DEVELOPMENT OF TOTAL QUALITY MANAGEMENT SYSTEM IN SEAFOOD (FREEZING) INDUSTRY IN KERALA

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TO MY PARENTS

DECLARATION

I, Shassi.S, do hereby declare that the thesis entitled **"Development of Total Quality Management System in Seafood (Freezing) Industry in Kerala"** is a genuine record of research work done by me under the guidance of **Dr. A.Ramachandran**, Reader, School of Industrial Fisheries, Cochin University of Science and Technology and has not been previously formed the basis for the award of any degree, diploma, associate ship, fellowship or other similar title of any university or institution.

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CERTIFICATE

This is to certify that this thesis is an authentic record of research work carried out by Smt. **Shassi, S.** under my supervision and guidance in the **School of Industrial Fisheries, Cochin University of Science and Technology** in partial fulfilment of the requirements for the degree of **Doctor of Philosophy** and no part thereof has been submitted for any other degree.

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CHAPTER 1

GENERAL INTRODUCTION

1. Evolution of Quality control and Inspection systems in the world

Effort on industrialisation in the late nineteenth and early twentieth centuries has increased the complexities in the manufacturing processes which in turn resulted in the need to form groups of workers that performed either similar or specific tasks. This opened the way for the era of supervisors in manufacturing organisations. The industrial organisations during those periods were comparatively smaller and the owners were physically present to supervise the various activities. Therefore standards were set and major decisions on quality were taken by the owners. Yet managers were needed to supervise the work in order to ensure that the quality of their work and of the product were in conformance with the set standards and goals.

Towards the end of the nineteenth century with the growth of industrialisation, the complexity of production and of the manufacturing units increased. The number of employees reporting to each supervisor increased and the organisations felt the need for individuals who are capable of inspecting the quality of the product. The employment of inspectors for maintaining the quality has helped the supervisors and the workers to concentrate and devote their time to the actual manufacturing processes. The need for greater control on the manufacturing processes has subsequently led to the development of control charts in 1924 in the United States

(Olmstead, 1967). Between 1925 and 1926 the Western Electric group of the United States defined various terms that are associated with control process. These include consumer's risk, probability of acceptance, Operating Characteristic curves (OC curves), Lot Tolerance Percent Defective (LTPD), Average Total Inspection (ATI), double sampling and type A and type B risks. Dodge (1943) presented the basic concepts of 'sampