Cochin is in October and that in Mangalore is in October - November period (Anon., 1982 d).

2.1.5. Mackerel (*Rastrelliger kanagurta*) resources :-

A detailed study of the mackerel resources of the Indian coast was carried out by Central Marine Fisheries Research Institute (Anon., 1979 e; 1982 e). In 1971 the total production was 2,04,575 tonnes, which declined in the following years to a level of 37,462 tonnes in 1974 whence increased to 85,233 tonnes in 1978. This upward trend was later reversed in in the following years and the landing decreased to 71,514 tonnes in 1979 and 55,279 tonnes in 1980. In contrast to the increase in the landings along the East Coast, the landings in the West Coast decreased during 1978 - 80 period. The mackerel catch in Kerala was 25,917 tonnes in 1980. In Kerala the southern most part of Trivandrum Coast had some amount of mackerel during the study period. On account of the operations of purse seines in and around Cochin, there were exceptionally good landings at Cochin Fishing Harbour. The Alleppey-Ernakulam-Trichur region is reported to have better catches than the Malapuram-Kozhikode-Cannanore region (1980). The main season is between September and October. During January-April, the catches were moderate except in March. The landings were meagre during July-August. In Trivandrum district the landing was highest in May. In Ernakulam and nearby areas it was September and February-April. The catches in Kozhikode-Cannanore area in December are found to be good.

2.1.6. Cephalopods :- Squids and cuttle fishes are important items exported from India. At present there is no aimed fishing for harvesting the resources. The landings come as incidental catches in traditional gears such as shore-seines, boat seines, stake nets and hooks and lines and in the mechanised boats operating trawl nets. Till recently the cephalopods had only limited demand in India. The export of squid and cuttle fish commenced in 1973 and thereafter the demand is ever increasing. However, the rise in production is not sufficient to meet the demand. There is a vast scope for stepping up production by employing modern fishing methods.

Several exploratory studies carried out by different organisations show good cephalopod resources in the South-West coast of India (Silas, 1968; 1969; Sulochanan and John, 1985).

During 1977-80, the estimated annual catches of Kerala varied between 2,976 tonnes and 4,975 tonnes and in the succeeding years there has been progressive rise in landing. The proper estimate of exploitable yield of cephalopods from the continental shelf of the country is not available. Based on the present production trend, some workers have forecasted the yield potential of the shelf area of the Indian Ocean. George, et al.(1977) worked out the exploitable production from South West coast of India to be 36,000 tonnes. The progressive rise in cuttle fish landings obtained as bye-catch of shrimp trawlers clearly indicate that there are extensive cuttle fish resources of the species Sepia aculeata, S. pharaonis, S. brevimana and Sepiella inermis in the outer shelf waters particularly at depths of 25 to 75 m. There is very good possibility of stepping up squid as well as cuttle fish production from the neretic waters of India by adopting suitable methods and by increasing effort.

2.1.7. Ribbon Fish :-

Ribbon fish constitutes one of the important fisheries of India. With the recent increase in demand from abroad for frozen ribbon fish products, this has become an important raw material for the sea food industry.

Very high potential resources of ribbon fish in deeper water, especially between 20 and 75 m, have been estimated. But these resources are yet to be exploited fully. The

UNDP/FAO Pelagic Fishery Project had estimated that the ribbon fish constituted nearly 7 percent of the fish biomass of the shelf waters of the project area. The average standing stock estimated was of the order of 67,000 tonnes during 1972-75 period. Observation of the landings made by Central Marine Fisheries Research Institute, Cochin also indicated possibilities of increased catches if appropriate methods are employed.

The biomass estimate of ribbon fish resources in different regions were carried out by different workers. The highest average estimate is along the coast of Kerala with 44,000 tonnes. In Kerala the great abundance was estimated between May to September. In the Western part of the Gulf of Mannar the highest estimate was found to be during the third quarter of the year. (Rao, et al., 1977). According to James, et al.(1986), the distribution of ribbon fish along the Indian coast is more or less continous with Trichiurus lepturus occuring throughout the coast. Four species are commonly found in Kerala namely, T. lepturus, T. savala, T. auriga and Benthodesmusten spp. They found that June to October is the main season with peak landing in July.

2.2. MARKET ANALYSIS (Forecast) :-

2.2.1. Shrimp := The study conducted by a team from Marine Products Export Development Authority shows that imports play a very important role in meeting the demand in French market. Mainly temperate varieties of shrimp dominate in the French market.

But the market is expanding for Indian products. The study also shows vast possibility of expanding markets in Malaysia, South Vietnam, Thailand, Singapore and Cuba. As per the study, considerable scope exists for the Indian processors to export to France, particularly, if regularity of supply can be assured (Anon., 1976 a).

The trade delegation sent by Marine Products Export Development Authority, Cochin to U.S.A. found that the import of shrimp into that country is stagnating around one lakh tonnes whereas the Japanese import have been on the increase (Anon., 1982).

Rockowe (1983) gives an account of the market and future prospects of shrimp exports. Japan is the single largest buyer from India. About 66.4 per cent (1975 - 1983) of the total frozen prawns exported from India was to Japan. The demand for shrimp has been rising steadily in the major markets. In Japan, about 60 per cent increase in demand was noticed during the period between 1971 and 1981. West Europe are thought to consume about 50 per cent of the world catch of tropical shrimps. Domestic landings in Japan provide only about one quarter of the total shrimp supplies. Imports of shrimps have grown steadily and rapidly in Japan since 1970. The 1,62,000 tonnes imported in 1981 were almost three times the level in 1971. Over sixty countries participate in this important trade, but five countries - India, Indonesia, China, Australia and Thailand accounted for about 60 per cent of the shrimp trade to Japan. Statistical forecast predicted an increase of 5 to 6 per cent per year in shrimp prices. Japanese market is capable of absorbing additional supplies of shrimp, which will tend to stablise price and thus increase demand. 50 per cent of the shrimp requirements in U.S.A. is met with by imports. India was until 1980, second only to Mexico in volume shipped to U.S.A. Ecuador is the other main supplier. The main items imported are Frozen Headless Shell-on Shrimp and Frozen Peeled and Undeveined Shrimp. In U.S.A. also the demand is predicted to increase by 1990 by 50 million pounds over the 1981 level. Europe is found to increasingly accept tropical shrimp. Although total use of tropical shrimp in Europe is still small when compared to that in U.S.A and Japan, consumption has increased in recent years, particularly in France, Spain and United kingdom. It is expected that the market for tropical shrimp in Western Europe will grow at the rate of 5 to 10 per cent for the next few years. The other main markets showing good prospects for shrimp based products are Hongkong, Singapore and Australia.

Salvin (1984) also predicted increased demand for all fish and fishery products in frozen conditions in U.S.A. except tuna.

According to Feidi (1986), Arab countries have also shown increasing attraction towards shrimp products.

Chawvin (1986) suggests marketing strategies for improving the shrimp trade. He points out that with the increase in world trade and development of new sources in many countries over the past few years, shrimp has attained the status of an international commodity. He discusses about major markets of shrimp - U.S.A., Japan and Europe. He also predicts increase in demand for shrimp and shrimp products. The paper points out the possibility of increased supply through aquaculture.

2.2.2. Squid and Cuttle fish (Cephalopods):- A study conducted by Marine Products Export Development Authority, Cochin shows a tremendous potential to expand squid and cuttle fish export. France is an important market for frozen squid and cuttle fish, The main suppliers to the market are Thailand, Morocco, Japan and U.S.A. At present, India is exporting only small quantity but the study shows great potential for Indian processors to penetrate into these markets (Anon., 1976 a).

A study conducted by Hotta(1982) states that Japan is the most important market in the world for squid and cuttle fish with over 6,00,000 tonnes live weight being used for consumption. There are eight major species which are marketed in Japan. They are: Totarodes pacificus, Loligo edulis edulis, Ommastrephes - bartrami, Nototadarus sloami, Illex illucebrosus, Illex argenia, Sepia officinalis, Sepiella esculenta. He also anticipates a growth in the demand for frozen and fresh squid and cuttle fish.

Trade enquiries for squid and cuttle fish are regularly being received in Marine Products Export Development Authority office from various countries like Cyprus (Anon., 1985 d), Singapore and Spain (Anon., 1986 a), England, Netherlands and Italy (Anon., 1986 c), Spain, Portugal, Italy, France, Belgium (Anon., 1986 d).

Marine Products Export Development Authority received trade enquiries from potential buyers of squid and cuttle fish during its participation in Sial International Food Products Exhibition at Paris in 1986. The important countries interested in buying frozen whole cuttle fish and squid are Spain, Italy, Portugal, France, West Sussex and Belgium. The main observation was that the only products that did not seem to suffer too much from the recent recession are squid and cuttle fish. In addition to the Mediterranean countries which are the largest consumers, these products have gained considerable consumer acceptance in other countries like Belgium, United Kingdom and Holland. It reports that although this is not an enormous market, there are opportunities to expand in the coming years (Anon., 1986 d).

<u>2.2.3. Lobsters</u> :- Lobster is one of the important marine products which is in short supply but demand is enormous. Any amount produced in India can be marketed. The main market is Japan. An average of 36.6 per cent (1975-1985) of the total lobster exported from India was to Japan. During the last few years there was a tremendous growth of Japanese market for Indian lobsters. From a meagre share of 5.62 per cent in 1975, export to Japan rose to 62.8 per cent in 1985. U.S.A. is the second biggest market for Indian lobster tail. The average

share of lobster export during 1978-85 to U.S.A. was 50.79 per cent. But there is a down fall in the market share of lobster in the U.S. market. The latest market share is 32.08 per cent (1985) of the total lobster export from India. The export to other countries is negligible (Anon., 1985 c). As such there is no need to expand the market since the entire catch landed is being exported to other countries without much difficulty. The other countries which require frozen lobster tails are Portugal, Switzerland, England (Anon., 1985 e), U.S.A. (Anon., 1986 a), Denmark, Canada (Anon., 1986 b), Netherlands (Anon, 1986 c), France, Switzerland, Belgium and Spain (1986 d). The trade enquiries show that there is a great scope for expanding the market.

2.2.4. Clam meat :- Frozen clam meat is a recent introduction from India. The export on commercial level started only in 1981 with a meagre quantity of 15.6 tonnes valued Rs.1,11,340 exported to Japan. But the export growth was so fast that in 1983 a total quantity of 608.6 tonnes valued Rs.7,67,711 could be exported. The market expanded from Japan to Federal Republic of Germany, France, U.A.E., U.S.A., Kuwait and Spain. The unit value (per Kg.) for frozen clam meat rose from Rs.7.12 (1981) to Rs. 14.28 (1985) within a period of five years (Anon., 1985 c).

2.2.5. Sardine :- Sardine is the single largest raw material available in India and the major share of its landings is from Kerala. The average sardine landing in Kerala is 1,23,349 tonnes

(1974-1985) which constitute 34.9 per cent of the total landings of marine fishes in Kerala (Anon., 1985 c). There is very good scope for developing products out of sardine which not only helps to utilise the unutilised facilities to some extent but also uses the fish in a better manner for human consumption. Product development with the fish helps in the economic utilisation of this resource. This will also help to improve the socio-economic conditions of thousands of fishermen in Kerala and adjacent states, as their main occupation is the exploitation of pelagic resources like sardine.

At present, sardine is mainly used in internal markets in fresh or iced form. Since sardine is highly suceptible to spoilage due to its soft nature and high fat content, a better processing and preservation method like freezing and cold storage will help to increase the shelf-life of the product. Studies conducted by Central Institute of Fisheries Technology, Cochin show that sardines can be preserved as a frozen product for more than 8 months (Kaimal, 1969 and Perigreen, et al, 1969).

Some processors have started exporting sardines on trial basis. But organised export is yet to be stabilized. The trade enquiries and market studies by Marine Products Export Development Authority in Gulf countries, South Eastern Asian countries, United Kingdom and Italy show promising results. There is also scope for acceptance of this product in international markets (Anon., 1984 b; Anon., 1984 c; Anon., 1984 d; Anon., 1984 e; Anon., 1984 f; Anon., 1984 i, and Anon., 1986 d)

<u>2.2.6. Mackerel</u> :- Frozen mackerel is showing a promising export trend especially to the Gulf countries (Anon., 1984 i; Anon., 1985 c) The demand is also existing in countries like Holland (1984 g); United Kingdom, West Germany (Anon., 1984 h);and Portugal (Anon., 1985 e).

<u>2.2.7. Tuna</u>:- Tuna is one of the under utilised resources of our Exclusive Economic Zone. There is great demand for tuna based products in countries like Japan, Singapore, Hongkong, West European countries and U.S.A. The seafood industry in India has not yet started utilising this resource for producing products which are in demand. India exported a meagre quantity of 635 Kg. worth Rs. 4,329 in 1978 to United Kingdom and thereafter the production and export of this product was discontinued. In 1985 a negligible quantity of 20 Kg. was exported on a trial basis to Singapore (Anon., 1985 c)

<u>2.2.8. Crab meat</u> :- Kerala has a good resource of big sized crabs and it can be utilised as a raw material to fill in the gap of idleness in processing plants. The main markets are U.S.A., Japan, Belgium, France, U.A.E., Singapore, Malaysia, Federal-Republic of Germany, etc. A total quantity of 80,396 Kg. worth Rs. 36,24,865 was exported from India in 1985 (Anon., 1985 c). Trade enquiries are being received by a number of countries (Anon., 1984 g; Anon., 1984 h; Anon., 1985 f; and Anon., 1986).

<u>2.2.9. Other products</u>:- Several other products like Frozen Red Snapper, Frozen Sole fish, Frozen Croaker, Frozen Ghol fish,

Frozen Eel, Frozen Octopus and fillets of a variety of fishes can be processed and marketed in the same processing line available in the processing plants in Kerala. All the above mentioned products have demand abroad (Anon., 1984 g; Anon., 1984 h; Anon., 1985 e; and Anon., 1986).

3. DATA AND METHODOLOGY

A Raw Material Availability Calendar, showing the availability of various species of fishes and shell fishes in the South West Coast of India during different seasons(months) is developed, based on the data available on fish landings.

Simplex method of Linear Programming as described by Gass (1975) and others like Srinath (1982) is used for developing a suitable model to select the best product mix during a quarter in seafood processing (freezing) industry. Since the fish landings are highly seasonal and dynamic, the whole year is divided into four quarters to make it a static system for the application of Linear Programming as suggested by Mikalsen and Vassdal (1981).

An indepth study was made on the existing conditions of production process in selected fish processing plants as described in the earlier chapters. The Gantt Chart as described by Srinath (1975) has been found suitable for the day to day scheduling of the production process. Two models of Gantt Chart - one for the existing freezing machinery (180 minutes freezer) and the other one for newly introduced freezing machinery (Ninety minutes' freezer) are developed for 24 hours production situation.

For the formulation of Gantt Chart, the entire processing activities starting from raw material entry into the processing hall to the end product storage are divided into three stages as follows:

1. <u>Pre-freezing stage</u>:- This stage comprises of activities starting from the raw material entry till the semi-processed material is ready for loading into the freezer. The process cycle time at this stage varies with the products and the raw materials used. Maximum allowance to accomodate the products with even longest process cycle time is provided (This is to accomodate diversified products which can be processed in the same process line) in the load chart to keep it flexible to absorb any raw material at any time. This is due to the uncertainity of the raw material arrivals in the plant.

2. <u>Freezing stage</u> :- This stage includes loading of packed material into the freezer, freezing and unloading of the frozen blocks from the freezer.

3. <u>Post-freezing stage</u>:- This stage comprises of master cartoning of frozen blocks, sealing and storing it in the cold store.

The production schedule is developed based on the following assumptions (observations).

1. Turnover of the Pre-freezing stage is 220 slabs or 500 Kg.per batch (load).

2. The cycle time at the Pre-freezing stage of most of the products which can be processed in the existing process line falls within 68 minutes (This is based on the work measurement). This much allowance is given to absorb the widely fluctuating nature of the raw material arrivals in the seafood processing plants.

3. The Freezing stage consumes 70 to 75 per cent (4 hours) of the total process cycle time of the entire production process (if 180 mintues freezer is used).

4. Post freezing stage consumes about 30 minutes.

5. The plant contains two plate freezers of 180 minutes normal time for freezing.(In the case of new model the normal freezing time is only 90 minutes.)

6. The capacity of the freezing stage is 220 slabs of 2 Kg. net drained weight per load in a freezer or approximately 500 Kg. per load.

7. Production is continous throughout day and night.

8. Daily maintenance of the freezers and other equipments are done along with the processing operations (between batches of production).

9. Total production cycle time for a batch is five hours and thirty minutes.(One hour for Pre-freezing, four hours for Freezing and thirty minutes for Post-freezing stage.)

A two stage scoring system is used to develop a new priority rule for processing of different materials. This is based on (1) the purchase price and (2) waiting time tolerance of the raw materials.

Proportionate scores are given with increasing unit purchase price of the raw materials and decreasing waiting time tolerance of the raw materials. The sum of the above two scores obtained for a raw material decides the priority with which it has to be processed in the processing line.

4. RESULTS AND DISCUSSION

4.1. Raw Material Availability Calendar:-

The Raw Material Availability Calendar is presented in figure 3. The calendar gives an idea about the abundance and shortages of different fishery resources during different months. This is helpful for the seafood processing factories while planning production during different seasons as well as for committing exports of the products to the customers abroad. At present alot of problems are faced by the processors due to the difficulty in meeting the committed export offers for want of raw materials. This tarnishes the image of the exporters and will ultimately affect the export trade. The use of raw material availability calendar will help to predict the availability of the fish resources at any time period and will inturn help to take decision while planning production and marketing.

FIGURE: 3.

RAW MATERIAL (FISH) AVAILABILITY CALENDAR FOR SEAFOOD PROCESSING PLANTS IN KERALA

Sl. No.	Name of fish(species)	JAN	FEB	MAR	APL	MAY	JUN	JLY	AUG	SPT	OCT	NOV	DEC	REMARKS
1.	SHARK (Scoliodon sarrokawah)	x	x	x	x	*	*	+	+	+	*	x	x	
2.	HAMMER HEADED SHARK (Zygaena and other Spp.)	*	*	x	x	x	x	x	*	*	+	+	+	
3.	WHITE SPOTTED RAY STING RAY	*	*	0	0	0	0	0	0	*	+	+	+	
4.	ELECTRIC RAY (Narcine)	0	0	0	0	0	0	+	+	+	0	0	0	
5.	OIL SARDINE (Sardinella longiceps)	+	*	*	x	0	0	0	x	*	+	+	+	
6.	ANCHOVIES (Anchoviella Spp.	*	x	0	0	0	0	*	+	+	+	+	+	
7.	DORAB (Chirocentrus Spp.)	0	0	0	0	0	0	+	+	+	*	0	0	
8.	SEA CAT FISH (Tachysurus Spp.)	x	0	0	+	+	+	*	x	0	0	0	0	
9.	RIBBON FISH (Trichiurus Spp.)	x	0	0	0	x	*	+	+	+	*	x	x	
10.	SILVER BELLY (Leiognathus Spp.)	0	0	0	x	x	x	+	+	+	*	x	x	
11.	FALSE TRIVALLY (Lactarius lactarius)	0	0	0	0	0	0	+	+	+	0	0	0	
12.	BLACK POMFRET (Parastomateus niger)	*	x	x	0	0	0	0	0	x	+	+	+	
13.	SILVER POMFRET (Pampus argenteus)	*	x	x	0	0	0	0	0	x	+	+	+	

...... Next page

CONTINUATION OF FIGURE: 3.

Sl. No.	Name of the fish	JAN	FEB	MAR	APL	MAY	JUN	JLY	AUG	SPT	OCT	NOV	DEC	REMARKS
14.	CHINESE POMFRET (Pampus chinensis)	0	0	0	0	0	0	0	0	x	+	+	+	
15.	INDIAN MACKEREL (Rastrelliger kanagurta)	*	*	*	x	0	0	0	0	+	+	+	+	
16.	OTHER MACKERELS	x	x	x	0	0	0	0	0	x	+	+	+	
17.	SEER FISH (scomberomerus Spp.	*	*	*	x	0	0	0	0	x	+	+	+	
18.	TUNA	+	*	*	*	*	+	+	x	x	+	+	+	
19.	BARRACUDA (Sphyraenas Spp.)	0	0	0	0	0	0	0	0	0	+	+	+	
20.	FLAT FISH (Psettodes Spp.)	0	0	0	0	0	0	+	+	+	0	0	0	
21.	SOLE (Cynoglossus Spp.)	*	*	+	+	+	+	+	+	+	x	0	0	
22.	WHITE SHRIMP (Penaeus indicus)	*	+	+	+	+	*	*	*	*	x	0	0	
23.	TIGER SHRIMP (Penaeus monodon)	0	0	0	0	*	*	*	0	0	0	0	0	
24.	GROOVED TIGER PRAWN (Penaeus semisulcatus)	x	x	x	x	0	0	x	x	x	x	x	x	
25.	BROWN SHRIMP (Metapenaeus dobsoni)	*	*	*	*	+	+	+	*	+	+	+	*	
26.	BROWN SHRIMP (Metapenaeus monoceros)	*	*	*	0	0	0	0	0	0	0	0	0	

.... Next page.

CONTINUATION OF FIGURE:3.

Sl. No.	Name of fish (species)	JAN	FEB	MAR	APL	MAY	JUN	JLY	AUG	SPT	OCT	NOV	DEC	REMARKS
27.	KARIKADI SHRIMP (Parapenaeopsis stylifera	*	+	+	+	+	+	+	+	+	*	*	*	
28.	SPINY LOBSTER (Panulirus Spp.)	x	x	0	0	0	0	0	x	x	x	x	x	
29.	SAND LOBSTER (Thenus Sp.)	0	0	0	0	0	0	0	x	x	x	x	x	
30.	CRABS (Different species)	+	+	*	x	0	0	0	0	x	*	+	+	
31.	CLAMS (Different species)	*	*	*	*	+	+	+	x	x	x	x	*	
32.	MUSSELS		*	*	*	*	*	*	*	0	0	0	x	
33.	CUTTLE FISH (Sepia Spp.)	*	*	x	x	x	0	0	*	+	+	*	*	
34.	SQUID (Loligo Spp.)	*	*	x	x	x	0	0	*	+	+	*	*	

+ indicates raw material availability in sufficient quantity, * indicates availability in moderate quantity, x indicates availability in low quantity, 0 indicates negligible quantity or data is insufficient for interpretation.

The Raw Material Availability Calendar is only a model and should be updated periodically. As the pattern of fish landing as a whole is highly dynamic in nature, prediction based on the calendar alone is not advisable. The 'daily landing/raw material availability report' and 'consolidated daily landing pattern report' as suggested under the chapter on 'Management Information System' will help to update the information on fish availability.

4.2. Application of Linear Programming:-

Linear Programming is found to be a useful tool for short term scheduling in seafood freezing plants. In seafood processing plants, raw material availability is highly seasonal and fluctuating. The processing plants cannot be run with a single type of fish during any period of time due to short supply of that particular fish. A proper prediction of the available landings during a period has to be done to schedule the production for that period. The first and foremost aspect is the forecast of available raw materials(fish landings) during the different quarters of the year. The raw material availability has to be ascertained based on the statistical data available with the various research organisations as well as based on the past experience of the management. The raw material availability can be summarized in a tabular form as shown in table 1.

Suppose in a fish freezing plant where the following

TABLE: 1.

RAW MATERIAL AVAILABILITY DURING THE FOUR QUARTERS IN A YEAR (IN TONNES)

Raw material	Ist qtr.	II qtr.	III qtr.	IV qtr.
HL shrimp	10	5	8	15
PUD shrimp	15	10	6	25
PD shrimp	25	10	10	20
Squid	20	30	20	10
Cuttle fish	20	40	25	10
WC Lobster	2	3	1	1
Lobster tail	1	-	1	1
Ribbon fish	20	10	30	30
Mackerel	5	5	10	20
Pomfret	2	2	2	5
Clam	2	5	6	4
Sardine	50	10	20	60

products are to be processed in the same production line:

1. Frozen Headless Shrimp (Fr. HL Shrimp)
2. Frozen Peeled and Undeveined Shrimp (Fr. PUD Shrimp)
3. Frozen Peeled and Deveined Shrimp (Fr. PD Shrimp)
4. Frozen Whole Cooked Lobster (Fr.WC Lobster)
5. Frozen Squid (Fr.Squid)
6. Frozen Cuttle Fish (Fr. Cuttle Fish)
7. Frozen Clam meat(Fr. Clam Meat)
8. Frozen Pomfret (Fr. Pomfret)
9. Frozen Lobster Tail (Fr. Lob. Tail)
10. Frozen Ribbon Fish (Fr. Ribbon Fish)
11. Frozen Mackerel (Fr. Mackerel)
12. Frozen Sardine (Fr. Sardine)

Suppose the contribution generated by one tonne of different products to fixed overhead and profit are as follows:

Sl. No.	Product	Rs.	Ps.
1.	Fr. HL Shrimp	8,000	00
2.	Fr. PUD Shrimp	2,000	00
3.	Fr. PD Shrimp	3,000	00
4.	Fr. WC Lobster	5,000	00
5.	Fr. Squid	1,250	00
6.	Fr. Cuttle fish	1,000	00
7.	Fr. Clam meat	2,500	00
8.	Fr. Pomfret	3,000	00
9.	Fr. Lob. Tail	10,000	00
10.	Fr. Ribbon fish	2,000	00
11.	Fr. Mackerel	1,500	00
12.	Fr. Sardine	1,250	00

These twelve products are to be processed in the same processing line and the problem is to develop a production schedule for a quarter that makes best use of the available resources. Since the same process is used to make all the products, every particular product that is scheduled for production will use up some resources that would otherwise be used to make other products and vice versa. The production area consists of three separate work centers (stages) - Pre-freezing, Freezing and Post-freezing stages. The table 2 shows the estimated time required for pre-freezing, freezing and post freezing activities of different products. Also given are the capacities available at different stages of processing in a quarter.

Assuming a demand restriction of 10 tonnes of sardine and 5 tonnes of mackerel.

The objective is to select a production mix during a quarter that will miximize the total contribution towards overhead and profit. The availability of different raw materials and the capacity at each stage of production form a definite constraint on the possible production of various products. The limitation in demand for frozen sardine and frozen mackerel form another set of constraints. Finally the data in table 2 indicate that the assumption of linearity is valid.

In order to formulate the problem in Linear Programming format, the objective and constraints must be stated as mathematical equations or inequalities. The mathematical formulation forces the decision maker to be very explict about what

TABLE :2.

PROCESSING TIME REQUIRED FOR THE PROCESSING OF ONE TONNE OF DIFFERENT PRODUCTS AND THE CAPACITY AVAILABLE DURING A QUARTER AT DIFFERENT STAGES IN THE PROCESSING LINE

Processing stage	Processing time in hours for different raw materials											
	HL	PUD	PD	WCL	SQ	CF	CLAM	POM	LT	RF	MAC	SAR
Pre-freezing (1248 Hrs.)	2.00	1.17	1.33	1.00	1.00	1.00	0.83	0.83	1.17	1.00	0.83	0.83
Freezing (1672 Hrs.)	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Post-Freezing (1248 Hrs.)	0.83	0.83	0.83	0.83	0.67	0.67	0.83	0.83	0.83	0.83	0.83	0.83

Figures in bracket indicate the capacities available at different stages of processing.

HL = Headless Shrimp, PUD = Peeled and Undeveined Shrimp, PD = Peeled and Deveined Shrimp, WCL = Whole Cooked Lobster, SQ = Squid, CF= Cuttle fish, CLAM = Clam meat, POM = Pomfret, LT = Lobster Tail, RF = Ribbon Fish, MAC = Mackerel and SAR = Sardine.

is to be achieved and what factors offect the decision. The objective is formulated as:

Maximize contribution = Rs. 8000 HLQ + Rs.2,000 PUDQ +
Rs.3,000 PDQ + Rs.5,000 WCLQ +
Rs.1,250 SQ + Rs.1,000 CFQ +
Rs.2,500 CQ + Rs.3,000 PQ +
Rs.10000 LTQ + Rs.2,000 RFQ +
Rs.1,500 MQ + Rs. 1,250 SAQ.

Where

HLQ	is the	quantity of	Fr. HL Shrimp	to be	produced per quarter
PUDQ	,,	,,	Fr. PUD Shrimp	,,	,,
PDQ	,,	,,	Fr. PD Shrimp	,,	,,
WCLQ	,,	,,	Fr. WC Lobster	,,	,,
SQ	,,	,,	Fr. Squid	,,	,,
CFQ	,,	,,	Fr. Cuttle fish	,,	,,
CQ	,,	,,	Fr. Clam meat	,,	,,
PQ	,,	,,	Fr. Pomfret	,,	,,
LTQ	,,	,,	Fr. Lob. tail	,,	,,
RFQ	,,	,,	Fr. Ribbon fish	,,	,,
MQ	,,	,,	Fr. Mackerel	,,	,,
SAQ	,,	,,	Fr. Sardine	,,	,,

(These are decision variables)

The equation for the objective is refered to as the objective function and in this case it implies that increase in production of the different products will result in higher total contribution. But there is a limit to the raw material availability and processing capacities at different stages of processing where the actual work is done. Therefore, the objective function is to be maximized subject to the following constraints:

1. For the raw materials used for different products the constraints are formulated as:

For Pre-freezing stage :-

Quantity of different raw materials used for processing ≤ Total capacity available at the Pre-freezing stage during the quarter.

For Freezing stage:-

Quantity of different raw materials used for processing ≤ Total capacity available at the Freezing stage during the quarter.

For Post freezing stage:-

Quantity of different raw materials used for processing ≤ Total capacity available at the Post freezing stage during the quarter.

In the example, the constraints will be as follows (Table:2):

(1) 2 HLQ1 + 1.17 PUDQ1 + 1.33 PDQ1 + 1 WCLQ1 + 1 SQ1 + 1 CFQ1 + 0.83 CQ1 + 0.83 PQ1 + 1.17 LTQ1 + 1 RFQ1 + 0.83 MQ1 + 0.83 SAQ1 ≤ 1248 hours ....(Pre-freezing stage)

(2) 8 HLQ1 + 8 PUDQ1 + 8 PDQ1 + 8 WCLQ1 + 8 SQ1 + 8 CFQ1 + 8 CQ1 + 8 PQ1 + 8 LTQ1 + 8 RFQ1 + 8 MQ1 + 8 SAQ1 ≤ 1872 hours ......(Freezing stage)

(3) 0.83 HLQ1 + 0.83 PUDQ1 + 0.83 PDQ1 + 0.83 WCLQ1 +
0.67 SQ1 + 0.67 CFQ1 + 0.83 CQ1 + 0.83 PQ1 +
0.83 LTQ1 + 0.83 RFQ1 + 0.83 MQ1 + 0.83 SAQ1 $\leq$
1248 Hours ...... (Post freezing stage)

Where

HLQ1	=	Quantity of	raw shrimp	(in tonnes)	used during the quarter.
PUDQ1	=	,,	PUD shrimp	,,	,,
PDQ1	=	,,	PD shrimp	,,	,,
SQ1	=	,,	raw squid	,,	,,
CFQ1	=	,,	raw cuttle fish	,,	,,
CQ1	=	,,	raw clam meat	,,	,,
WCLQ1	=	,,	raw lobster	,,	,,
PQ1	=	,,	raw pomfret	,,	,,
LTQ1	=	,,	raw lob.tail	,,	,,
RFQ1	=	,,	raw ribbon fish	,,	,,
MQ1	=	,,	raw mackerel	,,	,,
SAQ1	=	,,	raw sardine	,,	,,

2. Raw materials availability constraints are formulated for the first quarter as follows (from table:1).

HL	$\leq$	10 tonnes
PUD	$\leq$	15 tonnes
PD	$\leq$	25 tonnes
SQ	$\leq$	20 tonnes
CF	$\leq$	20 tonnes
WCL	$\leq$	2 tonnes
LT	$\leq$	1 tonne
RF	$\leq$	20 tonnes
P	$\leq$	2 tonnes
C	$\leq$	2 tonnes

$$M \leq 5 \text{ tonnes}$$
$$SA \leq 50 \text{ tonnes}$$

Where

HL	= Raw shrimp available during the quarter		
PUD	= Raw PUD shrimp	,,	,,
PD	= Raw PD shrimp	,,	,,
SQ	= Raw squid	,,	,,
CF	= Raw cuttle fish	,,	,,
WCL	= Raw WC Lobster	,,	,,
LT	= Raw Lob. tail	,,	,,
RF	= Raw ribbon fish	,,	,,
P	= Raw pomfret	,,	,,
C	= Raw clam meat	,,	,,
SA	= Raw sardine	,,	,,
M	= Raw mackerel	,,	,,

3. The demand constraints for sardine and mackerel are formulated as

$$SA_d \leq 10 \text{ tonnes}$$
$$M_d \leq 5 \text{ tonnes}$$

SOLUTION METHOD:-

Simplex method is to be used for solving this Linear Programming problem.(Most Linear Programming computer programs are developed by translating the procedure of the simplex method into a programming language.) Computer packages capable of solving large scale problems quickly and efficiently are available.

The simplex method is a general algorithm that can be used to solve any Linear Programming problem of any size.

It consists of arranging the constraint equations in the form of a tableau and systematically generating feasible solutions to the problems. The technique is iterative in nature, where each step in the procedure generates a new tableau that represents a feasible solution. The algorithm terminates when a solution is generated that cannot be improved. Like most algorithms, the simplex method is a very mechanical procedure that is easily programmed on a computer. The actual mechanics of the algorithm are not important, since virtually all practical applications of Linear Programming are solved by computer.

4.3. GANTT LOAD CHART :-

The Gantt Load Chart models developed for the use of existing seafood processing plants as well as the plants with improved layout (as suggested in the thesis) are presented in figures 4 and 5 respectively.

The 'X' axis represents the time in hours starting from 7 hours (7 a.m.). This is fixed as the starting time of shift I. The 'Y' axis represents the different stages of processing activities. The symbol 'A' represents the Pre-freezing activities, 'B' - Freezing activities in freezer No.I, 'C' - Freezing activities in freezer No. II and 'D' represents Post freezing activities.

MODEL: 1. (for existing plants) :-

Here the schedule is developed taking into consideration the existing freezing time of three hours (Normal time). The schedule is presented in figure 4. The blank space in between the activity bars indicates idle time which can be utilized as lunch break, for cleaning operations, tea break, change of shift etc. The detailed activity chart for the processing of different products are given in tables 3 to 5.

Pre-freezing stage :- This is the stage where most of the activities of processing take place. This stage is the most labour intensive stage in seafood processing. 20 female workers are estimated (as per work measurement) to be enough for completing the activities of one batch (220 slabs) of production in the pre-freezing stage in 1.13 hours. This time, as mentioned earlier keeps the stage very flexible to absorb the wide variation in the raw material arrival pattern. For instance, on a particular day the processing unit may have to process more than one type of raw material like Headless shrimp, Peeled and Undeveined shrimp, squid whole, squid tube, whole fishes, whole cooked lobsters etc. The type of raw material arrival is highly unpredictable and hence the schedule must be prepared to accept any raw material without affecting the smooth running of the plant. Taking into account all these factors, 1.13 hours is fixed as the optimum cycle time at this stage with the same turnover quantity. Here requirement is 20 females including 2 girls required for making ready duplex cartons and polythene sheets for packing and 3 males for other

FIG.4

A MODEL PRODUCTION SCHEDULE FOR A 2·5 X 2 TONNES (5 T.) FREEZING PLANT.

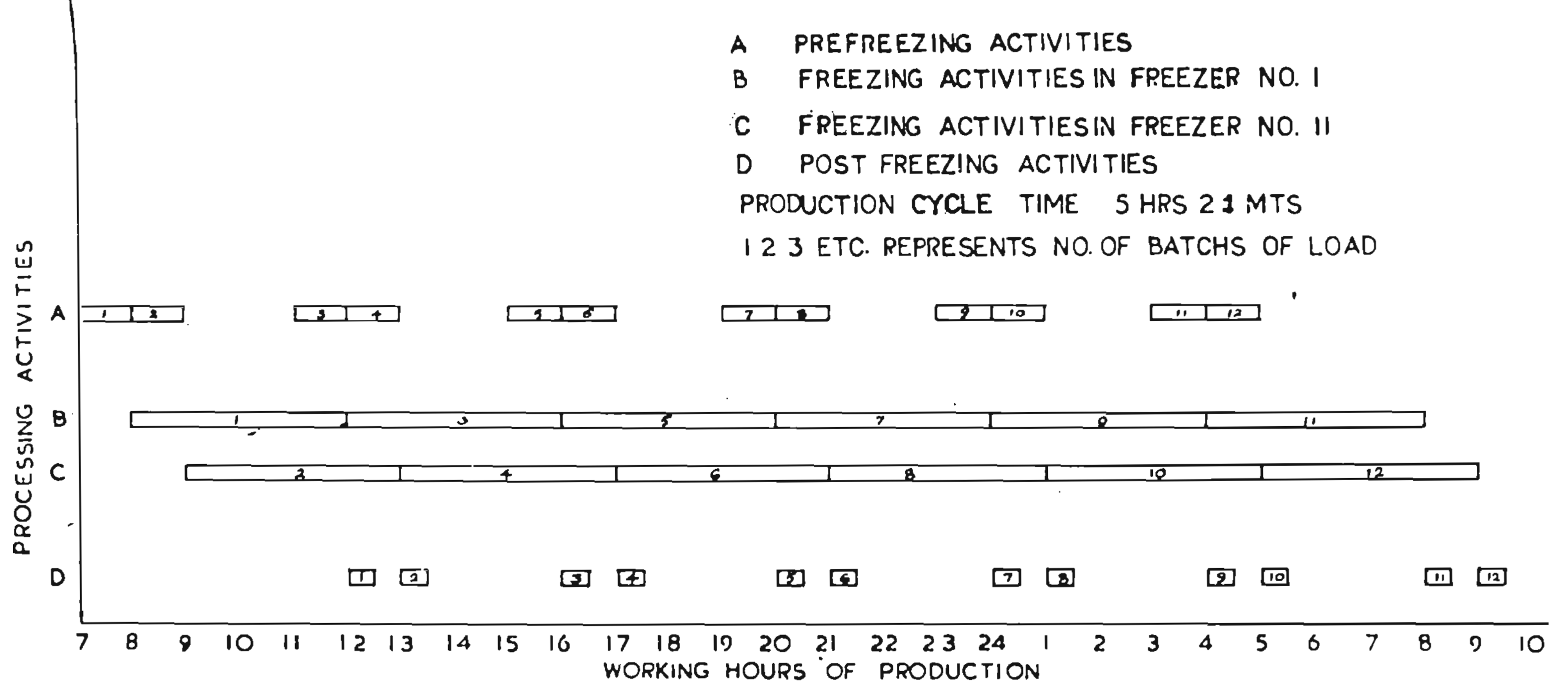


TABLE: 3.

ACTIVITY CHART FOR HL SHRIMP PROCESSING IN SEAFOOD PROCESSING PLANT SHOWING PROCESSING OF ONE BATCH (220 SLABS OF 2 KG. NET DRAINED WEIGHT

Sl. No./ Act. No.	Name of activity	Start time (Hrs)	Completion time (Hrs.)	Time taken in min.	Preceeding activity	No.of workers engaged
1.	R.M. transportation (100 Kg.) from chill room to washing & draining site (first batch)	7.00	7.05	5	-	2 M
2.	R.M. transportation of the remaining 400 Kg. in batches of 100 Kg. each for washing & draining	7.05	7.25	20	1	,,
3.	Washing and draining of first batch of R.M.	7.05	7.10	5	1	2 F
4.	Washing and draining of rest of the batches of R.M.	7.10	7.30	20	2, 3	,,
5.	Rechecking of quality & grades of first batch of R.M.	7.05	7.12	7	1,3	3 F
6.	Rechecking of quality & grades of rest of the batches.	7.12	7.40	28	4 ,5	,,
7.	Weighing	7.10	8.05	55	5,6	1 F
8.	Count slip writing & coding	7.10	8.05	55	5,6	1 F
9.	Distribution of weighed material to the respective layering workers	7.10	8.05	55	7,8	1 F
10.	Layering in duplex carton	7.11	8.06	55	9	8 F
11.	Glazing	7.11	8.06	55	9	1 F
12.	Setting in freezer trays	7.12	8.07	55	11	1 F

.... Next page.

CONTINUATION OF TABLE: 3.

Sl. No./ Act. No.	Name of the activity	Start time (Hrs.)	Completion time (Hrs.)	Time taken in min.	Preceeding activity	No. of workers engaged
13.	Loading in trolleys & transporting to freezer	7.13	8.08	55	12	1 M
14.	Loading in freezer	8.03	8.13	10	13	1 M
15.	Freezing	8.13	11.43	210	14	-
16.	Unloading from freezer	11.43	12.03	20	15	,,
17.	Master cartoning	11.43	12.12	29	16	1 M
18	Master carton sealing	11.43	12.17	34	17	2 M
19.	Storing in cold store	11.43	12.21	38	18	1 M
	PRELIMINARY PREPARATIONS					
20.	Making ready waxed cartons, polythene sheets etc. for the first 100 Kg. material.	7.00	7.10	10	-	2 F
21.	Making ready waxed cartons, polythene sheets etc. for the rest of the materials (400 Kg.)	7.10	7.50	40	20	,,

Total workers involved = 20 Females (F) and 7 Males (M).

Process Cycle Time = 5 hours and 21 minutes(321')

TABLE: 4.

ACTIVITY CHART FOR PROCESSING OF PEELED AND UNDEVEINED SHRIMP

(ONE BATCH OF 220 SLABS OF 2 KG.NET WEIGHT)

Act. No.	Name of activity	Start time (Hrs.)	Completion time (Hrs.)	Time taken (Min)	Preceeding act.	No.of workers involved
1.	R.M. transportation(100 Kg.) from chill room to washing and draining site (first lot)	7.00	7.05	5	-	2 M
2.	R.M. transportation of the remaining lots.	7.05	7.25	20	1	,,
3.	Washing of first batch of R.M.	7.05	7.10	5	1	3 F
4.	Washing and draining of the rest of the materials	7.10	7.30	20	2,3	,,
5.	Rechecking of quality & grades of first lot.	7.05	7.10	5	1	5 F
6.	Rechecking of quality & grades of the remaining lot	7.10	7.30	20	4,5	,,
7.	Weighing	7.10	8.00	50	5	1 F
8.	Coding of material & duplex cartons	7.10	8.00	50	5	1 F
9.	Distribution of weighed & coded material to respective sites for setting	7.10	8.00	50	7,8	1 F
10.	Setting in duplex cartons	7.10	8.00	50	9	3 F
11.	Glazing	7.10	8.05	55	10	1 F
12.	Setting in freezer trays	7.10	8.05	55	11	1 M
13.	Loading in trolleys & transportation to freezer	7.55	8.05	10	12	1 M
14.	Loading into the freezer	7.55	8.05	10	13	1 M
15.	Freezing	8.05	11.35	210	14	-
16.	Unloading from freezer	11.35	11.55	20	15	,,
17.	Master cartoning	11.35	12.04	29	16	1 M
18.	Master carton sealing	11.35	12.09	34	17	2 M
19.	Storing in cold store	11.35	12.13	38	18	1 M

(Preliminary preparations are similar to that of HL shrimp processing)

No. of Workers involved = 18 Females (F) and 7 Males (M).

Process Cycle Time = 5 hours and 13 minutes (313 minutes)

TABLE: 5.

ACTIVITY CHART FOR THE PROCESSING OF WHOLE FROZEN SQUID/CUTTLE FISH (ONE BATCH OF 220 SLABS OF 2 KG. NET DRAINED WEIGHT)

Sl. No./ Act. No.	Name of the activity	Start time (Hrs)	Completion time (Hrs)	Time taken (MIN.)	Preceeding activity	No.of workers involved
1.	R.M. transportation (100 Kg.) from chill room to washing and draining station(first lot)	7.00	7.05	5	-	2 M
2.	R.M. transportation of the remaining materials	7.05	7.25	20	1	,,
3.	Washing & cleaning of first lot	7.05	7.16	11	1	2 F
4.	Washing & cleaning of rest of the materials	7.16	8.00	44	3	,,
5.	Grading of first lot	7.05	7.16	11	1,3	4 F
6.	Grading of rest of R.M	7.16	8.00	44	4,5	,,
7.	Rechecking & draining of first lot	7.16	7.21	5	5	1 F
8.	Rechecking of rest of R.M.	7.21	8.00	30	6,7	,,
9.	Weighing	7.16	8.01	45	7,8	1 F
10.	Coding	7.16	8.01	45	7,8	1 F
11.	Filling, setting, glazing and loading in trolleys	7.16	8.01	45	9,10	6 F
12.	Transportation to freezer	7.16	8.01	45	11	1 M
13.	Loading into freezer	8.01	8.11	10	12	1 M
14.	Freezing	8.11	11.41	210	13	-
15.	Unloading	11.41	12.01	20	14	,,
16.	Master cartoning	11.41	12.14	33	15	1 M
17.	M. carton sealing	11.41	12.15	34	16	2 M
18.	M. carton storing	11.41	12.19	38	17	1 M

Note: Preliminary preparations are the same as in earlier charts. (In some type of processing, duplex cartons are not used)
Total worker required - 15 Females (F), and 7 Males (M).
Process Cycle Time = 5 hours 19 minutes.

activities as shown in tables 3 to 5.(The table shows the allocation of workers at different work stations) This stage is estimated to require about 82 per cent of the total workers requirement of the plant excluding supervisors and technologists.

New shift system :- Taking into account the high labour requirement at this stage, a new shift schedule is suggested which reduces three shift system into a two shift system (of 8 hours each as per the labour regulations) without affecting the continous production in the plant (table:6). This eliminates the overtime paid to the employees where two shift system is practised and reduces the staff strength by about one third in plants where 3 shift system is adopted.

In the two shift system as prevailing in some plants, the raw material has to wait for the next shift to start in the next day which results in a temporary suspension of production, forcing the facilities also to remain idle for some time. The recommended system is best suited for the special nature of the industry where raw material is being arrived continously irrespective of day and night and to reduce the holding time of raw material in the factory to the minimum possible level. This will improve the quality of the product.

As per the recommended Gantt Chart schedule, the production in a day at the pre-freezing stage starts at 7 a.m. with the first shift. The difference in the turnover time at the pre-freezing stage by about two times that of freezing stage

TABLE: 6.

W O R K / S H I F T S C H E D U L E
(BASED ON FIGURE:4)

Batch No.	PRE-FREEZING STAGE			FREEZING STAGE (FREEZER - I)			FREEZING STAGE (FREEZER - II)			POST FREEZING STAGE			REMARKS
	Start time	Finish time	Preceeding slack (Min)	Start time	Finish time	Preceeding slack (Min)	Start time	Finish time	Preceeding slack (Min)	Start time	Finish time	Preceeding slack (Min)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
FIRST SHIFT FOR WORKERS AT PRE.F.S.; AT P.F.S.,WORKERS OF PREVIOUS NIGHT CONTINUE													
1.	7.00	8.08	104	8.03	12.03	0	previous shift's load			11.43	12.21	134	
2.	8.08	9.16	0	-	-	0	9.11	13.11	0	12.51	13.29	30	
TEA BREAK & REST FOR WORKERS AT PRE.F.S.; CHANGE OF SHIFT OF WORKERS AT P.F.S.; AND CLEANING OF WORK SITES.													
3.	11.00	12.08	104	12.03	16.03	0	-	-	0	15.43	16.21	134	
4.	12.08	13.16	0	-	-	0	13.11	17.11	0	16.51	17.29	30	
LUNCH BREAK & REST FOR WORKERS AT PRE.F.S.; CHANGE OF SHIFT OF WORKERS AT P.F.S.; AND CLEANING OF WORK SITES.													
5.	15.00	16.08	104	16.03	20.03	0	-	-	0	19.43	20.21	134	
6.	16.08	17.16	0	-	-	0	17.11	21.11	0	20.51	21.29	30	
CHANGE OF SHIFT OF WORKERS AT PRE.F.S.; DINNER BREAK AND REST FOR WORKERS AT P.F.S.; AND CLEANING OF WORK SITES.													
7.	19.00	20.08	104	20.03	24.03	0	-	-	0	23.43	24.21	134	

.... Next page.

CONTINUATION OF TABLE: 6.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
8.	20.08	21.16	0	-	-	0	21.11	1.11	0	24.51	1.29	30	
DINNER BREAK AND REST FOR WORKERS AT PRE.F.S.; TEA BREAK AND REST FOR WORKERS AT P.F.S.; AND CLEANING OF WORK SITES.													
9.	23.00	24.08	104	24.03	4.03	0	-	-	0	3.43	4.21	134	
10.	24.08	1.16	0	-	-	0	1.11	5.11	0	4.51	5.29	30	
TEA BREAK AND REST FOR WORKERS AT PRE.F.S.; CHANGE OF SHIFT OF WORKERS AT P.F.S.; AND CLEANING OF WORK SITES.													
11.	3.00	4.08	104	4.03	8.03	0	-	-	0	7.43	8.21	134	
12.	4.08	5.16	0	-	-	0	5.11	9.11	0	8.51	9.29	30	

PRE.F.S = Pre-Freezing Stage; P.F.S. = Post Freezing Stage.

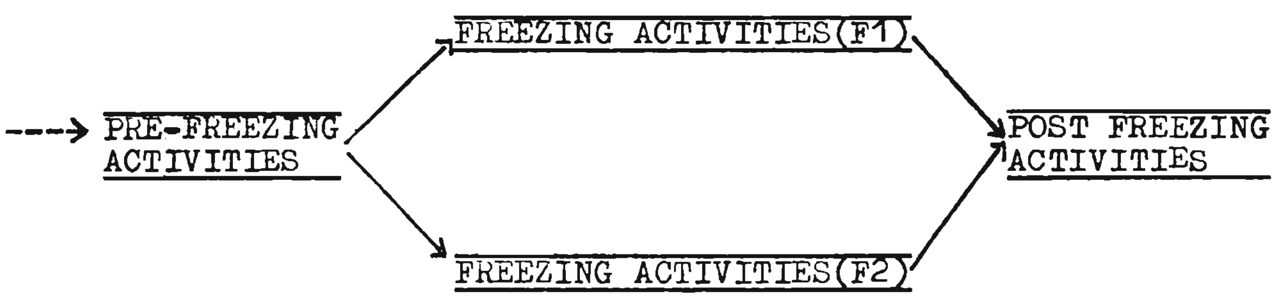
Note: The time required for daily maintenance, defrosting of freezers etc. is included as a part of the daily work at the Freezing stage.

Preliminary preparation like preparation of duplex cartons, polythene sheets, etc. is done concurrently as given in activity chart(Table: 3)

(The ratio of turnover at pre-freezing and freezing stages is 2:1) is utilised for adjusting the shift in this stage as given in table 4. This new system suggested helps to reduce the otherwise three continous shifts required to only two shifts without affecting the continous utilisation of the freezer facilities. With this new schedule the utilisation of freezer capacity is 100%.

<u>Freezing Stage</u> := The freezing stage involves loading of the packed material (in trays) into the freezer, freezing for the required time and unloading. The standard time at this stage is worked out to be four hours including allowances for defrosting and daily maintenance. The suggested schedule utilises the freezer capacity fully. Here the schedule is formulated for a two channel (double line) freezing facilities. This is because of the fact that most of the processing plants have two sets of freezers and ancillary facilities at the freezing stage.

The flow of in-process material as per the schedule is as shown below:



(F1 = Freezer I, F2 = Freezer II)

The pre-freezing and post-freezing stages have only single line of facilities where as freezing stage has double line. This is due to the prolonged cycle time (twice as that of pre-freezing stage) of freezing stage. The schedule is made for a plant having two freezers of 220 slabs per load capacity. Here only one male worker is required to handle the job.

Post freezing stage :- This is the shortest stage in the production line. Only 4 male workers are required at this stage with a turnover of 220 slabs in 30 minutes. Here sufficient allowance is given for all aspects of fish processing. Even though the turnover ratio of this stage with that of freezing stage is about 4:1, it is not advisable to reduce the workers strength or slow down the post freezing activities due to the thawing of the frozen blocks at room temperature. Keeping the frozen slab at higher temperature during the post freezing activities should be minimized to the possible extent to avoid deformation of the frozen blocks.

MODEL :2.

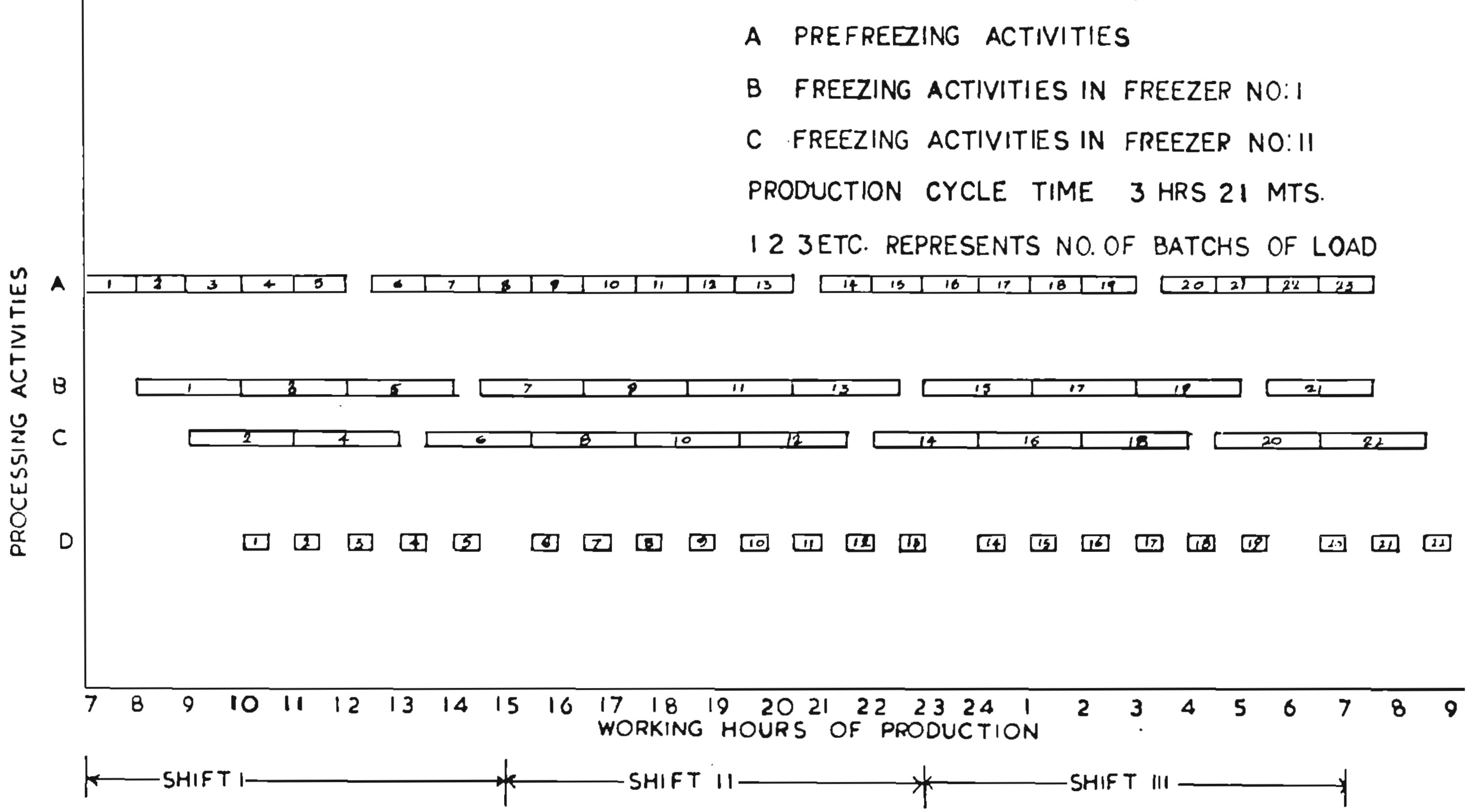
FOR NEW PROCESSING PLANTS (AS PER THE NEW LAYOUT SUGGESTED):-

In this model, the main drawback of the existing system that is the unbalanced nature of the processing line is minimized to the possible extent. The model is presented in figure 5.

Pre-freezing stage := The existing system of material flow

FIG. 5.

A MODEL PRODUCTION SCHEDULE FOR A 5 X 2 TONNES (10 T.) FREEZING PLANT.



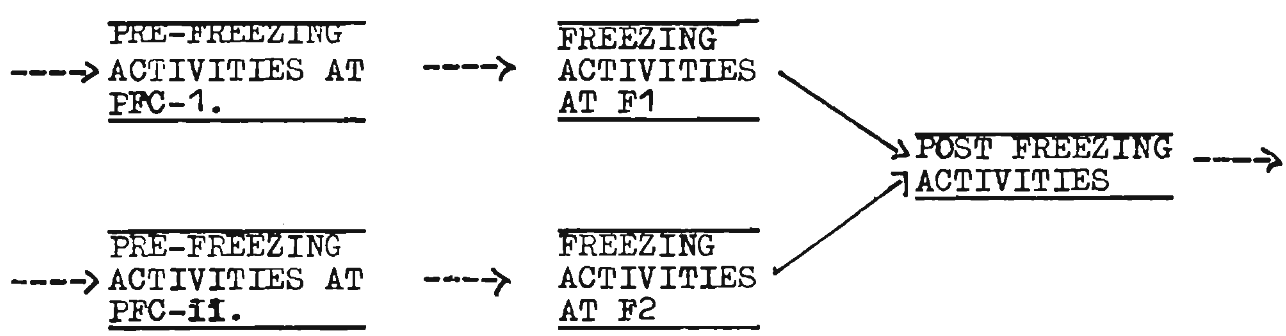
in processing plants had already been discussed. In that system there is only a single line at the pre-freezing stage. But this results in lots of problems like underutilisation of workers time, cross contamination, bottlenecks etc.

Under utilisation of workers time:- The processing plants receive different varieties (species) of raw materials from various landing centres at different times. It is also difficult to get sufficient quantity of a single raw material for processing in a day. So the processors are forced to process different materials even in a shift. This situation results in frequent washing and cleaning of the work sites before accepting a new variety of raw material for processing.(This is to avoid cross contamination) But during this process the workers have to stop their work and become idle till the washing and cleaning operations are over. This temporary suspension of processing within a shift period affects the smooth running of the plant.

Cross contamination :- Different raw materials have different quality problems and raw materials from different regions may carry different types of pathogenic organisms. Since the same facilities are being utilised for processing all these products, there is a great possibility of cross contamination of the products with these pathogenic organisms, dirt etc.

Bottlenecks :- The loss in time due to frequent cleaning operations as well as due to the temporary storage of raw materials,in-process materials etc. at different work sites in the single production line creates bottlenecks in movements of men and materials. Moreover, due to the single line of production at this stage, where the entire work is being carried out manually, the number of workers involved is more.

A two line pre-freezing facility with a single set of processing workers to overcome the above defects is proposed. The details of the layout and discussion on this aspect is given under the chapter on 'Facilities Layout and Line Balancing'.Here, the alternate batches of production can be done in pre-freezing centre 1 and II respectively. This will save a lot of time and labour. The production flow in the new layout is as given below:



Where: PFC I = Pre-Freezing Centre - I,
PFC II = Pre-Freezing Centre -II,
F1 = Freezer:1.,
F2 = Freezer:2.

Freezing stage:- Here a new freezing machinery is suggested with 'ninety minutes freezing time' instead of the existing one hundred and eighty minutes freezer. (The existing freezers can be converted into this form by adequate modifications.) This will help to double the freezing facility than the existing type of freezers. Moreover with the double line of freezing facilities, the utilisation of the facilities at the pre-freezing stage has been increased to 100% instead of 75% as in the case of earlier model. Quick freezing also is found to be advantageous to improve the quality of the product. It is also found to reduce the drip loss(Heen and Karsti, 1965 and Venugopalan, 1987).

Post-freezing stage :- With the recommended layout and schedule, the labour utilisation is almost double at this stage if manual operation is resorted. In the case of mechanisation as suggested in the layout, the workers requirement is further reduced to half of that required for manual operations.

The schedule of work and shift allocation at the pre-freezing stage in the new model is presented in figure 5. Here the start time and finish time of each shift is given. The slack period at the pre-freezing stage can be utilised for lunch break, cleaning operations etc. This schedule can be practised in seafood processing plants to have better production control and management.

4.4. PRIORITY RULE

As the profitability of the processor depends directly on the production cost, and since he is unable to fix the export price, he has to reduce the cost of production by all means to exist in this highly competitive field. The seafood export from India functions in a buyers market. The buyers in the importing countries fix the price for the product taking into account the international market situation and demand. The processor in India has no say in fixing the price. So if he has to exist in the field, he must control the production cost by improving the quality and yield.

A two stage scoring system is suggested to decide which raw material has to be processed first.

SCORE FOR UNIT PURCHASE PRICE

The purchase rate varies with raw material. For example, one Kg. of squid costs only Rs.4.00 whereas one Kg. of headless shrimp on an average costs Rs.60.00. Loss of a small quantity of headless shrimp is too costly for the plant to afford than the same quantity of squid or sardine. Hence a proportionate score is given with increasing unit purchase price of the raw materials as given below:

Score for the purchase rate of raw materials purchased by the processing plant

Sl.No.	Range of purchase rate in rupees per Kg. of material	Score
1.	Upto 3.00	1
2.	Above 3.00 and upto 5.00	2
3.	,, 5.00 ,, 10.00	3

Sl. No.	Range of purchase rate in rupees per Kg. of raw material				Score
4.	Above	10.00	and upto	20.00	4
5.	,,	20.0	,,	30.00	5
6.	,,	30.00	,,	40.00	6
7.	,,	40.00	,,	50.00	7
8.	,,	50.0	,,	60.00	8
9.	,,	60.00	,,	70.00	9
10.	,,	70.00	,,	80.00	10
11.	,,	80.00	,,	90.00	11
12.	,,	90.00	,,	100.00	12
13.	,,	100.00	,,	110.00	13
14.	,,	110.00	,,	120.00	14
15.	,,	120.00	,,	130.00	15
16.	,,	130.00	,,	140.00	16
17.	,,	140.00	,,	150.00	17
18.	,,	150.00	,,	160.00	18
19.	,,	160.00	,,	170.00	19
20.	,,	170.0	,,	180.00	20

Note: The score for any raw material can be added to the list as and when necessary.

WAITING TIME TOLERANCE SCORE OF RAW MATERIALS:-

Studies conducted by various research organisations like Central Institute of Fisheries Technology, Cochin, Tropical Development and Research Institute, London, Food and Agriculture Organisation,etc. have shown that different fishes have different quality problems and shelf-life at room temperature, during ice preservation and on storage. This is due to various reasons like (1) variations in the duration of rigor mortis depending on the species, methods of capture and ways of handling the fish (Amlacher, 1961); Variations in the microbiological quality of fish depending on the species, method of handling and the temperature at which it is preserved (Shewan, 1961;and Bramstedt and Auerbach,1961 ; Curran, et al., 1980; Curran, et al., 1981); variations in fat content, size, shape, season and fishing and feeding ground also contribute to keeping quality and affect shelf-life (Mathen, 1979; Santos,1981).

The study revealed that for a day's production, raw materials have to be collected from many of the scattered landing centres. The fish is also caught by different gears from different fishing grounds. The material is transported by different means like uninsulated to insulated trucks. The handling of the fish on board the vessel, landing centre and while transportation varies. All these factors influence the quality of the raw material.

Thus different raw materials have different safe periods of waiting without spoilage and loss in yield. This is taken into account while formulating the score for waiting time tolerance score for raw materials. The observed tolerance range is found to fall between 2 hours to 48 hours in Kerala (ice preserved raw materials). An inversely proportional scoring is suggested with increasing tolerance limit of waiting of raw materials before processing. The score suggested is as given below:

Waiting time tolerance limit score of raw material

Sl. No.	Range of tolerance in hours	Score
1.	Above 45 hours	1
2.	,, 40 and upto 45 hours	2
3.	,, 35 ,, 40 ,,	3
4.	,, 30 ,, 35 ,,	4
5.	,, 25 ,, 30 ,,	5
6.	,, 20 ,, 25 ,,	6
7.	,, 15 ,, 20 ,,	7
8.	,, 10 ,, 15 ,,	8
9.	,, 5 ,, 10 ,,	9
10.	Upto 5 hours	10

THE TOTAL SCORE

The sum of the two scores of a particular raw material decides the priority with which it has to be processed in the processing plant. The raw material which is having the maximum total score should be processed first and the one having next higher total score second and so on.

As the score changes during different periods due to fluctuation in the purchase rate as well as the variation in the waiting time tolerance limit, the production manager/ technologist have to regularly check the priority position of the raw material.

The waiting time tolerance limit of the raw material varies with the season, delay in the arrival of the raw material in the plant as well as handling and preservation practiced while transporting. The quality supervisors have to ascertain the tolerance limit of the raw material with his experience and knowledge in the field. This can be included in the regular production schedule to improve the quality and yield of the products.

QUALITY CONTROL AND INSPECTION

1. INTRODUCTION

Quality is defined as a measure of how clearly a good or service conforms to specified standards. The objective of quality control measures is to ensure that specified standards are adhered to in the production of a firm's products. Quality control is the operational techniques and activities which sustain the quality of product or service that will satisfy given needs, also the use of such techniques and activities. The aim of quality control is to provide quality that is satisfactory (safe, adequate, dependable and economical). The overall system involves integrating the quality aspects of several related steps including the proper specification of what is wanted, design of product or service to meet the requirements, production to meet the full intent of the specification, inspection to determine whether the resulting product or service conforms to the applicable specification.

Quality control in the case of seafood means all the steps taken between harvest and retail trade which protect the quality of the final product (Mathen, 1979). Inspection is defined as the process of measuring, examining, taking, gauging or otherwise comparing the unit with the applicable requirements.

1.1. History and evolution of quality control and inspection in seafood processing industry in Kerala:-

When India started exporting seafood in 1953, there was no scientific quality control system prevailing then. The foreign buyer wanted only good quality products that he could sell and the exporters exported only good quality goods since he had a reputation to maintain. As such, the goods we exported were able to pass through the quality control regulations in force in U.S.A. which was the most prominent importing country at that time. Gradually as the number of processing plants increased, good quality water, ice and other facilities required for processing became inadequate. There were complaints about quality and rejections based on it (Anon, 1967).

Fish starts to spoil the moment it is taken out of water. It has been observed that four hours is the maximum duration of time for which it remains in prime state of freshness in tropical temperature conditions, when once it is taken out of its habitat (Govindan, 1978).

To tackle all the problems, a system of compulsory Pre-shipment Inspection for major seafood items meant for export was introduced in 1965. This system had lots of draw backs. Since the inspection was done at the end stage, loss due to rejection was enormous. Mathen (1979 a) reported that atleast 10 per cent of the products were found to be substandard, indicating losses incurred in producing a substandard product. The end product inspection system looks for conformity of the end product to the notified requirements and it cannot enquire into the conditions under which these products have been manufactured.

1.2. In-process quality control and inspection:-

With a view to making the quality control and inspection scheme more meaningful and effective, the Government of India introduced the In-process Quality Control Scheme for frozen shrimps, lobsters, lobster tails, cuttle fish, squids and pomfrets with effect from 1977. Under the provisions of the notification of the In-process Quality Control Scheme of fish and fishery products, a panel of experts have been constituted to assess the facilities prescribed therein. Based on the recommendation of the panel, the units are declared as approved or non-approved. Under the scheme, the following procedure of inspection is being followed.

1. For the purpose of inspection under these rules, a day's production constitute a control unit.

2. A control unit may have more sub-units depending upon the species of the product. Samples are drawn from the raw materials, different processing stages, and the final product in accordance with the guidelines laid down by the Export Inspection Council. Those of the lots which meet the laid down standards are treated as approved lots (Majumdar, 1985).

The manual for In-plant Quality Control Scheme of the Export Inspection Agency gives the executive instructions and procedures to be followed for quality control and inspection in seafood processing plants which fall uner this category (Anon, 1985 f)

1.3 Modified system of In-process Quality Control Scheme:-

It has been decided by the Ministry to introduce the modified system of in-process quality control scheme in the case of units who have accorded approval to process under this system of inspection. It is the sole responsibility of the processors themselves to exercise total surveillance of their units under the guidance and assistance of the Export Inspection Agency to ensure organoleptic and bacteriological quality of the product. However, in the case of all the above systems of inspection, certificates of export worthiness are issued by the Export Inspection Agency.

A recent development has taken place subsequent to the rejection of a few tonnes of Indian shrimps by Japanese Quarantine Authority for the contamination of cholera germs, Vibrio cholerae test in frozen shrimp consignments to Japan has also been made compulsory (Majumdar,1985). The Pre-Shipment Inspection and Quality Control Manual published by Export Inspection Agency from time to time gives the instructions and procedures to be followed under this scheme (Anon., 1986 e)

1.4. International Organisations in Seafood Quality Control:-

Codex Alimentarius Commission of FAO and WHO of the

United Nations has a separate committee on fish and fishery products in international trade and also to work out codes of practices, where applicable. The committee has formulated few standards like that for canned Pacific salmon, canned shrimps or prawns, quick frozen fillets of cod and haddock, quick frozen fillets of Ocean perch, canned tuna and bonito in water or oil, canned crab meat, quick frozen lobsters, canned sardines and mackerel. They are also preparing more and more standards for other products (Mathen,1979; Brackkan, 1982).

1.5. National Agencies in seafood quality control and inspection

The Indian standards Institution (now known as Indian Standards Bureau) is the national agency which brings out standard specifications for fish and fishery products. These standard specifications are formulated after consultation with the traders, manufacturers, research institutes and all other organisations interested in seafoods. More than thirty five standards are available at present. The Central Institute of Fisheries Technology, Cochin is giving advice on quality aspects to seafood processors. The institute is mainly responsible for implementation of compulsory Pre-Shipment Inspection at present carried out by Export Inspection Agency. All export consignments are to be accompained by a certificate of fitness for exports (Mathen,1979).

1.6. Quality problems:-

Fish is the most perishable of all foods. The spoilage starts with the capture of the fish. Under Indian conditions, untreated fish becomes unwholesome within about eight hours (Anon., 1976 b).

Indian seafood products which are exported suffers from a lot of quality problems due to lack of proper process and quality control measures. During 1978-79, the US FDA reported for the first time that Indian shrimp was contaminated with salmonella. On this account, there were also many detentions of Indian consignments in various U.S. ports. Apart from salmonella, high percentage of decomposition and filth were also reported by U.S. FDA and they detained almost all the Indian consignments. Subsequently they also block listed all the Indian shrimp with effect from 5th October,1979. India was infact the first country to be block listed with regard to shrimp (Anon., 1982).

Impact of block listing:- Due to the block listing and consequent heavy detentions of Indian shrimp by U.S. FDA, our exports suffered a severe fall. The prices also dropped steeply. Uneconomical prices offered by U.S. buyers for Indian shrimp also contributed significantly to the export decline. Meanwhile, Indian exporters were reluctant to pack for U.S.A. because of stringent quality measures enforced by U.S.FDA (Anon., 1982)

1.7. Other quality problems:-

The trade delegation sent by Marine Products Export Development Authority, Cochin to study the export prospects in Japan reported the important defects of the Indian products. The important defects they pointed out are:

1. Mixing of spoiled pieces with high quality material
2. Arrangement of shrimps in blocks is not always done carefully and aesthetically leaving much to be desired.
3. Very often glazing is not even and the square shape of the block is not retained.
4. Inner cartons are not in good shape.
5. Broken pieces of shrimp shell, antennae and foreign bodies appearing in Indian frozen blocks reduces its consumer appeal.
6. Sometimes a few pieces of smaller or bigger pieces of shrimp that can very well go with blocks of lower or higher counts as the case may be are seen in a particular block.
7. According to Frozen Foods Inspection Institute, Japan, our products contain lot of foreign matters like cigarette filter, wooden pieces, bamboo bites, rice husk, iron pieces, nails, human hair and pebbles.

Such problems result in reprocessing companies making claims against importers who inturn find it difficult to get compensated from the exporters. As an example, the recent case of some 15 tonnes of Peeled and Undeveined Shrimp each imported in 1982 by a particular trading house, for two reprocessing plants were found to contain 478 instances of foreign material. Normal practice followed is to treat three pieces of foreign matter as one complaint and altogether 1,060 such complaints were reported in February, 1982 alone (Anon., 1982 a). Apart from such defects occurrence of soft shell in Shell-on Shrimp was also not uncommon.

Rao and Pillai (1967) have indicated co-relation between the occurrence of defective pieces at Pre-freezing and earlier stages. This shows that a strict process control and quality control is a must from the first stage of processing onwards to get a good quality end product.

Unnithan, et al.(1976) carried out a statistical study on the weight loss in frozen prawns during storage. The study estimated a weight loss in Peeled and Deveined (PD) prawns between 7 to 12 per cent and in Headless shrimp it was between 5 to 7 per cent. This high fluctuation and high rate of weight loss is mainly due to lack of standardized processing and quality control measures in processing plants.

Similarly delay in processing of the material arriving at the processing hall or factory affects the quality of the products to a greater extent. The delay will considerably reduce the ultimate yield of the product. This will increase the cost of production. Nair, et al.(1979) found out that delay in processing the prawns in factories soon after it is caught accounts to considerable waste owing to spoilage. It is essential to control this phenomenon not only to conserve the material but also to improve the quality of the finished product. As per their estimate, the spoilage accounts for considerable reduction in the final yield. The wastage of prawns due to spoilage accounted to about 0-12 % in 1974, 0-35 % in 1975, 0-4 % in 1976 and 0-4 % in 1977. Spoilage increases with the time lag between catching and processing and also due to defective icing.

A through study was conducted to understand the situation and problems involved in quality control and inspection in seafood processing plants. Measures are suggested to improve the quality and yield of the products. Important measures like introduction of statistical quality control charts at various stages of processing and institution of 'Quality Circles' in seafood processing plants are suggested.

2. LITERATURE REVIEW

2.1. Rules and Regulations on hygiene, Sanitation and Quality Control:-

Many countries have strict rules and regulations to maintain hygiene, sanitation and fish quality in fish processing plants.

In Canada, before inspection will be granted by the Department of Fisheries, all establishments, or those sections of such establishments where fish is processed, should meet the specified requirements for plants (Anon,1958).

In Chile, all persons handling oysters shall be immunized annually against typhoid fever. Any person handling oysters, who is proved to be a carrier of a communicable disease and who, in the opinion of the Board of Health, may contaminate the oysters, shall be withdrawn from the work. The person handling oysters shall be in possession of a health certificate issued by the Health Authority or the competent Municipal Authority, the certificate has to be renewed every three months. Oyster distributions or vendors shall have in their possession the sanitary authorisations or certificates controlling the transport and indicating the origin of oysters(Anon., 1960 a).

In France the health regulations are still more stricter. Besides commercial consideration which demand products of high and consistent quality, a large body of regulations governs the production, import and sale of processed foods, including frozen foods in France. There are legal distinctions between products which are'surgeles' (Quick Frozen) and those which are 'congeles' (frozen). Since June 1974 all these products had to be deep frozen at -18°C or less. Because of the stringency of the definitions of quick frozen ('surgele') in France, a number of manufacturers have preferred to label their products as 'congeles' rather than 'surgeles', although by other technological criteria such products might be deemed quick frozen. The most important legislation regarding the quality of seafoods in France is given below.

1. Products destined to be frozen must initially be in a perfect state of freshness and completely free from

pathogenic organisms.

2. The adjective 'surgele' (Quick Frozen) can only refer to products effectively submitted to a quick freezing process.
3. Frozen foods must be kept at a temperature equal to or less than -18°C until the moment of sale
4. Frozen foods must be sealed in packages which ensure their protection.

The French authorities maintain a watchful guard over supplies from countries judged to have potential hygiene problems, particularly India. It was reported that regular arrivals of froglegs from India had to be rejected, either because the legs had grey stains or because a hygienic inspection showed the presence of too many pathogenic germs. The rejection of food shipped from India at French ports, and press coverage of these rejections, have strengthened a French prejudice against food originating from the Indian subcontinent, where hygiene standard is considered to be low (Anon.,1976 a).

Import Regulation Register published by Food and Agriculture Organisation (FAO) covers detailed information on tariffs, duties, quantitative restrictions and other barriers existing in importing countries. This will help the exporters to formulate their strategy for marketing in these countries (Anon., 1981)

Many countries have strict rules and regulations to control the import of poor quality products. Saudi Arabian Health Ministry has recently formulated policies and programmes to check cholera-stricken countries from importing contaminated food stuffs in the Kingdom (Anon., 1984 j).

Japanese Government has stipulated quality standards and inspection procedures for the export of various marine products The important aspects covered in the standards are appearance, colour, freshness, spoilage rate, glaze, temperature of frozen blocks etc. in addition to microbiological and biochemical tests. India's main market is Japan and it is a must to follow their quality standards and inspection procedures to successfully market her products in Japanese markets. India's main export to Japan is frozen shrimp and the quality standards stipulated by them for export of frozen shrimp is discussed below.

Appearance:- The shrimp, individually frozen, that holds the original form without being substantially split or otherwise broken, is considered to be of good appearance. The cake of shrimps, collectively frozen is not considered to be of good appearance.

Colour:- The shrimp that possesses such colours characteristic of the particular species of shrimp is considered to be of good colour. Not withstanding in the case of Taisho Ebi (*Penaeus-orientalis*), the presence in a slight degree of the red colour in whole body or in a portion of the tail, is admitted. In the case of the above two, any presence of the greyish white colour caused by dehydration is not admitted.

Odour:- The shrimp is required to be free from such odour as of hydrogen sulphide, ammonia or any other odour that is not characteristic of the particular species of shrimp.

Uniformity:- The size in a specific assortment is required to be mostly uniform. Mixture of any different species is not admitted.

Spoilage:- The shrimp that is not spoiled with sand, flesh wastes or any other extraneous substance is accepted as clean.

Glaze:- The glaze is required to be crystal clear, transparent and sufficiently thick to prevent the occurrence of dehydration. Not withstanding, in such cases where packagings will ensure against such deteriorations, the glaze may not be necessiated.

Temperature:- The temperature is required to be below -10°C at the internal centre of the flesh.

The standards for other products also follow similar pattern but vary according to the intrinsic property of fish and preparation of the products(Japanese Quality Standards and Inspection Procedure for Export of Frozen Marine Products, Government of Japan, Japan.).

The Food and Drug Administration of the United States of America (US FDA) has imposed certain regulations on the use of sulphiting agents in shrimp. It has recognised the need for sulphiting agents to prevent 'black discolouration' in shrimp.

Potassium bisulphite and meta bisulphite, Sodium sulphite, bisulphite and metabisulphite and sulphur dioxide are recognised to be safe (G R A S) additives. The fact that a substance is listed as a G R A S additive does not mean, however, that it can be safely used at any level in foods. The regulations for each of these substances state that they are considered safe when used in accordance with Current Good Manufacturing Practices (C G M P). For example, use of sulphiting agents in meat and fish to restore a bright colour or fresh appearance is generally prohibited in the States. However, sulphites may be used on shrimp in accordance with C G M P to inhibit black spot formation. US FDA regulates imported shrimp by analysing for residual sulphiting agents. It considers that 100 ppm is an indication of abuse. Shrimp products with residual levels of more than 100 ppm sulphiting agents are considered adulterated because they contain an unsafe amount of food additive (Federal Register, Vol. 50, No.15, p.2957, 1985) Shrimp exported to the U.S. should, therefore, contain a maximum sulphiting agents residue of 100 ppm in the edible portion (Finne and Miget, 1985)

Majumdar (1985) describes the various Indian Standards for quality - Physical, Organoleptic, Analytical and Bacteriological. He also decribes the In-process Quality Control and Inspection System as well as Modified System of In-process Quality Control System. The need for ensuring high quality of products was felt by the Government of India from the very begining of the frozen and canned fish trade and initial attempts to regulate the quality of products were undertaken in 1963. A scheme of voluntary inspection of export consignments was undertaken with the co-operation of the industry. Meanwhile, Indian Standards Institution(now known as Indian Standards Bureau) has formulated standards for frozen shrimps and canned shrimps in brine. Another significant step in that direction was the enactment of Export Act by the Government of India in the year 1963. Under this act, the Central Government by a notification in the gazette of India ensures that a product before its export conform to the specification laid down and the product is not allowed for export unless it is accompanied by a certificate of export worthiness issued by the competent inspection agency recognised for the purpose. The marine products first to be brought under compulsory quality control and pre-shipment inspection under the act were frozen and canned shrimp with effect from 15th March, 1965. Gradually other products like frozen froglegs, frozen lobster tails, frozen cuttlefish and squids, frozen pomfrets, dried shark fins and fish maws, dried shrimps, fish, beche-de-mer and fish meal were brought under the purview of the scheme.

2.2. Quality Problems:-

Ambacher (1961) gives an account of the post mortem changes occuring in fish during storage. One of the factors which,for certain lapse of time retards the post mortem autolysis and bacterial decompostion of the flesh and its protein is the death stiffening of the muscle tissue - rigor mortis. Rigor mortis in fish starts 1 - 7 hours after death. Its peak in slaughtered fish, kept in ice, lies between 5 and 22 hours after death. The total duration of the rigor covers 30 - 120 hours. Suffocated fishes not held in ice show a shorter period of muscle toughness (32 - 93 hours). A prolongation of the rigor mortis period, consequently, is of great economic importance.

Fish will maintain its freshness when stored in ice right after catch, but if it is to be stored for a period longer than 10-14 days, frozen storage will be necessary. Frozen storage is an excellent method for preventing putrefaction and autolysis of fish meat, however, deterioration cannot be avoided when the storage period is lengthened. For example, when fish has been frozen for a long period and thawed, it will show softened texture, loss of flavour, etc. When thawed fish is cooked, changes such as toughness, wooliness, dryness and loss of juiciness will be observed. With frozen fish meat that has been stored, the functional properties such as emulsifying capacity, lipid binding capacity, water holding capacity and gel forming capacity are much lower than in fresh fish. The main cause of these quality changes in meat can be found in the denaturation of protein, especially in that of myofibrillar proteins (Dyer and Dingle, 1961)

Tsuchiya gives an account of the problems associated with rancidity of fish oil and suggests measures to reduce it. Development of rancidity in fish has been attributed chiefly to the atmospheric oxidation of the fish oils.This process involves the formation and the decomposition of peroxides. The decomposition products include various acids, carbonyl compounds and condensation products. Some of the acids and carbonyl compounds are said to have unpleasant flavour or odour. Basically, the development of rancidity can be attributed to two types of chemical deterioration of the oils. One is the oxidative deterioration, and the other the hydrolytic deterioration. Of these two types, the oxidative deterioration is chiefly responsible for the development of rancidity.

Fish should be iced and placed in a dark place immediately after their capture. It is desirable to transfer the iced fish as soon as possible to the refrigeration storage at temperatures below -20°C. The shorter the period of ice storage, the more prolonged the keeping quality of the frozen fish. Proper glazing will help to protect the fish flesh from the penetration of air, hence from oxidative deterioration. Filling of carbon dioxide or nitrogen gas in the storage chamber is also suggested. Use of antioxidants are also suggested to prevent oxidative rancidity. (Tsuchiya, 1961).

Shewan (1961) has reviewed the work done on the microbiological flora and quality problems associated with sea water fishes. Wide variation in the microbiological quality was reported depending upon the species, method of handling and temperature at which fish is preserved.

Similar observation was made by Bramstedt and Auerbach (1961) in fresh water fishes.

Bramsnaes (1965) gives a complete picture of the effect of handling of fresh fish on the keeping quality. The keeping quality of the fish depends on the species, seasons, method of fishing, fishing grounds, temperature of storage, delay in icing, eviceration and removal of gills, washing, quantity of ice used and cleanliness of ice, ice box and fish store.

According to Nair, et al. (1974) fish before the complete resolution of rigor was not found to affect the quality of fish to any greater extent during subsequent storage. But delay beyond this level was found to affect the shelf-life.

Mathen (1979) points out the difference and special nature of the quality problems involved in the seafood industry when compared to other food industries. In the first instance, he points out that in other food industries like fruits, vegetables, meat etc. we can harvest the required species at the right time and at the right place.This means that it is possible even to select the right species, to rear them to the desired levels of growth and to harvest them in a pre-determined place as per pre-determined schedule. In the case of seafoods, the harvesting is done from the sea, from stocks of unknown identity as to age, sex,etc. under most difficult conditions. Hence the intrinsic quality varies in all possible combinations. In addition the initial handling, processing and preservation are carried out under highly unfavourable conditions giving room for imperfect operations. Another hurdle in proper quality control is the unpredictability of catch.

According to Iyer (1979) the bacterial contamination contributes to the following problems.

1. Potential loss of organoleptic and nutritive quality.
2. The risk of the food rapidly becoming unwholesome in the presence of excessive bacteria.
3. Production of heat stable toxins by some bacteria (Staphylococus aureus)
4. Production of rancid odours in fatty fishes by Pseudomonas fragi and Mycobacterium phlei)
5. Conversion of histidine (an amino acid) to histamine (a poisonous substance) by organisms belonging to the species Proteus morgani.
6. Cross contamination in refrigerated storages.
7. Esthetics :- It is generally accepted that the consumer has the right to be protected against unwarranted contamination in foods.

He points out the various sources of contamination as food contact surfaces, faecal contamination, poor handling, air and dust. He also gives a cleaning schedule for utensils and equipments in fish processing factories.

Kandoran (1979) describes the effect of slow freezing on the quality of fish muscle. Slow freezing forms big ice crystals inside the fish cells rupturing the tissues more. Quick freezing results in the formation of small ice crystals within the cells. Hence slow freezing leads to more drip loss than in quick freezing.

A number of other workers have also reported the behaviour of protein in fish at low temperature and its chemical deterioration (Matsumoto, 1979; Matsumoto, 1980; Suzuki,1981; Regenstein and Joe, 1983).

Hempel and sjef (1985) reported that the shigella incident in Netherlands dealt a serious blow to shrimp exports from the Asian/Pacific region. Fourteen deaths allegedly resulted from contaminated shrimp from South East Asia. As a result, imports from the region was reported to take a dive and it took nearly six months to get back to normal trading. They, the people of Netherlands, are reported to be of the opinion that unless and until these producers have been allowed to demonstrate that they can supply good, consistent quality products, the perception in the mind of the people will not change.

Haran (1985) gives an account of the bad effect of salmonella on the quality of the marine products and he gives some measures to avoid salmonella contamination in seafoods. Some 1,300 types of salmonella have been identified and according to him it may be more than this figure. The most notorious strain is S. typhi, the agent of typhoid fever. Salmonella is widely spread throughout our environment, especially in animals. For this reason, meat, poultry and animal based products or ingredients are especially susceptible to salmonella contamination. The microbes multiply rapidly at room temperature and under ideal conditions they will double in number every twenty minutes. Hence salmonella prone food kept at room temperature for several hours has frequently been the case of salmonellosis (food poisoning). Salmonella can be picked up at any time during the various stages of processing, storage or marketing. Federal states and local agencies have sets of regulations - good manufacturing practices - for the food manufacturers to follow. The objective of salmonella control programme is not to meet minimum requirements or to develop more sophisticated testing procedures, but to provide 'salmonella free food products' to consumers. He suggests a chain of food sanitary practices for the processing plants starting from raw material to finished product. Any breakdown of sanitary discipline can completely wreak an eloborate and costly programme.

2.3. Quality Assessment and Quality Control Systems:-

In order to maintain the hygienic conditions and proper sanitation in seafood industry as well as to assess the quality of various products produced by the processing plants, Indian Standards Bureau, New Delhi has developed certain standards and procedures. The following is a list of the standards and procedures developed by the Bureau.

Sl. No.	Name of specifications	Specification Number and year of publication.
1.	Dried white baits (Anchoviella Spp.)	IS 2883-1964

Sl. No.	Name of specifications	Specification Number & year of publication
2.	Dried and laminated Bombay duck	IS 2884-1964
3.	Frozen froglegs	IS 2885-1964
4.	Shark liver oil for veterinary use	IS 3336-1965
5.	Mackerel (Rastrelliger spp.) canned in brine	IS 3849-1966
6.	Dry salted cat fish	IS 3851-1966
7.	Dry salted leather jacket (Chorinemus spp)	IS 3852-1966
8.	Dry salted horse mackerel (Caranx spp)	IS 3853-1966
9.	Frozen lobster tails	IS 3892-1966
10.	Dry salted mackerel	IS 4302-1967
11.	Tuna canned in oil	IS 4304-1967
12.	Prawns (shrimp) canned in brine (first revision)	IS 2236-1968
13.	Fresh silver pomfret and brown pomfret	IS 4780-1968
14.	Fresh threadfin	IS 4781-1968
15.	Frozen silver pomfrets and brown pomfrets	IS 4793-1968
16.	Frozen threadfin	IS 4796-1968
17.	Dry salted seer fish	IS 5198-1969
18.	Dry salted shark	IS 5199-1969
19.	Dried shark fin	IS 5471-1969
20.	Fish maws	IS 5472-1969
21.	Sardine oil	IS 5734-1970
22.	Recommendation for maintenance of cleanliness in fish industry	IS 5735-1970
23.	Dry salted Surai (Tuna)	IS 5736-1970
24.	Pomfret canned in oil (first revision)	IS 2168-1971
25.	Frozen prawns (shrimp) first revision	IS 2237-1971
26.	Mackerel (Rastrelliger spp.) canned in oil (first revision)	IS 2420-1971
27.	Sardines (Sardinella spp.) canned in oil (first revision)	IS 2421-1971
28.	Mackerel. fresh	IS 6032-1971

Sl. No.	Name of specifications	Specification Number & year of publication
29.	Mackerel, frozen	IS 6033-1971
30.	Lactarius spp. canned in oil	IS 6121-1971
31.	Seer fish (Scomberomorus spp.) frozen	IS 6122-1971
32.	Seer fish (Scomberomorus spp.) fresh	IS 6123-1971
33.	Dried prawns (first revision)	IS 2345-1972
34.	Sardines (Sardinella spp.) canned in brine and in their juice	IS 6677-1972
35.	Master cartons for export of frozen seafoods and froglegs	IS 6715-1972
36.	Dry salted thread fin (Dara) and dry salted jew fish (Ghol) (first revision)	IS 3850-1973
37.	Fish meal as livestock feed (first revision	IS 4307-1973
38.	Crab meat, canned in brine	IS 7143-1973
39.	Glossary of important fish species of India	IS 7313-1974
40.	Code for hygienic conditions for fish industry: Part I pre-processing stage (first revision	IS 4303-1975
41.	Part II canning stage (first revision)	IS 4303-1975
42.	Basic requirements for fresh fish stalls	IS 7581-1975
43.	Crab meat, solid packed	IS 7582-1975
44.	Frozen cuttle fish and squid	IS 8076-1976
45.	Procedure for checking temperature of quick frozen foods	IS 8077-1976
46.	Basic requirements for a fish market	IS 8082-1976

Based on these standards and procedures , Export Inspection Agency is regularily monitoring and controlling the quality of seafoods produced for export. Quality assessment and control are carried out under two separate schemes as discussed earlier.

Many workers have highlighted the use and formulation of statistical quality control system for better process and quality control. Statistical quality control applies the theory of probability to sample testing, on inspection. Inspection work in seafood industry is possible only by sampling and this system suits well for the industry. The objective of statistical quality control are to show how reliable the sample is and how to control the risks. Statistical quality control helps control processing by warning manager of the deviation in the production process. This helps the manager to take immediate remedial measures. Not only does statistical quality control indicate when a process is out of adjustment and turning out bad work, but it warns the operator if the machine is getting out of adjustment. It monitors operations and indicates drifts toward defectives. This helps prevent defectives and cuts losses due to scrap.

When statistical quality control is used to control operations, samples of products are checked from time to time, and their measurements are plotted on 'control charts'. Since it is impossible to make two absolutely identical products, some minor variations in measurement always occur even when the machines are in adjustment. A machine will occasionally produce an unacceptable product, even when it is in adjustment. Control charts show when operations are producing too many unacceptable products and indicate to operators when they need to reset their machines. Ramdom sample is used for statistical quality control to get a representative picture of the population. It is desirable to consider each day's production from automatic machines as a separate lot (Kramer and Twig, 1962; Rao, 1971; Rao, 1971 a; Rao, 1972; Upada, 1978; More and Hendrick, 1978; and Grant and Leevenworth, 1980).

Rao (1971) developed a control chart for gross weight which indirectly gives a measure of the drained weight of frozen prawn. According to him the drained weights are susceptible to variation due to a number of factors. Since determination of the drained weight involves destructive and time consuming procedures, application of control chart for drained weight on the processing line is not possible. He found that the gross weights of the products are significantly co-related with their drained weights and the determination of the former does not have the disadvantag of determination of the latter, the drained weights can be controlled through the application of control chart for the gross weights. Rao (1971 a) gives the procedure for setting up a variable control chart for use in filling operation of cans in a shrimp canning factory. A comprehensive description of the procedure for different kinds of control charts, the kinds of action to be taken under different conditions and the adjustments necessary in the filling process to suit the minimum specified fill weight are dealt with. Rao (1972) also gives a method to control the drained weight in some fishery products.

Statistical control charts are also used by Food and Drugs Administration of the United States of America (US FDA). They are used for inspection of variables like fill weights etc. (US FDA standards for inspection, part 52.201).

Udupa (1978) describes the usefulness of statistical quality control charts on Attributes in fish processing. Statistical quality control chart for fraction defectives is explained by noting defective fish sausages per shift from a sausage industry while control chart for number of defectives is illustrated for number of defective fish cans in each hour of its production of a canning industry. 'C' chart is another type of control chart which is explained here for number of defects per single fish fillet sampled at random for every five minutes in a processing plant. These statistical quality control charts help in the more economic use of resources, time and labour than control charts for variables of products. Also control chart for attributes exhibit the quality history of finished products at different times of production thereby minimising the risk of consumer rejection.

In addition to giving a detailed description of the significance of statistical quality control systems, More and Hendrick (1978) also describe how to select the sample size for quality control purpose. According to them the reliability of a sample does not depend on its proportion of the universe; its reliability is almost entirely dependent on its own numerical size. The size of the whole lot has little effect on the sample's reliability. Only very small samples, proportionately need to be inspected from large lots. Eastman Kodak set the sample size for much of its inspection of using the following formula:

$$n = \sqrt{2N}$$

where n = sample size and N = whole lot.

Eastman inspects larger samples for products he thinks might be of uneven quality. But the largest samples, even if Eastman suspects that a lot is of uneven quality, are limited to 25 times the usual sample size, or 500 in the case of a 20,000 lot. They also describe various control charts and give steps to go through for setting up control charts.

2.4. Human factor involved in Productivity and Quality Control:-

Gitzendanner, et al. (1983) describe the involvement of management in the strategic utilisation of the human resources. They conducted a study for comparing human resource management techniques at highly productive large companies with those at less productive competitors.They found a world of difference between the two groups of human resource practices - and strategic human resource management is central to the success of leader companies. According to their findings, five characteristics distinguish how America's productivity leaders manage the human resource function.

1. In leader companies, human resource management is a joint effort between human resource managers and line management.

2. In leader companies, people-related progremmes are consistent with strategic business plans.
3. Leader companies solve people's problems with current resources before seeking additional resources.
4. Leader Human Resource Function (HR) staffs are more proactive in initiating focussed programmes and in communicating with line management.
5. In leader companies, corporate and divisional HR staffs share responsibilities for policy development and programme administration.

Strategic H R Management:- In the five step process that strategically oriented companies use to manage human resources, managers from all areas of the company are involved, the company's people related goals exist for the success of the enterprise, not the enhancement of the human resource division. Each and every manager's success today and in the future depends on the effectiveness of his or her staff. The strategic human resource management steps are:

1. Identification of the people requirements of business plans.
2. Analyis of the environment's impact on the company's ability to achieve its goals.
3. Identification of needs regarding the future human resources.
4. Formulation of human resource goals and priorities and short and long range plans.

5. Focusing of human resource programmes and management activities.

A Joint Effort := Strategic management of the human resources is a joint venture of the management team. While the human resources function provides the technical leadership, it is the role of management in each area of the corporation to identify the human resources needed to meet today's and tomarrow's business goals. In addition to implementing programmes (in such areas as recruitment, training and compensation), managers must use the methods available to them by virtue of their positions to structure the organisation appropriately, develop and motivate employees, and create an atmosphere that supports co-operation and productivity.

They also point out that many corporations are managing their business portfolios strategically and focussing today's financial resources on achieving tomarrow's business goals. Most of America's productivity leaders, however, have also discovered that preparing people to manage the business is another key to success. An organisational structure stepped with capable, motivated employees who are capably managed provides a base on which success can be built.

Smith (1983) is of the opinion that people (employees) need a work environment where there normal, everyday insecurities are not allowed to dominate their thinking; where they can learn to see themselves as part of the organisation - one that encourages them to take responsibility for its problems and its successes. He co-relates the customer needs with workers need through Maslow's 'Hierarchy of Needs'. He says that when the insights of Maslow's 'Hierarcy of Needs are applied to the concept of 'total customer support', a strong indication emerges showing that this support can only be accomplished by totally satisfied employees.

Cole (1983) suggests improvement of product quality through continous feed back. He suggests that management must see to it that quality improvement is not a limited operation aimed at just one particular level; it must be an ongoing process that involves the co-operation of all organisational departments.

Quality improvement is an issue that is going to be around for a long time. There will be facts on how to improve quality, but competition through quality is a management strategy, indeed a management philosophy, whose time has come. There is a growing recognition that setting new quality standards can be used not only to increase ones share of the existing market, but also to change consumer taste and thereby create new market demands. This is especially important under condition of a slower growing economy and one where we are dealing more replacement markets. The nice thing about being able to change consumer tastes is that you are then in a unique market position to satisfy these new tastes. This inturn can be translated into higher price and/ or market share. According to him, quality is not the responsibility of only the quality control department. All major functions of the organisation must participate and take responsibility for quality improvement. These departments have to learn to co-operate with each other on this effort. Top management must set the tone and provide visible support. Existing quality systems often lead to the establishments and maintenance of bureaucratic systems based on the flow of paper, an emphasis on defect reduction, and acceptable quality levels rather than prevention; further these systems contribute to the adverse relations between departments and between original equipment manufacturers and suppliers.

Quality and productivity:- Improved quality leads to improved productivity. The goal of production is to produce a given amount of goods at a competitive price, quality and delivery date. To do that, a company must conduct these activities: control of quality, control of costs and control of amount of production and delivery date. These three activities should not operate as a set of trade-offs for one another, for that would overlook the intimate relation between quality improvement, cost reduction and improved adherence to specified delivery dates of the required production. The author suggests in-line inspection of semi-finished parts instead of the traditional approach of inspection at the end stage. It involves greater reliance on self-inspection and on having employees at each stage inspecting the immediately preceding stages. One major reason this approach leads to a reduction in costs is that, as studies show, when defective parts are corrected far from their sources, there is a dramatic escalation of costs. If quality control is set in the right direction, then the other two, namely the cost control and meeting delivery dates with the specific production, will follow suit.

Rai (1984) while describing the problems associated with productivity by neglecting the human factors of production, quote the Japanese example of success in handling human components in production centres. He points out that Japan has taken a realistic and constructive approach to the problem of declining productivity. According to him the following factors lead to higher productivity in Japan.

The dedicated middle-managers with their dedication and sense of responsibility have been able to involve the workers fully in the production process and thereby for the economic miracle witnessed in Japan. It needs to be emphasized that it was the work climate produced by these middle-level managers that ensured the equally sincere work of the common workers, which caused the economic progress. People work and high levels of productivity are achieved when the organisation has able leadership and high morale can be maintained. Maintaining high morale and team spirit are of great importance for successfully carrying out the set performance.

Organisation comprises of interacting small autonomous groups.Such a concept is possible only in an informal working atmosphere. The 'Quality Circle' concept creates in effect such autonomous groups, where all employees get an opportunity to (1) be informed of goal, (2) know how their unit contributes to the organisations goal,(3) suggest improvements in working methods, (4) take part in discussions concerning quality and production, (5) broadly understand why various decisions were being taken on different jobs and (6) share different chores and thus enrich their job content and break the monotony and tedium of endless repetition and derive job satisfaction, would improve productivity. He says that it is not possible in any industry or organisation to define comprehensively the job content of each individual. Even if this were possible, the experience, judgement and ability, required for each job would differ from individual to individual. These two factors make it necessary that individuals in a group spontaneously help each other out, especially in the inevitable grey areas between defined job contents of various functions. And this is exactly what is meant by 'team work'.

Thus he says that when consultative pattern of management exists, the involvement of employees in thefunctioning of the organisation becomes possible and where such involvement is forthcoming higher levels of organisational performance are achieved.

Padaki (1985) conducted a study on the job enrichment in textile mills based on the theories of Maslow and Herzbery. Contrary to the common belief of the managers that theories of Maslow and Herzbery cannot be practiced especially in Indian organisations, the study shows that employees do appreciate enriched jobs which fulfil their psychological needs. It also shows that it is possible to modify work content even in the most traditional organisations such as textile mills.

Japan recognised the benefit of 'Quality Circle' and introduced in her industries as a part of the post war rebuilding programme. In 1962, over 2,000 Japanese companies were operating the system with very considerable success. Since that date thousands more have taken it up. Once the concept had become firmly established in Japanese industries American companies began to follow suit, again with marked success. With United Kingdom firms,the story has been rather different. It took until the late 1970s for any interest to begin to take root. Other countries have shown an equally variable response.

Brain-storming :- The technique employed may include among others, brain-storming, simple mathematical graphical techniques and easily operated systems such as pareto analysis (A B C technique or 80:20 rule). The selected group should meet on a regular basis, say once every two weeks, and hammer out the problems identified. The results of such meetings are then forwarded to the company management for consideration and, hopefully, action.

Cost Saving :- The most obvious benefit of 'Quality Circle' is in cost saving. Some quite remarkable results have been achieved from the adoption of this technique. Another benefit is that the work force is encouraged to become a real part of the organisation. This means that the worker will feel that he 'belongs' and identifies himself with his firm. Thus he will become genuinely more interested in his work, because he knows that any ideas he may have will be considered by his bosses. Management is also encouraged by the creation of a responsive and willing work force. The job of managing becomes more rewarding and easier, knowing that the work force is in accord. Trade unions can also benefit. Despite early suspicions, many unions are coming around to the idea that 'Quality Circles' can involve them more in the day to day running of a company. Perhaps they also see room for productivity bargaining and manipulation. This management technique does have a very valid place within the fisheries industry. It is labour intensive and so is well suited to the application of 'Quality Circles'. It has already been mentioned that equipment manufacturers and fish processors are especially good candidates.

In conclusion it should be said that the manager must recognise that this work force represents a tremendous fund of ideas and knowledge, no matter how unprepossessing it might look in its overalls (Anon., 1985 g).

Chandrashekharan (1986) gives a complete detail of the history, structure, functions and benefits of 'Quality Circles'.

3. MATERIALS AND METHODS

A detailed study on the various aspects of handling, processing and quality of the seafood products were carried out in six seafood processing plants (factories) selected at random from Cochin region. Random samples of the products and random observations on the processes were carried out in these plants to study the variation in quality and processes involved for the production of products.

Freezing Time :- The time between loading of the material into the freezer and its unloading from it was noted to find out the variation in the freezing time (The normal freezing time in the freezers was 3 hours.)

Freezer Temperature :- The temperature of the freezer at the time of freezing was periodically noted to find out the deviation of freezer temperature from normally required temperature of -40°C.

Cold store Temperature:- The fluctuation in the cold store temperature was also noted at random.

Drained Weight:- The drained weight of the frozen products was noted at random as per the Modified In-plant Quality Control Scheme and the study was carried out as per CAS/RS 92/1976 (1977).

Count per pound:- Observations on the count (number of pieces per pound) was carried out as per the instruction of Export Inspection Agency of the Government of India

Total Bacterial Count(T B C):- The total bacterial count was estimated using Tryptone Glucose Agar (T G A) at 37°C. The incubation was done for 48 hours.

Vibrio cholerae and Salmonella :- Observations on the samples analysed at the laboratory of the fish processing plants selected for the study were carried out to estimate the occurrence of *Vibrio cholerae* and Salmonella in frozen products.

4. RESULTS AND DISCUSSION

4.1. Freezing time ;- The freezing time observed in six processing plants is given in table: 1. Wide fluctuation was noticed in the freezing time in some plants especially plant numbers 1, 2, and 3. This was mainly found to be due to the variation in the decision of the technologists to adjust to the fluctuating arrivals of raw materials. The inefficiency of the freezers was another reason. This was due to the faulty maintenance system of the processing plants.

Freezing of the product for a shorter period than the stipulated period will result in deformation of the slabs, and chances of spoilage are more. This will reduce the consumer acceptance as found by the study team sent by Marine Products Export Development Authority to Japan (Anon., 1982 a).

Freezing for a longer period than the required normal time will result in reduced turnover of processing and the situation is very critical as the freezing stage consumes about 75-77 percent of the total process cycle time for the processing of a product. In addition to this, the slow freezing will result in quality problems as described by many research workers like high thaw drip, damage to the muscles, increased desiccation of the surface of the frozen block, etc. (Reuter, 1916; Taylor, 1927; Weld, 1927; Birdseye, 1929; Poole, 1935; Kandoran, 1979 and Venugopalan, 1987).

4.2. Freezing temperature:-

Wide fluctuation in temperature during freezing and storage was noticed in the fish processing plants as shown in tables 2 and 3 respectively. The fluctuations in the freezing and storage temperature were found to seriously affect the quality of the products. Studies conducted by several researchers have sustantiated this aspect. The chemical reaction and bacterial spoilage in fish tissue proceeds at a considerable rate at higher temperature and since the main goal of freezing and cold storage preservation is to prevent spoilage and present a product similar to the genuine fresh fish, one should try to suppress or retard chemical changes to the utmost during storage. Reay, et al.(1950); Stansby (1955); Dyer, et al.(1957), etc. found that lowering of temperature by 10°C at the -10°C level induces a four fold increase in the shelf-life, whereas at the -20°C level a 10°C reduction in temperature doubles the shelf-life. Curran, et al. (1980) studied the rate of spoilage and shelf-life of gold lined bream (Rhabdosargus sarba) at 0°C and at 10°C and established that the rate of spoilage at 10°C is approximately five times more than at 0°C. Curran, et al.(1981) also studied the shelf-life of thread fin bream (Nemipterus japonicus) at different temperature and established the same findings.

Temperature fluctuations in freezers and cold stores:- The temperature fluctuations in the freezers and cold stores in the processing plants were due to avoidable and unavoidable reasons. The avoidable reasons noticed are the following.

1. Poor and untimely maintenance like checking of gas pressure, leakage, etc.
2. Unnecessary opening and closing of freezers/cold stores while at work.
3. Prolonged time taken to load and unload the fish into the freezer/cold store.
4. Careless handling of freezers/cold stores.
5. Lack of arrangement of alternate measures immediately when electricity failure occurs.

Unavoidable reasons are the following:-

1. Temperature fluctuation due to loading and unloading
2. Due to mechanical aspects inherent in the freezer/cold store.

The observations on the temperature fluctuation in the study plants (Table:2) show that the main problem is associated with avoidable factors.

Fluctuation in cold store temperature of even 10°C was noticed in some plants (Table:3). This much fluctuation will affect the quality of the products. Minor fluctuation in storage temperature has only little effect on the quality but wider fluctuation will have detrimental effect. Pottinger (1952) found that the fluctuation of the order of 10°C has adverse effect on the quality of fish. Shenoy (1976) while studying on the characteristics of tropical fishes also establishes that at -10°C the shelf-life of fishes like Scomberomorus guttatus are shorter than the shelf-life at -23°C. At -10°C, the freshly frozen seer fish was found to be unacceptable within 16-20 weeks compared to 28-32 weeks for the fish stored at -23°C.

Proper training of the workers along with the introduction of process control charts will help to control the temperature fluctuations in freezers and cold stores.

4.3. Drained weight:- The observations on the drained weight of peeled and deveined shrimp and peeled and undeveined shrimp are presented in tables 4 and 5 respectively. The average weight of the thawed and drained material was between 2.30 Kg.(110/120 grade) and 2.37 Kg.(91/110 grade) in the case of peeled and deveined shrimp. The required drained weight is 2.27 Kg (5 lbs.) per slab (block). In the case of peeled and undeveined shrimp the range was between 2.07 Kg.(200/300 and 300/500 grades) and

TABLE:1.

OBSERVATIONS ON THE FREEZING TIME IN SIX FISH PROCESSING PLANTS IN COCHIN REGION (in minutes)

Factory No.	Normal time for freezing	Av.Freezing time observed	Range of freezing time observed	Standard Deviation	No. of observation
1.	180.00	183.95	160.00-240.00	18.84	21
2.	180.00	184.29	160.00-210.00	14.43	21
3.	180.00	180.71	165.00-195.00	6.90	28
4.	180.00	181.46	175.00-190.00	5.99	24
5.	180.00	171.19	150.00-200.00	16.75	21
6.	180.00	181.25	165.00-190.00	6.66	20

TABLE: 2.

OBSERVATIONS ON THE FREEZING TEMPERATURE IN THE FREEZERS OF SIX PROCESSING PLANTS IN THE COCHIN REGION

(temperature in °C)

Factory No.	Required temperature	Av. Temperature noticed	Range of Temperature noticed	Standard Deviation	No.of observation
1.	-40	-38.61	-35.00 & -41.00	2.12	18
2.	,,	-37.89	-35.00 & -40.00	1.71	18
3.	,,	-39.16	-38.00 & -41.00	1.21	19
4.	,,	-39.11	-38.00 & -41.00	0.99	19
5.	,,	-37.21	-35.00 & -41.00	2.37	19
6.	,,	-38.58	-36.00 & -40.00	1.30	19

TABLE: 3.

OBSERVATIONS ON THE TEMPERATURE INSIDE THE COLD STORES OF SIX PROCESSING PLANTS IN COCHIN REGION

(Temperature in °C)

Factory	Temperature required	Av. Temperature noticed	Range of temperature	Standard Deviation	No.of observation
1.	-18	-18.68	-15.0 & -25.0	2.77	19
2.	,,	-17.37	-15.0 & -20.0	1.95	19
3.	,,	-18.00	-15.0 & -21.0	1.49	19
4.	,,	-18.89	-16.0 & -25.0	2.31	19
5.	,,	-18.58	-15.0 & -21.0	1.80	19
6.	,,	-18.42	-16.0 & -21.0	1.46	19

TBALE:4.

OBSERVATION ON THE DRAINED WEIGHT OF PEELED AND DEVEINED SHRIMP AFTER THAWING THE FROZEN BLOCKS WITHIN TWO WEEKS OF STORAGE AT -18°C (WEIGHT IN KILOGRAMMES)

Sl. No.	Product grade/lbs.	Av. weight noticed	Range observed	Standard deviation	Net drained weight required	No.of observation
1.	61/70	2.330	2.29 - 2.35	0.029	2.27	4
2.	71/90	2.320	2.28 - 2.37	0.037	,,	18
3.	91/110	2.370	2.27 - 2.45	0.063	,,	8
4.	110/130	2.300	2.27 - 2.35	0.040	,,	29
5.	130/200	2.330	2.27 - 2.38	0.029	,,	17
6.	200/300	2.330	2.27 - 2.42	0.050	,,	7
7.	300/500	2.341	2.26 - 2.43	0.050	,,	22
8.	Broken	2.360	2.25 - 2.45	0.055	,,	30

2.138 Kg.(Broken grade) The drained weight required for peeled and undeveined shrimp is 2 Kg. per slab. A wide fluctuation was noticed in the drained weights. This shows that on an average the processors are packing 2.335 Kg. of peeled and deveined shrimp instead of 2.27 Kg. required for a slab. This results in a loss of 2.87 per cent of meat in excess of the required level. In the case of peeled and undeveined shrimp also it was found that instead of the required level of 2 Kg. per slab, 2.095 Kg is being packed. This works out to be 4.76 per cent higher than the required level. Since the unit value of prawn is very high, this much loss in material will affect the yield and overall profitability of the firm. This is mainly due to the improper process control practiced in the processing plants. Process control charts will help a long way in controlling the deviations caused in the net drained weight to the required level. Study shows that different products and even a single product of different grades show variation in drip loss and hence drained weight after freezing, storage and thawing.

4.4. Count:-

Seafood products are graded based on the number of pieces per pound or per kilogramme. The observations on the count/ pound of various samples of peeled and deveined shrimp and peeled and undeveined shrimp blocks analysed from various study plants are presented in tables 6 and 7 respectively. There was wide variation in the counts of a particular grade

TABLE:5.

OBSERVATION ON THE DRAINED WEIGHT OF PEELED AND UNDEVEINED SHRIMP AFTER THAWING THE FROZEN BLOCKS WITHIN TWO WEEKS OF STORAGE AT -18°C (WEIGHT IN KILOGRAMMES)

Sl. No.	Product grade/ lbs.	Av. weight noticed	Range of weight	Standard deviation	Drained weight required	No. of observation
1.	100/200	2.103	2.00 - 2.23	0.071	2.00	14
2.	200/300	2.070	2.01 - 2.15	0.066	,,	6
3.	300/500	2.070	2.00 - 2.21	0.062	,,	19
4.	Broken	2.138	2.03 - 2.35	0.101	,,	15

TABLE:6.

OBSERVATION ON THE COUNT (NUMBER OF PIECES PER POUND) OF VARIOUS SAMPLES OF PEELED AND DEVEINED SHRIMP ANALYSED AFTER THAWING WITHIN TWO WEEKS OF STORAGE AT -18°C.

Sl. No.	Product grade	Av. Count	Range of Count	Standard deviation	No. of samples analysed
1.	61/70	66.40	65.00 - 68.00	1.14	5
2.	71/90	84.80	78.00 - 99.00	5.89	15
3.	91/110	98.30	96.00 -102.00	2.54	10
4.	110/130	119.86	111.00 -129.00	4.91	21
5.	130/200	183.57	122.00 -198.00	14.78	28
6.	200/300	275.50	252.00 -296.00	12.39	10
7.	300/500	444.66	361.00 -515.00	44.75	29

and the deviation was found to be more in the case of small size grades. This was mainly due to the improper grading and sorting of the material. This results in lack of uniformity among the pieces in a particular pack which in turn results in consumer rejection. In both peeled and deveined shrimp and peeled and undeveined shrimp slabs of some grades, the range was beyond the tolerable limit. To cite an example, under peeled and deveined slabs some samples exceeded the maximum limit of 500pieces in 300/500 grade packs. Same was the case with peeled and undeveined shrimp also. This was also contributed due to the attitude of some processors to fetch more income by putting or mixing a lower grade (small size) material with a higher grade (bigger size) material, in the hope of getting better return from their products. (Bigger size materials usually fetch higher price) This in the long run results in loosing the confidence of the buyer on the supplier. This was also revealed by a study team sent by Marine Products Export Development Authority to Japan, The Japanese buyers pointed out the defects of the Indian marine products and one of the main defects they pointed out was the non uniformity in grades and cheating of the customers with this type of malpractices (Anon., 1982 a). In the case of count also the processors can introduce statistical quality control by using control charts to find out the deviations from the standard requirements.

4.5. Total Bacterial Count (TBC):-

The observations on the(monthwise) total bacterial count of frozen peeled and undeveined shrimp and peeled and deveined shrimp from two factories in the Cochin region are given in tables 8 and 9 respectively. (Since management of other study plants did not favour for such a study in their plants, the study could not be carried out in these plants.) The total bacterial load of the samples drawn from the two plants were found to be within the specified standards. This was mainly attributable to the immediate icing of the raw materials and inprocess materials which helped to wash away the surface bacteria and to control their multiplication. But a wide fluctuation in the bacterial counts in the samples drawn during the same month. This may be due to the fact that the raw materials are being received from a large number of scattered landing/ pre-processing centres. None of the samples analysed had Vibrio cholerae or salmonella.

4.6. Control charts:- Statistical control charts will help to control the process and quality at different stages of processing as mentioned earlier. Control charts should be introduced especially to control variations in material count, weight, temperature in freezers and cold stores. This will help to locate deviations and timely correction and control is possible.

4.7. Workers involvement in productivity and quality control:-

Fish processing industry in Kerala and else where in India has totally neglected the contribution of workers in the productivity, quality and overall growth of the industry. The workers

TABLE: 7.

OBSERVATION ON THE COUNT (NUMBER OF PIECES PER POUND) OF VARIOUS SAMPLES OF FROZEN PEELED AND UNDEVEINED SHRIMP ANALYSED AFTER THAWING WITHIN TWO WEEKS OF STORAGE AT -18°C. (PER GRAM)

Sl.No.	Product grade	Av. Count	Range of count	Standard deviation	No. of samples analysed
1.	100/200	183.80	156.00-198.00	12.65	15
2.	200/300	265.50	252.00-276.00	10.25	4
3.	300/500	437.55	361.00-532.00	49.01	22

TABLE: 8.

OBSERVATION ON TOTAL BACTERIAL LOAD OF FROZEN PEELED AND UNDEVEINED SHRIMP FROM TWO FISH PROCESSING PLANTS AT COCHIN REGION (at 37°C) (PER GRAM)

Month	Factory: 1. AVERAGE	Factory: 1. RANGE	Factory: 2 AVERAGE	Factory: 2 RANGE
Jan.	87,652	32,300 - 92,500	1,11,500	98,000 -1,28,000
Feb.	NA	- -	85,000	78,000 - 92,000
Mar.	60,933	51,000 - 71,000	NA	- -
Apl.	71,909	61,500 - 82,000	2,18,000	90,000 -2,36,000
May	98,000	78,000 -1,02,000	1,84,800	1,59,000 -2,10,000
June	NA	- -	1,11,000	- -
July	1,03,267	48,000 -1,29,889	1,76,400	1,34,000 -2,44,000
Aug.	97,125	20,000 -1,62,500	1,47,000	1,20,000 -1,74,000
Sept.	NA	- -	2,12,395	81,580 -3,18,000
Oct.	2,05,366	1,65,000 -2,35,450	1,35,180	71,200 -2,21,000
Nov.	1,04,444	57,900 -2,10,450	1,30,050	93,200 -1,54,000
Dec.	1,21,667	90,000 -1,40,000	1,48,200	1,16,000 01,77,000

TABLE: 9.

OBSERVATION ON TOTAL BACTERIAL COUNT OF FROZEN PEELED AND DEVEINED SHRIMP FROM TWO FISH PROCESSING PLANTS AT COCHIN REGION

Month	FACTORY: 1		FACTORY:2.	
	Average	Range	Average	Range
Jan.	98,478	64,610-1,57,500	80,700	52,000- 96,300
Feb.	NA	- -	57,100	50,000- 61,000
Mar.	55,253	37,500- 86,000	NA	- -
Apl.	1,07,233	50,833-1,33,333	69,200	54,000- 94,600
May	84,325	43,300-1,25,000	69,667	31,000-1,06,000
June	1,28,591	1,00,000-1,89,900	1,64,000	52,000-2,64,000
July	1,29,889	1,18,666-1,33,000	1,33,750	69,000-1,91,000
August	1,43,000	- -	1,22,500	98,000-1,47,000
Sept.	NA	- -	1,98,343	70,370-3,18,000
Oct.	90,000	65,000-1,15,000	1,05,720	43,600-1,48,000
Nov.	1,01,280	85,000-1,20,000	1,05,675	93,200-1,58,600
Dec.	1,63,363	62,850-2,05,000	1,29,600	83,000-1,55,000

N.A. = No production during that period.

are found to have little say in the production process and they are treated just like machines working to the tune of the instructions from the owner of the firm or managing director. This total neglect of workers is one of the main reasons of low productivity and low quality of the outputs in the industry. The processing plants in Kerala run with minimum number of permanent staff in the pay rolls and additional staff is recruited on contract basis for a season or for a short period of time. The factories appoint production managers, technologists, supervisors, etc. to look after the affairs but their powers are limited to the routine supervision of production. They have little voice in the decision making process even in the activities which come under their powers. Every thing has to come from top and the suggestion going up from the floor or middle level is not considered with full spirit and faith. The employees job was just implement the command with little job enrichment. They are not aware of what is happening to the inprocess material or product after it passes on from their hands during the production process.

This results in workers dissatisfaction and is reflected in the frequent resignation of the staff from higher to floor level even without prior notice to the management. And it is time to think in a broader perspective especially when the industry is handling a very highly perishable material which has to be processed and marketed to a highly competitive international markets where quality has a great role to play.

Rai (1984) while describing the importance of human factor in productivity, quote the Japanese example of success in handling human components in production centres. According to him Japan has taken a realistic and constructive approach to the problem of declining productivity. The higher productivity of Japanese workers is attributed to the 'Japanese style' of management or Japanese social culture'.

According to Gupta (1985) productivity management in India is a very complex problem in view of equally powerful Private and State Enterprises. Politically conscious labour force, non-committed labour leaders, individualistic management, outdated technology, Government's industrial policy and tax structure, etc. has led the productivity movement into utter confusion. He suggests that it is necessary for the three major partners ie. the Government, The Employers and the Employee to have some basic understanding of how to achieve higher productivity for everyone's benefit.

<u>High Morale</u>:- It is essential to motivate workers, to have a high morale, to give of their best. Under such conditions the employees are not only willing to do their best, their feeling of involvement is such that they would not wait to be told what has to be done, not debate whether the particular task were covered under the specified duties of a particular individual, but join hands and accomplish the task. While describing the outcome

of a seminar of senior level executives, administrators and consultants, Kanungo and Misra (1985) express the feeling that there is an overall lack of proper work ethic in the Indian society. According to them Indian organisations lack proper work motivation among employees at all levels of the organisation, which inturn resulted in improper utilisation of resources. They believed that worker alienation pervades Indian society resulting in passivity and indifference towards the attainment of work objectives. Padaki (1985) establishes that proper work motivation and job enrichment is necessary to achieve positive results.

'Quality Circle':-

It is high time to introduce 'Quality Circles' comprising of employees at various levels in the processing industry. This will help to improve the productivity and quality of the products. Ultimately the quality and yield of the seafood products lie in the hands of the workers. An irresponsible or unmotivated worker may stand against the smooth functioning of the organisation. Many authors and researchers have pressed the need for workers involvement in productivity and establishment of 'Quality Circles' (Udapa, 1983; Smith,1983; Rai, 1984; Chandrashekaran, 1986)

To conclude, a proper layout of facilities; a proper process control and production schedules; good training and guidance of workers regarding quality control and maintenance; introduction of process control charts as suggested earlier; and setting up of a better work climate by introducing 'Quality Circles' to enrich and motivate the workers will definitely improve the quality and productivity of the industry to a greater extent.

MANAGEMENT INFORMATION SYSTEM

1. INTRODUCTION

Even though India is retaining the 6th or 7th position among the nations most of the recent years for fish production, her utilisation of the landings still centres around the traditional practices of drying and curing. With the growth of organised seafood processing plants (Freezing and canning) to cater the needs of export market, the overhead and investment of the processors increased and there needed a scientific management application for better utilisation of the available resources for optimum benefit. But the industry lacks it and this results in the decline of the industry in Kerala and leads to the present state.

India is having 276 fish processing (freezing) plants with an annual installed capacity of about 4,57,000 tonnes based on 250 working days with three shifts (Iyer, et al.,1982). With the present freezing capacity alone India could process all the important marketable fishes landed in India. For instance the landings of important varieties of fishes in India during 1984 was 7,99,856 tonnes (Table: 1) and if we take 50 per cent processed yield for all the above fish items combined together a total quantity of 3,99,928 tonnes are available for freezing. This is still only 87.5 per cent of the total installed capacity

TABLE: 1.

LANDING OF IMPORTANT VARIETIES OF FISHES IN INDIA IN 1984

FISHES	QUANTITY IN TONNES
Elasmobranchs	52,703
Eel	8,381
Cat fishes	72,030
Chirocentrus	20,055
Oil sardine	1,86,012
Hilsa ilisha	21,019
Perches	28,831
Red mullets	26,620
Ribbon fish	68,184
Pomfret	46,432
Mackerel	54,655
Seer fish	32,294
Tunnies	20,964
Soles	21,855
Penaeus prawns	1,18,200
Lobsters *	11,764
Cephalopods	19,857
TOTAL	7,99,856

* 1982 figure.

Source: Central Marine Fisheries Research Institute, Cochin.

of processing plants in India. But the present average utilisation (average of 1980 to 1984) of the freezing capacity is only 71,138 tonnes (Anon.,1985 c) ie. only 15.6 per cent of the existing capacity is being utilised.

In addition to this, other existing facilities like very good skilled and unskilled labour force, best locations along the coasts of backwater systems and port facilities are being under utilised. The market intelligence is provided by the Marine Products Export Development Authority of the Government of India.

Hence an attempt is made here to find out the lacunae in the existing management system which failed to utilise the available resources for the optimum running of the factories in the seafood industry. In this chapter an attempt is made to develop a 'Management Information System' which suits the seafood processing factories to improve the present situation of low productivity and poor capacity utilisation.

2. Management Information System (MIS)

Numerous workers have described the benefit of a good 'Management Information System' for the optimum utilisation of the resources in production systems. More and Hendrick (1978) described that any source of information like through personal contact, by discussion with other people, or by reading reports, etc. are a part of Management Information System. But they consider reports as the main source of information for the manager and they recommend that such reports for control purpose should cover only short periods of time and should be made often so that managers will learn quickly what is happening. Sundaresh(1981) and Sahay (1981) have also highlighted the significance of Management Information System for successful management and control.

Management information system provides an objective basis for decision making by furnishing the executives at various levels of management with the factual, accurate, complete and timely information (Khan,1985).

2.1. Role of M.I.S. in improving productivity

The Management Information System functions comprise of planning, organising, directing, co-ordinating, motivating and controlling of all activities for making optimum use of resources to achieve the desired goal. It provides the means for critical and systematic analysis of the various work centres, which in-turn provides the basis for necessary action.

The development of an effective information system with the goal of highlighting critically important aspects of seafood processing industry will help in a long way in fulfilling the objective of management in improving the use of production facilities and thereby increasing the profit margin by way of cost reduction.

3. OBSERVATIONS, RESULTS AND DISCUSSION

The landing of fish is highly seasonal and is scattered to 304 fishing villages in Kerala (Anon., 1981 a). At present there is no means for the seafood processors to regularly monitor the resource landings in the numerous landing centres in Kerala and the nearby states.

The price of the fish purchased from a landing centre varies from the purchase price of the same fish landed in a different landing centre on the same day. Even the price of a particular species of fish in a landing centre at a time also varies with fishermen and with the arrival pattern of the fish in the landing centre. So this is a complex problem faced by the seafood industry which is not prevailing in any other industry to this extent.

The processors are not in a position to predict the price expected and the quantum of landings due to lack of a systematic information system. The only way of gathering information is through their past experience, through few depots operating in some major landing centres in the case of big processors and through informal messages from fishermen or contractors. Due to this, most of the plants run out of raw materials even if the landing is there. This is clearly indicated by the study on the purchase pattern in sea food processing plants in Cochin. The study shows that some plants have no purchase or arrival of raw materials on a day when some other plants in the same locality have maximum purchase of the raw materials.

The important documents the purchase department of a seafood factory maintains are:

1. Landing Receipts
2. Purchase Bill Book
3. Purchase Day Book
4. Suppliers Ledger.

Landing Receipts (L/R):- The landing receipt is the bill issued to the supplier for the quantity of material receiving on his behalf. The details in the Landing Receipt are the serial number, date, name of the party, item, count, weight in kilogrammes and general remarks. It should be mentioned here that purchase counts are usually written in the Landing Receipt. This is in triplicate form, one copy to the supplier, another to the accounts department and the remaining is kept for official use of production department.

Purchase Bill Book:- This is issued in triplicate form where in the following details are mentioned. Serial number, date, name of the party, Landing Receipt number with date, particulars, quantity, corresponding rate and total amount. The bill is checked by accounts section and is checked by the management for its day to day operation. One copy of Purchase bill is issued to the party, one to the bank and the third one is kept as office record.

Purchase Day Book:- The particulars obtained from the bill book is transfered to the purchase day book. In this the details mentioned are the Landing Receipt number with date, Purchase bill number with date, name and address of the supplier, quantity of raw material landed in kilogrammes, type wise landing ie. Headless flower, headless tiger, peeled and deveined shrimp etc. The purchase day book also contains value and ledger folio number.

Suppliers Ledger:- From the purchase day book each day's purchase is posted to the suppliers ledger and the details mentioned in this ledger are name and address of the party, date, purchase day book folio particulars, quantity, debit, credit, balance, etc. The particulars are directly derived from the purchase bill book.

REGISTERS FOR QUALITY CONTROL

Production Registers

Consolidated Production Register (for type wise):- In this register date, the slab in gradewise, total number of slabs, signature of technologist and remarks/signature of Export Inspection Agency officer are to be furnished. Separate colums are provided for previous stock, production, total, less despatch, balance etc. Total production represents the total stock available in the store. After shipment the corresponding slabs were deducted from the total stock to show the balance.

Packing Register:- Packing register indicates the total master cartons of each days production. The mixed code also are represented by taking the previous slabs. Here the date of packing, code, the number of cartons (grade wise), remarks, type of product etc. are shown in the packing register.

Analytical Register:- This contains date and code of production, name of fish product, quantity, stage and type, number of samples, etc. In general it shows organoleptic and bacteriologica assessment.

Register for Approved Lot:- It represents the approved master cartons present in the store. Approval is made after satisfying the organoleptic and bacteriological requirements. The following details are shown in the approved register - date, factory code, production code, number of master cartons, total quantity, details of bacteriological test, remarks and signature of the technologist.

Register for assessing the sanitary standards of the unit:-

It shows the sanitary and hygienic performance of the unit. Here the details given are date, details of samples drawn, total plate count at 37°C/ml/gm/sq.inch/sq.cm., action taken, remarks and signature of the technologist.

Register for non-conventional packs:- All export rejectionable items are packed in one kilogramme packs and are recorded in the non conventional pack register. The details in the register include quantity, date, variety, type of pack, total stock, details of disposals, remarks and signature of the technologist.

Register for filth test:-.From each production code, 6 half slabs have to be drawn as a sample for filth test. The results are recorded in the filth register. It shows the date of examination, type of code, total number of cartons, grade, filth flies, incidental flies, fly fragments, large body parts, cockroaches - whole or excreta, rat hairs, other hairs, remarks and signature of the technologist.

Register for raw material examination:- Contains the quantity of raw material received, accepted, results of analysis, disposal of rejected materials, etc.

Register for freezing:- Contains the details of freezer, load number, number of slabs, variety, loading and unloading time etc.

Daily production register:- This report is maintained for recording daily production. Quantity of purchase of raw material, and the processing gain/loss are also recorded in this register.

Daily production analysis:- In this register the quantity of finished products, store items, stationery,etc. are noted.

MARKETING REGISTERS

Purchase order register:- A register is maintained showing the details of purchase order and the finished products exported.

This register will also indicate the contracting agent, importer, agents bank, the rate in U.S. dollars at which mutually agreed to supply and the period of contract within which the supply must be effected and whether or not is realised through the processors dealing bank.

Export register:- This register indicates the following details: Invoice number and date, bill of lading number and date, G.R.I number and date, shipping bill number and date, number of cartons exported, name of the steamer on board of which loaded, destination, invoice value, rupee value, freight charge in rupees, FOB value in rupees, etc.

A file is also maintained about the cash assistance declared by the Government on various fish products from time to time.

The observations on the canning activities in Kerala revealed that all the canning plants except the one under Government ownership are continuing the old and traditional method of canning processes with thick tin cans. The international markets no longer require this type of packing to the extent which was required some time back. The consumer demand has shifted to aluminium cans or pouch type of packaging which can be handled easily and have more attractions.

But the processors in India failed to sense the market movements and consumer acceptance. They continued with the old style of packing which was started some 27 years back in India.

This along with the high cost of materials lead to the present situation for the industry in Kerala.

The study shows that the majority of the processing factories have a better control and co-ordination with regard to processing activities once the raw material reaches the factory. But none of the factories have a well developed information system to get quick and readymade information about the raw material availability in different landing centres during different days and seasons. This is very clearly indicated by the weakness of the processing plants to procure the raw materials. The study shows that even when some plants in a locality have very good raw material purchase on a particular day, some other plants in the same locality had not purchased any raw materials. (Details are given under the chapter on 'Productivity study'.) This clearly indicates the weakness of the information system existing in the plants.

Similarly the study conducted by the researcher in Veraval region indicates that the processors from this region are exporting diversified fish products than concentrating on shrimp alone and they are managing to export all the fish items produced by them. The market study conducted by Marine Products Export Development Authority in different countries on various products also show demand for most of the marine resources available in Kerala.(A detailed literature review on the market study is given under the chapter on 'Scheduling and Production

Control'.) Our processors seem to be blind in this regard. This shows a wide gap between the information gathering by the processors and the actual market situation.

The following reports are suggested to be incorporated for better information gathering and for necessary action.

Daily landing/ raw material availability report:-

A model of the report is given in table 2. The report will have information about the type of fishes available in the landing centre; its grade and variety; total quantity landed and time of landing; prevailing market price; procurement time by the processor; quantity procured by the factory and the percentage share of purchase over landing.

Consolidated daily landing pattern report:-

This report gives the consolidated picture of the landings of different raw materials arrived in different landing centres in a period. This can be prepared from the daily landing/ raw material availability report collected from different landing centres. The report will also give the total quantity of different raw materials and their market price prevailing in a particular moment of time. A model of this report is formulated and given in table 3. Since the seafood processors have to collect the raw materials from a large number of landing centres, the above given report will help the processors to locate the landings of a particular species of fish and to predict the quantum of

TABLE:2.

DAILY LANDING/ RAW MATERIAL AVAILABILITY REPORT

Time of landing/procurement by pre-processing centre: Date:
Time of procurement by factory :
Name of the landing centre/pre-processing centre :

Sl. No.	Name of R.M.	Qty. landed	Prevailing market price	Qty. procured	purchase rate	Method of preservation on board/ P.P.C.	Quality of R.M.			Remarks
							App. & col.	odour	texture	
1.	Shrimp:									
	HLW :									
	HLT :									
	HLB :									
	HLF :									
	PUD :									
	PD :									
	Lob.tail									
	WCL :									
	Squid :									
	Cuttle fish :									
	Pom. :									
	Seer :									
	Mac. :									
	Sar. :									
	R.F. :									
	Others :									

R.M. = Raw material, P.P.C. = Pre-processing centre, HLW = Headless white, HLT = Headless tiger, HLB= Headless brown, HLF = Headless flower, PUD = Peeled & undeveined shrimp, PD = Peeled and deveined shrimp, WCL = Whole Cooked Lobster, R.F. = Ribbon fish.

TABLE: 3.

CONSOLIDATED DAILY LANDING PATTERN REPORT

Date:

R.M.	COCHIN FISHING HARBOUR									OTHER * LANDING CENTRES				
	Qty. available	Market price	Qty. procured	Purchase price	Time of landing/arrival at P.P.C	Time of procurement	Time of arrival at fac.	Quality at L.C.	Quality at Fac.	.. .. ..	Total Qty. avail.	Total Qty. purchased	Av. Market price	Av. purchase price
HLW														
HLT														
HLB														
HLF														
PUD														
PD														
LT														
WCL														
SQ														
CF														
POM														
SAR														
MAC														
R.F														
OTHERS														
Total Qty.														
Total purchase price.														

L.C. = Landing centre; SQ = Squid, CF = Cuttle fish, LT = Lobster tails, Other abbreviations are the same as that used in table:2.

* The various columns should be repeated for other landing centres also as in the case of Cochin Fishing Harbour.

fish available and its market price trend. This will help to minimize the unwanted search for the fish along the long stretch of coast line. Since most of the companies have their own depots or agents or associates in important landing centres, they can do this work without any additional cost.

The Raw Material Availability Calendar as suggested in the chapter on ' Scheduling and Production Control' will also help to plan the purchase during different seasons. Periodic information about the fish landings and its potential landings are available from Central Marine Fisheries Research Institute, Cochin. The survey of the State Fisheries Departments also contribute to this information. A regular monitoring of the information from these sources also help to improve the present situation.

The study conducted by the researcher revealed huge under-utilisation of the work force available in processing plants. At present there is no system in the processing industry to assess the output of workers and hence the following measures are recommended.

A chart showing workers output is recommended (table:4). It gives information ataglance about the number of direct workers involved at each stage in processing division; their actual output and expected output. This chart helps the production manager to assess the efficiency of his workers with respect to different products.

Another report suggested for better control of labour force is the idle time analysis report of direct workers. This report helps the production manager to find out the reason for idling and the duration of time idled which help him to take necessary remedial actions. A model 'Idle time Analysis Report' suitable for seafood processing plants is developed and is given in table 5.

Other informations regarding processing like raw material consumption, freezer utilisation, position of stock in the store, etc. are available with the existing system of process and quality control.

Another major area left out by the existing practice is the market intelligence. None of the processing plants studied have an organised marketing division as compared to any other industry. The study shows that about 92 per cent of the total marketed(exported) products from processing plants in Kerala are shrimp based products, whereas the market is found to accept various other products too which can be prepared from various marine fishery resources of our coast. This shows a wide gap between information flow to the processors and the actual market situation (demand pattern). Even in other parts of the country like Bombay, Veraval, Porbunder, etc. the processors have started process and product diversification (Ramachandran, et.al., 1988). Their share in the export of new products are ever increasing.

TABLE: 4.

DIRECT WORKERS OUTPUT CHART FOR SEAFOOD PROCESSING PLANTS

Day/Week :
Norm .....Kilogrammes/day/week

Section	No. of direct worker in the section	Actual qutput Kg./ tonnes	Expected output as per norms	Remarks
Purchase				
Processing				
Marketing				
Shipment				

TABLE: 5.

IDLE TIME ANALYSIS OF DIRECT WORKERS

Section : Month/week/day:

Idle time in hours due to cause Nos. (1),(2), (3), (4), (5),(6), (7), (8).	Total idle time	Time worked	Over time	Under time	Total attendance	Ratio of idle time/ attendance

Cause No.	Description
1.	Lack of raw materials (fish items)
2.	Lack of other raw materials like cartons, polythene sheets, etc.
3.	Lack of demand.
4.	Lack of any skilled worker in any of the stages of processing (like freezer operators, cold store operators, technologists, etc.
5.	Break down of equipments.
6.	Waiting for inspection.
7.	Power failure.
8.	Water shortage.

This is not because of the fact that they reduced the quantity of shrimp export, but because of the fact that they increased the capacity utilisation, by the production of so many other fishery products in the same line of production.

The important frozen products being exported from Bombay and Veraval are frozen cuttle fish whole, frozen squid whole, frozen cuttle fish fillets, frozen squid tubes, whole frozen pomfret, whole frozen tuna, whole frozen seer, whole frozen red snapper, whole frozen ghol, frozen ghol fillet, frozen red snapper fillet, frozen flat fish fillet, Individually Quick frozen shrimp (IQF), frozen lobster tails, frozen whole cooked lobster, frozen headless shell on shrimp, frozen peeled and deveined shrimp, frozen peeled and undeveined shrimp,etc.

The processors need to concentrate more on the market and demand study. A market intelligence report is suggested to be incorporated in their routine analysis(Table:6.). The following are the information which can be obtained from this report:

1. Product demand and the type and style of packing.
2. Country/market where it is demanded.
3. Price offered and quantity required.
4. Source of information and remarks.

The data for this report can be collected from the market intelligence wing of the Marine Products Export Development Authority or through the list of buyers regularly published in

TABLE: 6.

MARKET INTELLIGENCE REPORT/DEMAND SURVEY REPORT

Date: Month/Week :

Sl. No.	Product demanded	Type & style of packaging	Required country (destination)	Price FOB/ C&F	Qty. Req-uir-ed	Source of in-form-ation	Rem-arks

the Seafood News Letter of Marine Products Export Development Authority, Cochin. Information can also be collected by directly contacting the buyers over telex or other communication means. Meanwhile, the processors can also study the internal demand for various products so that they can utilise the excess capacity in their processing plants for producing products for internal consumption. In the case of some fish products, which can be processed in the same existing production lines, demand are equally attractive in internal markets too.

SUMMARY AND FINDINGS

Seafood processing industry, which was once the most lucrative industry is now struggling for existence. This is evident from the low productivity of the processing units, huge idle capacity and the closing down of some of the plants. The quality of the products processed vary widely among the processors and even within a processing plant from time to time thus resulting in various marketing problems like block listing and rejection. The main objectives were to study the various aspects of production of seafood in processing (freezing) plants and to find out the reasons and problems associated with low productivity and poor quality of the products so as to suggest suitable management measures to improve the situation.

The study was carried out on the following aspects of production.

1. Locational significance of seafood processing plants.
2. Layout of facilities and line balancing.
3. Productivity studies.
4. Work Measurement of the processing of important products.
5. Scheduling and Production Control.
6. Quality control and inspection.
7. Management Information System (MIS) for seafood processing plants.

1. LOCATIONAL SIGNIFICANCE OF SEAFOOD PROCESSING PLANTS

1.1. Distance of fish processing plants from the main landing centre:-

For plants in Cochin region, the Cochin Fishing Harbour which has a fleet of more than thousand boats operating in the region, is considered as the main landing centre. In Quilon region, Sakthikulangara-Neendakara fishing centre is the main landing centre. 60 per cent of the processing plants (32 numbers) in the Cochin region are located between one and 10 Km. from Cochin Fishing Harbour whereas 67 percent (12 numbers) of the plants in the Quilon region are within 1 Km. from the main landing centre.

1.2. Main raw material (fish) source:- No plant is receiving sufficient raw material from a single supplier or from a single landing centre. The plants receive raw materials from a large number of landing centres scattered along the South West Coast and East Coast of India. The raw materials are received mainly from the following landing centres: Ambalapuzha, Shakthikulangara-Neendakara, several landing centres scattered between Quilon and Kovalam, Aroor, Kalikavillai and various landing centres upto Kanyakumari, Cochin Fishing Harbour, Kozhikode, Vypeen Island, Tuticorin, Thirichandoor and Mangalore.

1.3. Means of raw material transportation:- 82 per cent of the plants out of the 21 plants surveyed collected raw materials either by their own fleet of insulated trucks or by hired insulated vehicles. 12.5 per cent of the plants receive raw materials through seaways too ie. by boats.

1.4. Mode of procurement of raw material :- There are different methods adopted by the processors to purchase raw materials. They are: through agents, through contract, direct purchase, through own depots at the landing centres and partially from their own boats and partially through other means.

1.5. Time lag in raw material transportation:- Time lag between raw material purchase at the landing centres/pre-processing centres and its arrival at theprocessing plants is very critical for the quality of the fish and the objective should be to reduce the time lag as far as possible to get a good quality product. 10 out of the 15 plants studied in Cochin region have an average time lag ranging between 4 and 6 hours. In Quilon region this falls in all the plants between 6 and 8 hours. It was also found that no plants have an average time lag beyond 8 hours.

1.6. Availability of labour force:- The fish processing activities in Kerala and elsewhere in India are highly labour intensive and the study revealed that there is no shortage of skilled and unskilled labour for the processing plants in Kerala. The only problem faced by the plants is the frequent resignation of the technologists from service in search of better job opportunities.

1.7. Water source:- Water is one of the most vital inputs in fish processing industry. The main sources of water to the processing plants are municipal supply and bore well. In Cochin region 82 percent of the plants studied were found to have regular municipal water supply. 90 per cent of the plants situated in Cochin Corporation limit and all the plants situated in Quilon Municipality were found to have got regular supply of municipal water.

<u>1.8. Electricity</u> :- Like water, electricity is also a very important input for the smooth functioning of the plants. Failure in electricity supply for a few hours will force the production to stop due to non-working of freezers and various other machineries and equipments including cold stores. Any failure in the power supply for a short period will adversely affect the quality of the product due to the rise in temperature in the cold store. Previously Kerala was having surplus electricity supply. But recently after the state suffered a severe power shortage during 1983 due to extreme drought, the situation has not been encouraging. 16 processors out of the 22 processors surveyed complained about the discontinous supply of electricity and the related problems faced by them. 6 processors complained about the undependable nature of the power supply.

<u>1.9. Generator</u> :- 78 per cent of the plants studied in Cochin region and all the plants in Quilon region were found to have generators of various capacities to safeguard their products and to facilitate continous production. Most of the processing

plants installed the generators only after the power (electricity) shortage in 1983.

<u>1.10. Availability of other materials</u>:- Seafood processing plants in both Cochin and Quilon regions were found to get sufficient raw materials (other than fish items) and other inputs from the local market itself within a short lead time.

<u>1.11. Local transport facilities</u>:- The raw material required for the plants are to be collected from various scattered landing/pre-processing centres. Moreover the landings are unpredictable and uncertain. Hence the availability of transport facilities locally was studied and found that transport facilities could be arranged within a short notice in both the centres.

<u>1.12. Nearness to the Port</u>:- All the plants depend mainly on Cochin Port for shipment of finished products. 91 per cent of the plants in Cochin region are located within 5 Km. from Cochin Port. The plants in Calicut and Quilon are about 250 and 130 Km. away from Cochin Port respectively. This shows that the plants located in Cochin region have a special advantage of having the port very close to them. This reduces the shipment time, temperature fluctuations in the frozen blocks and cost of transportation compared to the plants in Quilon and Calicut.

<u>1.13. Waste disposal</u>:- All the plants surveyed were found to be on the banks or close to either lake/backwater or sea. All the plants were discharging their liquid waste into the respective water bodies. The solid waste is either discharged in an

open place or shore from where it is later taken for the manufacture of fish meal or manure.

1.14. Environmental conditions:- In both Cochin and Quilon regions the weather is humid most of the time and temperature is medium between 22°C to 36°C. The surroundings of 64 per cent of the plants in Cochin region were found to be satisfactorily clean whereas it was only 25 per cent in Quilon region.

1.15. Comparison of alternate locations:- Three locations were studied for selecting the best location for establishing a new seafood processing unit. It was found that Cochin is the best one for various locational advantages. Quilon is the second best location.

2. LAYOUT OF FACILITIES AND LINE BALANCING:

2.1. Existing layout :- All the fish processing (freezing) plants in Kerala have a process layout. This is mainly due to the following reasons:

1. Cheap and sufficient labour availability
2. Vast variation in fish landings of a particular species of fish.
3. Variation in the size of the fish available in different seasons.
4. Insufficient landing of a particular species throughout the year which hinders processors from establishing specific product line for each product due to economic reasons.

5. Lack of indigenous product line machineries.
6. High cost of establishing the product line.
7. Products produced in India is mainly for industrial use (Exporting for the reprocessing units in the buying countries)

The entire processing activities in the processing plants in Kerala are done manually except in a few cases like washing of peeled and deveined shrimp in some plants. The raw materials are arriving in the plants with very wide fluctuation and it is difficult to predict the quality, quantity and type of fish available on a particular day. So the only possible alternative is to keep the facilities open and flexible to absorb the available raw material. In this situation it is preferable to have a process layout than a product layout to minimize the idle capacity and cost of production.

There is no uniformity of raw material movements in the processing plants. None of the plants have a balanced layout. The important observations on the existing layouts in the processing plants are the following:

1. Unbalanced line of processing resulting in the piling up of in-process material in the material store, and in between operations especially at the freezing station.

2. Irregular and unnecessary movement of raw material and in-process materials in the production line resulting in cross contamination of finished products or semi-finished products.

3. Poor and bad planning of the construction of the plant buildings.

4. Unnecessary handling and movement of workers.

5. Forced idling of workers at one work station or the other due to non-availability of facilities continously in the next or subsequent work stations.

6. Unnecessary and unusual exposure of raw material and in-process materials at higher temperature due to poor arrangement of work facilities.

7. Difficultly in the free movement of men and materials due to want of space in between operations as well as for transportation of materials from one work station to the other

8. Unnecessary investment on the facilities like excess capacity at the pre-processing stage, cold store, etc. which are unproductive.

9. Poor floor arrangement and drainage system resulting in waste water stagnation at some places and hindrance to free movement of waste water through the drainage system.

2.2. Improved layout developed

An improved layout is worked out which reduces the above mentioned defects to the possible extent. A flexible process layout with continous flow of material like that in a product line is suggested. This takes into account the special nature of the industry, future diversification and expansion. The important features of the improved layout and the guidelines for its use are also presented.

1. The floor of the processing hall is suggested to have a drainage facility which helps the waste water to flow in opposite direction of the flow of the material in the production process.

2. For quick and efficient purchasing of raw materials, the entire purchasing section is suggested to be located at one place in the processing plant. This will help the workers, supervisors, technologists, purchase officers, etc. to interact quickly to take purchase decision.

3. A separate raw material store is suggested in addition to chill room.

4. Instead of cement tanks/galvanised iron tanks in work stations, a uniform high density plastic tub is suggested with a capacity of 25 to 30 Kg. This will avoid unnecessary handling of material and labour. The present practice is to keep the material with ice in cement tanks/galvanised iron tanks which results in unnecessary shifting of materials using shovels and other equipments from tank to tank at each work station. This process is found to damage the material in addition to excess labour and handling. The plastic tubs suggested can be taken in trolleys from work stations to work stations.

5. The present practice of directly taking the raw material from purchase section or raw material store to the processing hall is against the sanitary and hygienic practice of fish

processing. No raw material should be allowed to enter the processing hall directly from the purchase section or from the raw material store. The pre-processing hall must be provided with processing tables, washing machines and required containers. The raw material after washing and cleaning should be temporarily stored in the chill room till the priority of the material comes for processing.

7. A sixteen tonne ice plant is suggested which is sufficient for internal use as well as for taking it outside for the procurement of raw materials.

8. The processing hall is provided with a two line facility upto the post-freezing stage to overcome most of the difficulty experienced by the processors. This will have the following advantages:

* Considerable reduction in the process cycle time.
* Work force can be reduced at the pre-freezing stage by about 50 per cent. This is achieved by increasing the workers utilisation by about 100 percent.
* Since 'Ninety Minutes Freezers' are suggested instead of the existing 'One hundred and eighty Minutes Freezers', the turnover is doubled with the same processing facilities. Since the extra cost of installing the new type of freezer is only marginal, this is advantageous. This helps in balancing the processing line to a greater extent as this is the longest activity in the processing line consuming about 75-77 per cent of the total process cycle time.

4. The two line system is the best to improve the quality of the products as it reduces the processing time and avoids cross contamination.

5. The peak landing season of the commercially important varieties of fishes coincide. And the peak season is only for a short period of time. The processors have to utilise this peak period to increase their turnover and to meet the customer needs. The price of the raw material also will be minimum during the peak season. The two line facility helps to absorb the excess raw material available during peak season by increasing the workforce during the period.

6. A single line facility is suggested at the post-freezing stage (packaging stage) as the cycle time at this stage is only half of that of pre-freezing stage. The present practice of manual master cartoning and sealing is tedious, labour intensive and affects the quality of the product and packaging due to rough handling, non-uniformity in sealing and delay in sealing. An automatic master carton sealer is suggested which reduces the packaging and sealing time, manual labour and cost of production. The cost benefit is worked out to be Rs. 3,454.00 every year if the sealing operation is mechanized. This will also help in uniform sealing of the cartons without damage.

7. Two separate cold stores of 100 tonnes capacity each is suggested for a 10 tonne capacity fish processing plant. With this storage capacity, 20 days full production can be stored

at a time and since the lead time of shipment is very short, about two weeks, this capacity is sufficient. And if the store is over loaded due to some peculiar situation, the material which is ready for shipment can be shifted to the cold store facility at the port. This helps in avoiding unnecessary excess capacity.

2.3. Movement of material/in-process material in the processing plants:- A material flow pattern in the processing plant has been suggested to avoid bottlenecks and to avoid delay in processing activities.

2.4. Acceptability of improved layout:- The layout which is developed and recommended by the researcher was tested for acceptability by presenting the layout along with the layouts of the existing plants to a 'Test Panel' and found that the 'new layout' suggested scored maximum for all the factors considered for the study.

3. PRODUCTIVITY STUDY

3.1. Organisational structure :- The organisational structure vary with the size of the processing plants. The processing plants are either partnership companies or private limited companies. A production manager is in charge of production who is assisted by purchase officer and technologists. The purchase officers and technologists are inturn assisted by supervisors

Most of the processing work is carried out by workers who are working on contract basis.

3.2. Purchase Section

3.2.1. Raw material supply:- No supplier or landing centre can supply the required raw material in sufficient quantity to a processor. Plants have to procure raw materials from different landing/pre-processing centres. About 80 per cent of the processing plants studied were found to procure the raw materials only after getting the purchase offer from the buyer abroad for their products.

3.2.2.In depth study on the purchase pattern:- A detailed study on the purchase pattern of four randomly selected seafood processing plants in Cochin region was carried out during 1983 and 1984. The study shows that there is wide fluctuation in the daily purchase quantities of different raw materials in all the plants. The most important observation is that when a plant is having peak arrival of raw material (fish items) on a particular day some other plants in the same locality are having no purchase or arrival of raw material at all. This clearly indicates the inefficiency of the purchase divisions or systems existing in the plants. In all the plants the main item of purchase is confined to shrimps

In all the plants the raw material purchase is found to be far below the daily requirements. 39 per cent of the working days in 1983 and 1984 the plants in Cochin were found to be without any raw material purchase or production. This shows the magnitude of idleness of facilities and other related problems associated with it.

3.2.3. Expenditure on various inputs of production:- The expenditure on the purchase of fish items is the single largest component of operational cost which consumes maximum financial resources of the firm. The data from five fish processing plants shows that about 76.5 per cent of the total operational costs were utilised for fish purchase alone. The range of the cost was between 57.0 and 89.0 per cent depending on the product mix.

The packaging cost constituted to about 2.28 per cent of the total operational costs of the factory, the range being 2.0 to 4.98 percent depending on the style and quality of packaging adopted by the factory. The expenditure on refrigerants was 0.52 per cent of the total operational costs and that for electricity was 0.40 per cent. Expenditure on ice purchase was 0.52 per cent of the total operational costs. The wage of processing workers accounted to only 0.59 per cent of the total operational costs.

3.3. Production Section/Processing Section

3.3.1. Capacity available and capacity utilized:- The general method of processing followed by the processing plants in Kerala is broadly classified into three stages - Pre-Freezing, Freezing and Post-Freezing stages. There is found to be a wide gap in the capacities provided at different stages of processing. The Pre-Freezing stage has excess capacity in almost all the plants. This is mainly due to the bad planning in the line of production. Due to difference in the capacities provided at different stages in the production line, production flow gets affected which in-turn affects the quality of the products.

No work study was carried out so far in seafood processing plants in India and this was the main reason for an unbalanced line of facilities in the plants. The private entrepreneurs had no other alternative but to develop facilities based on their experience and knowledge in the field.

3.3.2. Monthwise production study:- The factories do not show consistency in production. There are wide fluctuations in production even within a short period of time. One day there may be peak production whereas the very next day there may not be any production at all. The plants showing peak production in a particular month in a year do not show the same trend the next year. This is mainly due to the shift in the fishing season or fish landings.

3.3.3. Cold store holdings:- The cold storage stocks of the plants studied during 1983 and 1984 period showed rapid replenishment in all the plants. So the chances of piling of inventory in the cold store was rare. This was also due to the fact that most of the processing plants made their products to order(after obtaining the offer for export of their products from the buyers abroad). The capacity utilisation of the cold stores in the processing plants in Cochin region during the study period was found to be very low. The range of capacity utilisation was between 1.25 and 22.33 per cent with an average utilisation of 13 per cent. This was mainly due to the low productivity of the plants.

3.3.4. Share of different products in the total production:-

In all the plants the major share of production was shrimp products. Out of the 13 plants studied in 1984, 4 plants produced only shrimp based products. The share of shrimp production among the plants in 1984 ranged between 51.3 and 100.0 per cent. The share of export earnings from shrimp during the period ranged between 64.8 and 100.0 per cent. In 1985 the quantity-wise shrimp export was between 38.9 and 100 per cent and valuewise it was between 53.49 and 100 per cent. The combined average production of shrimp products by all the plants was 92.25 per cent (quantity) and 94.52 per cent (value) in 1984. The export share in 1985 was 80.20 and 86.91 percent respectively

The second product which was produced in somewhat larger quantity was frozen cuttle fish fillets. Its share in export (quantity) varied between nil and 21.0 per cent in 1984. In 1985 it was between nil and 36.5 per cent. The other products which were produced in minor quantities during the period were frozen whole cuttle fish, frozen squid tube, frozen clam meat, frozen lobster tails, frozen fish and frozen crab meat. The study shows that the plants in Kerala are mainly dependent on the shrimp based products and little effort is taken by them to diversify their production with new products utilising the available fishery resources of the South West Coast of India.

3.3.5. Process Cycle Time:- A wide fluctuation in the process cycle time was noticed in all the plants. The process cycle time for the production of a batch of frozen headless shrimp was found to fluctuate between 310 and 420 minutes with a standard deviation of 39.07 minutes. The cycle time for frozen peeled and undeveined shrimp was found to fluctuate between 290 and 370 minutes with a standard deviation of 27.21 minutes. The wide fluctuation in the process cycle time is mainly due to the following reasons:

1. Lack of standard production methods adopted by the processors.
2. Shortage of raw material of a particular variety sufficient for a full load in the freezer. This results in the waiting of the semi-processed material at the pre-processing stage.
3. Variation in the workers skill from plant to plant and from time to time in a particular plant due to changes in the workers in the plant very frequently.(Workers are mostly employed on contract basis) So workers commitment to production and productivity is at a very

low level.

4. Variation in the quality of the raw material used for the process.
5. Poor scheduling:- This is due to the lack of proper production schedule in the processing plants. The production is found to be carried out as per the wish and pleasure of the shift technologists or supervisors. This variation in the sequence of production of different products during different times results in fluctuating quality levels and production turnovers.

4. WORK MEASUREMENT

4.1. Present situation :- It was observed that in fish processing plants in Kerala the production is carried out in a manner which requires excess work content and man hours. As fish is highly perishable, any delay or excess handling will seriously affect the quality of the product. Hence work measurement of important products were carried out to understand the basic work content and the normal time required for the processing of different products. This will inturn help to standardize the production method by eliminating unwanted excess work and handling and to reduce the rate of spoilage of the products.

The excess work content in the fish processing plants were found to be due to the following reasons:

1. Lack of standardisation of processing methods.
2. Inefficient method of production due to the use of

wrong production facilities.

3. Bad layout causing wasted movements.
4. Bad planning and scheduling of work and orders adding idleness to men and machines and spoilage of materials.
5. Inefficiency of freezers and cold storages due to poor maintenance resulting in the consumption of excess time and energy for processing. It also accelerates spoilage.
6. Shortage of raw materials (fish).
7. Fluctuations in raw material landings.
8. Uncertainity of landings of a particular variety of raw material resulting in developing a highly flexible system for processing which inturn results in employing excess staff and providing excess production facilities to absorb the fluctuations in the material availability
9. Difficulty in obtaining raw material from far away places due to its high perishability.

4.2. Time study:- The time study of the following products were carried out and the production method and production time at each and every activity during the production were standardized.

1. Frozen headless shell-on shrimp (2 Kg. slab)
2. Frozen peeled and undeveined shrimp (2 Kg. slab)
3. Frozen peeled and deveined shrimp (2.27 Kg. slab)
4. Frozen whole squid (2 Kg. slab)
5. Frozen whole cuttle fish (2 Kg. slab)

6. Frozen squid tube (2 Kg. slab)
7. Canned Shrimp (128 gm. pack)

The standardized production method and standard time will help the processors to control the production process and decide on the efficiency of the workers to introduce incentive system, etc.

5. SCHEDULING AND PRODUCTION CONTROL

51. RAW MATERIAL AVAILABILITY CALENDAR:- At present a lot of problems are faced by the processors due to the difficulty in meeting the committed export offers for want of raw material in time. This tarnishes the image of the exporters and this ultimately affects the export trade in the long run. Hence a 'Raw material Availability Calendar' is developed for the use in seafood processing plants as a ready reckoner of the landing pattern of various species of fishes in the South West Coast of India. The calendar gives the peak and lean periods of fish landings in a year. This is helpful for the seafood processors while planning production during different seasons as well as for committing export dates to the customers abroad.

5.2. Application of Linear Programming (L P):- It is found to be a useful tool for short term scheduling in seafood processing plants. Due to seasonality and short supply of fish items, processing plants cannot be run with a single type of raw material like shrimp during any period of time. A Linear Programming model is developed to select the best product mix in a season which contributes maximum towards overheads and profit. This Linear Programming model can be adapted by the processors to get the best out of their facilities which at present are lying idle most of the time.

5.3. Gantt Chart Scheduling:- The need for developing a proper production schedule in seafood processing industry was felt during the course of the study on the production process in the plants. At present there is no scientific or standardized production planning and control practiced in the industry. This results in huge idleness of capacity, underutilisation of men and materials and accumulation of raw materials or in-process materials at different work centres. This ultimately results in poor quality of the products and low productivity. Gantt chart scheduling is found to be suitable for daily production scheduling and control in seafood processing plants and two models of the schedule - one for the present setup and another one for the new layout suggested - are developed and given in the thesis. This will help to schedule and control the production process. The deviation from the set schedule can be easily located and corrective action taken immediately. Work schedules and shift schedules are suggested based on the Gantt Load Chart Schedule. In this new shift schedule, the work is scheduled in such a way that a reduction of about one third of the total workers strength at the pre-freezing stage is possible.

5.4. Priority Rule :- In seafood processing plants where a number of different products are to be processed through a single facility, the order with which the fishes are to be processed is of great significance. It is found that none of the existing priority rules are very useful in deciding the sequence of production in seafood processing plants due to its special nature as decribed below:

1. The work to be carried out in fish processing plant is the processing of fish and fishery products and unlike in other industries, raw material cannot be procured and stored as and when wished by the processor.
2. The raw material landing is irregular and uncertain.
3. The raw material cannot be stored even for a few days due to high perishability.
4. The fish purchase is in small quantities from different scattered landing/pre-processing centres.
5. The raw material purchase is continous throughout day and night.
6. Everything has to be kept flexible in the production line to absorb any variety of raw material entering the plant.
7. Rate of spoilage of different raw materials vary.
8. Production cycle time of most of the products have only marginal difference.

Hence a new priority rule specially suited for fish processing plants is developed. This is based on all the above mentioned special nature of the industry. The new priority rule is simple and easy to adopt and can be handled by the supervisors themselves.

A two stage scoring system is suggested to decide which raw material has to be processed when and with what sequence. This is based on the unit purchase price of raw materials and the tolerance score of raw materials to withstand spoilage. The total score obtained from this two stage scoring decides the priority of the raw material to be taken for processing. The raw material which has maximum points (score) will be processed first and so on.

6. QUALITY CONTROL AND INSPECTION:-

Indian sea food products suffer from a lot of quality problems due to the lack of proper process and quality control measures. During 1978-79, the US FDA reported that Indian shrimp was salmonella contaminated. On this account, there were also many detentions of our consignments at various U.S. Ports. Apart from salmonella, high percentage of decomposition and filth were also reported by US FDA and detained all the consignments. Due to block listing and consequent heavy detentions of Indian shrimp by US FDA, Indian exports suffered a severe fall. The price also dropped steeply. Uneconomical prices offered by U.S. buyers for Indian shrimp also contributed significantly to the decline in export to that country.

Japan is the main market for Indian marine products and about 70 per cent of India's export is to this country. Any problem with this country will lead to collapse of our trade. Japanese buyers have reported several defects in Indian frozen products like mixing of spècies, non-uniformity in grades, uneven glazing of slabs, non-uniformity in the shape of frozen slabs, damage of cartons, contamination with foreign particles, etc.

Two types of Quality Control Systems are in practice in seafood processing industry - (1) In-plant Quality Control Scheme and (2) Modified In-plant Quality Control Scheme. In the former one the officials of the Export Inspection Agency control the quality by analysing the samples of the raw materials, finished products, etc. In the latter, the factory is authorized to inspect the samples by establishing a laboratory in the factory. Approved technologists of the factory are authorized to carry out the quality control and inspection work. The export certificate for quality fitness is issued by the Export Inspection Agency based on the analysis report given from the factory. Here the Export Inspection Agency is empowered to cross check the quality control measures being carried out by the factory.

Wide fluctuation is noticed in the yield of the material during peeling and subsequent processing. This is due to the lack of process standardisation and non-adoption of scientific process control measures. The delay in the processing of the material arrived at the processing hall of the factory affects the quality and ultimate yield of the products which inturn increases cost of production.

6.1. Freezing Time:- Wide fluctuation was noticed in the case of freezing time in some plants which is mainly due to poor maintenance of the freezers and careless production methods. Freezing of the product for a shorter period than the stipulated period will result in deformation of the slabs and chances of spoilage are more. This will reduce the consumer acceptance of the products. Freezing for a longer period than the required normal period will result in reduced turnover of the frozen materials. Since freezing time consumes 75-77 per cent of the total process cycle time for the production of a product, this delay is very critical and may lead to accumulation of in-process material at the end of the pre-freezing stage.

6.2. Freezing and Cold storage Temperature:- The standard temperature for freezing in plate freezer is -40°C and that for cold stores is -18°C. Wide variations in the freezer and cold store temperatures were noticed in the plants. The temperature fluctuation in the freezers and cold stores in the processing plants are due to avoidable and unavoidable reasons. The important avoidable reasons are the following:

1. Poor and untimely maintenance like checking of gas pressure, leakages, etc.

2. Unnecessary opening and closing of freezer/cold store door while at work.
3. Prolonged time taken to load and unload the fish in the freezer/cold store.
4. Careless handling of freezers/cold stores.
5. Lack of arrangement of alternate measures immediately when electricity failure occurs.

The temperature fluctuation of even 10°C was noticed in cold stores of some seafood processing plants which will adversely affect the quality of the product and its shelf-life.

6.3. Drained Weight:- The study shows that the processors are losing large quantity of materials by way of excess weight added due to poor process control and fluctuation in raw material quality. The study shows that on an average the processors are packing 2.34 Kg. of Peeled and Deveined meat instead of 2.27 Kg. required for the slab on thawing. This results in the loss of 2.87 per cent of meat in excess of the required level. In the case of Peeled and Undeveined shrimp also it is found that instead of the required level of 2.0 Kg./slab (on thawing), 2.10 Kg is being packed. This works out to be 4.76 per cent higher than the required level. Since the unit value of prawns is very high this much loss in material will affect the yield and the overall profitability of the firms.

6.4. Count :- Seafood products are graded based on the number of pieces per pound/kilogramme. There is a wide variation in the counts of a particular grade and the deviation is found to be more in the case of small size grades. This is due to the improper sorting and grading of the raw material. This results in lack of uniformity among the pieces in a pack which inturn results in consumer dissatisfaction and rejection. In both peeled and deveined shrimp and peeled and undeveined shrimp the range in some blocks were found to be beyond tolerance limit. This in the long run results in losing the confidence of the buyers on the supplier.

6.5. Total Bacterial Count (T B C):- Observations on the bacterial quality of the frozen products from plants in Cochin region shows that the Total Bacterial Count of the products are within the specified standards. This may be attributable to the immediate icing of the raw materials and subsequent washing, which helps to wash away the surface bacteria and to control their multiplication. None of the samples observed had Salmonella or Vibrio cholerae contamination.

6.6. Control Charts:- Statistical Quality Control Charts will help to control the process and quality at different stages of processing. The control charts should be introduced especially to control variations in material count, weight, temperature fluctuations in freezers and cold stores. This will help to locate deviations and timely correction and control is possible.

6.7. Workers involvement in productivity and quality:-

Fish processing industry in Kerala is found to neglect the contribution of workers in productivity, quality control and overall growth of the industry. The workers are found to have little say in the production process and decision making. They are treated just like machines working to the tune of the instructions of the management. The total negligence of the management on the workers leads to poor quality and turnover of the output. The processing plants in Kerala run with minimum number of permanent staff in their pay rolls and additional staff is recruited on contract basis for a season or for a short period of time. The workers are not aware of what is happening to the in-process material or final product onces it passes out of their hands during the production process. The workers dissatisfaction is evident from the frequent resignation of the staff members even without prior intimation to the management.

It is essential to motivate workers, to have high morale, to give their best. Institution of 'Quality Circles' comprising of employees at various levels, management and trade union leaders is suggested to improve the quality of the products and to improve the productivity of the industry.

7. MANAGEMENT INFORMATION SYSTEM (M I S)

With the growth of organised seafood processing plants to cater the needs of export demand, the overheads and investment of the processors increased and there needed a scientific management application for better utilisation of the available resources for maximum benefit . But the industry ignored this aspect and this resulted in the downfall of the industry in Kerala.

India with an annual installed capacity of about 4,57,000 tonnes for freezing can process all the marketable varieties of fishes being landed in India. But it is reported that only about 16 per cent of the existing capacity is being utilized. The study shows that in Kerala the capacity utilisation of the freezing plants varies from nil to 45 per cent. One of the main reasons of this low production is the lack of knowledge and sufficient information about the resource availability of various species and the demand pattern of various products which can be produced from these materials. The development of an effective Management Information System will help in a long way in fulfilling the objective of management to improve the use of production facilities and thereby increasing the profit margin by way of cost reduction.

The landing of fish is highly seasonal and is scattered along the 304 fishing villages in the state. At present there is no means for the seafood processors to regularly monitor the resources landed in the numerous landing centres in Kerala and the nearby states. The price of the fish purchased from a landing centre varies from time to time and even within a short period of time. The price is also dependent on the quantity of fish landed and the demand for it. The price of a particular variety of fish may vary even within a few hours in a landing centre. So it is a complex problem faced by the sea food industry which is not prevailing in any other industry to this extent. The processors are not in a position to predict the price expected and the quantity available due to the lack of a systematic information system. Similarly there is no means to measure the workers efficiency, or idle time in a processing factory. Marketing of seafood to international markets require day to day information about the market positions and prices offered by different markets Seafood market is highly dynamic and the consumer preference changes then and there. It is a must to watch the movements of consumers and markets daily. But no system is at present prevailing to get such information to the factories. Hence the processors are still continuing with the traditional products from shrimp which forces the plants to be idle most of the time.

Hence the following reports are suggested to be incorporated for information gathering and for necessary action.

1. Daily Landing/Raw Material Availability Report.
2. Consolidated daily landing pattern Report.
3. Workers Output Chart.
4. Idle time Analysis Report.
5. Market Intelligence Report.

CONCLUSION AND RECOMMENDATIONS

Seafood processing industry in India had emerged as a good foreign exchange earner within a short period of time. From one processing plant(freezing plant) in 1953 with a modest export of 13 tonnes, it has grown to 276 plants in 1985 with an export of about 80,000 tonnes worth Rs. 460 crores. But despite this apparent glory of the industry, the individual processing plants are struggling for existence due to low productivity and loss. Many industrialists had left the field and more and more units are becoming sick year after year. The capacity utilisation is far below the break-even level. This is the result of unrestricted entry of the entrepreneurs into the field in the initial stage attracted by the huge profit margin prevailed at that time for shrimp products. This resulted in severe competition among the processors for raw material and subsequent reduction in the profit margin. The cost of production has shot up without corresponding increase in export price.

Till date no study was carried out to find out the reasons of low productivity of the industry with respect to production. Hence the study was taken up to sort out the various reasons of poor quality of the products and low productivity of the industry to recommend measures to improve the situation.

R E C O M M E N D A T I O N S

The following recommendations are made for the benefit of the industry.

1. The industry is at present having huge idle capacity and large number of processing plants are remaining closed. Hence efforts should be made to use the already established facilities rather than building up new facilities.

2. Whenever processors are thinking of a new location, they have to do a thorough locational analysis with respect to the availability of the raw materials, labour, water, electricity, transport, environmental conditions, waste disposal facilities, land cost, port facilities and cold storage facilities.

3. Layout of the present plants are unbalanced and not favourable for maintaining smooth flow of materials, good sanitary and hygienic practices. The layout should be optimally balanced taking into account the irregularity and seasonality of fish landings and other constraints. There should not be any bottlenecks or delay in the production line as it seriously affects the quality of the products. The manual processing of the products should be continued with process layout for quite sometime due to the present pattern of raw material landings in small quantities and in different sizes.

4. The building should be constructed in the East-West direction. This helps in preventing sunlight directly falling inside

the processing hall or materials.

5. The inner walls of the processing premises should be fixed with glazed tiles atleast 1.5 to 2 metres above the floor for easy cleaning and quality reasons.

6. The entire stretch of the outside wall of the pre-processing hall, chill room, processing hall, and packaging section must be provided with transparent glass windows above 2 to 2.5 metres from the floor to get natural day light in the production sites.

7. The processing hall and other premises should be constructed to help quick drainage in the opposite direction of the material flow. This helps in preventing cross contamination of the material with waste water.

8. Sufficient light arrangements must be provided to have day light brightness to check the quality of the material and to locate any foreign particles in the material.

9. Good quality water should be provided at the work sites.

10. The purchase section must be provided with all facilities like platform balance, water points, facilities for supervision an quality checking, etc.

11. A separate raw material store should be provided to keep raw fish apart from chill room to have better quality of the final products. The raw material immediately after purchase can be temporarily stored here for pre-processing.

12. The present practice of some processors of directly taking the raw materials to the processing hall or chill room without proper washing or cleaning should be avoided. The raw materials should be properly washed and pre-processed and stored in chill room till the turn comes for that particular raw material for processing as per the priority rule.

13. Instead of cement tanks or galvanised iron tanks, small standard size plastic tubs of 25 to 30 Kg. capacity should be used at all the work sites to avoid excess handling and to keep the small quantities of raw materials arriving from different landing centres separately. (This is to avoid mixing of materials of different quality.)

14. A two line processing facility upto the post-freezing stage is suggested instead of the existing single line production to improve workers utilisation, quality of the products and to reduce the process cycle time.

15. Quick freezing is suggested with the 'Ninety Minutes Freezer' rather than the 'One hundred and eighty Minutes Freezer' to reduce the process cycle time and to improve quality of the end product.

16. An automatic master carton sealing machine is suggested instead of the existing practice of manual sealing due to the following advantages:

1. Automatic master carton sealing is quick and results in uniform packing and sealing. It reduces the bursting of master cartons and hence improves product appeal. Since the process is quick, it reduces temperature rise in the frozen slabs.

2. It reduces the man hour requirement to half that required for manual operations and hence reduces cost of production to some extent.

17. An ice plant of about 16 tonnes and two cold stores of 100 tonnes capacity are suggested for a processing plant with a capacity of 10 tonnes.

18. Necessary guidelines suggested for material movement in the processing plants to prevent bottlenecks and cross contamination should be followed.

19. The processors have to diversify their production utilising various fishery resources available which can be processed in the existing line of production. At present, production is mainly confined to shrimp products alone which results in underutilisation of men and facilities due to short supply of shrimp and its seasonality in landings.

20. Standard time has been established for various activities in the production of important products. This should be adopted by the processors for strict production control. Any excess work content or unnecessary handling or delay must be avoided

21. A'Raw Material Availability Calendar is developed for the use in the factories. This will help as a ready reckoner to find out the raw materials available during a season. This will help to know which raw material is abundant during a period so that production planning and market commitment can be made.

22. A model of the Linear Programming is developed for short term production planning to select the best product mix in order to maximize the contribution towards overheads and profit. Similar programming can be made use of for all the seasons for short term production planning in the seafood processing plants.

23. Models of Gantt Load Chart scheduling suitable for day to day scheduling of production and its control are developed and this can be made use of after making necessary modifications to suit the individual plants.

24. Taking into account the special nature of the seafood industry, a new priority rule has been suggested for use in the plants to decide the sequence of processing of different raw materials arriving at the plants. This will help to reduce quality problems and improves the ultimate yield of the products.

25. Statistical Quality Control Charts should be used at different work sites like weighing, counting, freezing, etc. to control the variation in the various processes and to take

immediate remedial measures.

26. Workers should be properly trained regarding their job, quality aspects of the products, need of sanitation and hygienic practices, purpose of controlling quality, yield, etc.

27. Efforts and measures should be made by management to motivate the workers to get maximum benefit from them.

28. 'Quality Circles' should be instituted at the processing factories to improve the workers commitment to work.

29. Management Information System should be strengthened with sufficient staff and reports. The following reports are developed and are suggested to be included in the day to day functioning of the factories.

1. Report of daily landing pattern/raw material availability and procurement pattern.
2. Consolidated daily landing/ raw material availability report.
3. Report of Idle time analysis of direct workers
4. Direct workers output chart.
5. Market intelligence/demand survey report.

The Government should permit the seafood processing factories to process seafood for internal marketing also without curtailing the facilities provided for 100 per cent export oriented business. This is a must to reduce the idle capacity of the processing plants and to prevent the frequent layoff in the factories.

With the above mentioned suggestions and recommendations the productivity of the seafood processing plants and the quality of the products could be improved,to a greater extent.

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Annexure: 1.

P R O F O R M A

1. Name of the plant :

2. Address :

3. Location :

4. Product brand :

5. Nearest landing centre and its name :

6. Other landing centres from which company receives raw materials :

7. Types of raw materials handled and source of availability
   (a) Crustaceans :
   (b) Fishes :
   (c) Others :

8. Means of raw material transportation (percentage wise) :

9. Mode of procurement (percentage wise) :

10. Average purchase rate of different raw materials (grade wise)
    (a) Crustaceans :
    (b) Fishes :
    (c) Others :

11. Time taken between purchase at the landing centre & unloading at factory :

12. Availability of labour force
    a.Skilled - like Supervisors,Technologists etc. : Acute shortage/shortage/s surplus.

(b) Unskilled - like washing & cleaning staff store boys,etc. : Acute shortage/shortage/sufficient/surplus.

13. Agreement of contract with workers/contractors :

14. Availability of technically qualified persons like quality control personnels etc. : Acute shortage/shortage/sufficient/surplus.

15. Availability of managerial personnels : Acute shortage/shortage/sufficient/surplus.

16. Availability and source of supply of other raw materials and their unit prices:

Material	Source	Unit price
a. Master cartons (shrimp):		
b. Waxed carton (,,):		
c. Baby carton(10lbs. lobster) :		
d. Master carton for lobster tails :		
e. Master carton for fish:		
f. Master carton for cuttle fish/squid :		
g. Polythene rolls(guage & price/kg.) :		
h. High density polythene for lobster packaging (guage and price/kg.) :		
i. Other polythene bags if any :		
j. Garstrap (price/roll) :		
k. Tightner		
l. sealer		
m. Clip/1000Nos.		

n. Chlorine/litre :

o. Marker :

p. Rayon strap/roll (1000 mts) :

q. Rubber band :

r. Teepol :

s. Other detergents :

t. Refrigerants :

u. Water (quantity required/tonne of fish) :

v. Electricity(requirement & availability like continous/discontinous and dependable/undependable. :

w. Generator/s & capacity :

17. Environmental conditions

a. Weather : Dry/ Moderately humid/ Humid.

b. Temperature (range) : Low/ Medium/ High

18. Surroundings : Clean/Unclean.

19. Means of waste disposal (solid & liquid) :

20 Av. quantity of waste disposed/day

a. Solid :

b. Liquid :

II. LAYOUT

1. Layout pattern :

2. Products produced :

3. <u>Receiving Division</u>

a. Arrangement for procurement of raw material :

b. Average quantity of raw material received/day :

c. Means of handling of raw materials while transportation and during unloading. :

d. Method and type of balance used for weighing :

e. Av. count size of different species received. :

4. <u>Peeling/Pre-processing Division</u>

a. Shape and size of the : Peeling/Pre-processing hall

b. No. of tables & type :

c. Dimension of tables :

d. Equipments used in this division and their description. :

e. Source & means of water supply :

f. Types of flooring and side walls :

g. Type of roofing :

h. Type of ventilators & doors :

i. Description of utensils used :

j. Capacity of peeling hall

k. Av. Capacity utilised :

l. Mode of washing of raw materials :

m. Rate of chlorination :

n. Cleaning schedules, if any :

o. Other raw materials handled by peeling hall apart from prawns :

p. Drainage system in peeling hall :

5. <u>Processing Division</u>

a. Shape and size :

b. No. of tables and other equipments. :

c. Dimension of tables :

d. Mode of storage of raw materials and semi-finished products. :

e. Type of floor and wall :

f. Source of water supply :

g. Level of chlorination :

h. Movement of raw materials and semi-finished products :

i. Type of drainage :

j. Handling equipments used and their Nos and make. :

k. Method of washing the raw materials : manual/washing machine

l. If washing is by machine give details of make, capacity, efficiency and year of installation :

m. Quantity of ice used/kg of material/day :

n. Frequency of reicing :

o. Type of freezers :

p. Freezing medium used :

q. Precribed time for freezing a load :

r. Actual time used :

s. Time consumed for loading and unloading :

t. Make of freezers & capacity :

u. Mode of packing of different products :

1. Prawns :
2. Lobsters :
3. Cuttle fish :
4. Squid :
5. Fish items :
6. Fillets :
7. Others :

v. Packaging equipments involved and its cost :

w. Handling equipments involved and their cost :

6. Cold Store

No. and size of cold store/s :

Capacity :

Mode of handling the finished products in cold store :

Location of the cold store :

Temperature maintained :

Range of temperature fluctuations noticed :

Which system you follow to stock different products in cold store. Why ? :

Average inventory in the store (month wise) :

Average annual inventory :

III. PRODUCTION, EXPORT AND CAPACITY UTILISATION

1. Item wise production and export(quantity wise and value wise) during 1984 and 1985 (if space is not sufficient additional sheets may be used)

Product	Production(tonnes)		Export			
	1984	1985	1984		1985	
			Qty	Value	Qty	Value

2. Do you have regular production in your plant, give details :

3. Additional weight added for different products to compensate drip.

Product (grade wise)	Additional weight added/kg.

4. Yield percentage of different products from raw materials

Product	Grade	Yield (from whole fish)

5. percentage loss of different finished goods due to spoilage, deterioration, and other causes.

6. Peak season of production :

7. Slack season of production:

8. How many shifts are there in your factory? Give timings also. :

9. How you adjust the workforce and shift in different seasons like slack season :

10. Do you purchase raw materials when it is available in plenty and store it till you get an order from abroad or you purchase only according to demand from foreign buyers. :

11. Do you get sufficient quantity of raw materials at the right time as per your order. If not why ? :

12. How do you schedule your raw material for processing ? On what sequence ? :

13. How do you schedule your finished products for export ? :

14. Did you ever try diversification of products/lines of productions :

15. If answer to the above question is 'yes' give details. :

16. Do you have any idea of mechanizing your plant ? If 'yes' to what extent. (If not already mechanised) :

17. What is your arrangement with your suppliers to get continous supply of raw materials ?

18. What is the average observed time required for different products to be processed and stored ?

19. Do you think that this time can be reduced ? if yes to what extent ?

20. How much is the turnover quantity per month in your store ?

21. What is the average time taken between receiving an export order and its actual shipment ?

22. Peak season of demand for your products :

23. Slack season of demand :

24. Which are your export markets :

25. What is the periodicity of shipment from your factory ? :

26. Which are your shipping Ports :

27. Which is your main port and what percentage of total quantity you exported from that port:

28. Do you have any idea about temperature fluctuation during transportation to different ports:

29. Which product you export more, how much ? Why ? :

30. Which product you export less, How: much ? Why?

31. Could you supply goods as per demand, if not why ? :

32. Did you have to face any rejection during the last two years either by Export Inspection Agency or by the buyers. :

33. If 'yes' give details :

34. What is the capacity of your peeling/pre-processing hall :

35. Average capacity utilisation of peeling hall :

36. What is the capacity of your processing hall ? :

37. Average capacity utilisation of processing hall :

38. Do you think that the plant can be utilised at 100% capacity, if not why ? and at what level it can be utilised ? :

39. No. of workers engaged in different stages of production:
    a. Peeling/pre-processing stage :

    b. Pre-freezing stage :

    c. Freezing stage :

    d. Post freezing stage :

40. Have you faced any problem with shortage of workers :

IV. INVESTMENTS, EXPENDITURE, ETC.

1. What is the total investment of your factory ? :

a. Investment on land :

b. Investment on buildings :

c. Investment on machinery :

d. Investment on other installations :

e. Investment on vehicles :

f. Investment on other items, if any :

2. Other overhead expenses :

3. Interest rates for the money taken from different sources :

4. Insurance premium (annual)m :

5. Property tax (annual) :

6. Other taxes if any :

7. Source of finance to the factory :

8. Obsolesence cost if any :

9. Expenditure on fish purchase(annual) :

10. Expenditure on packaging materials:

11. Expenditure on refrigerants :

12. Electricity charges :

13. Marine products cess and Inspection fee :

14. Wage of processing staff :

15. Expenditure on ice :

16. Other expenditures if any :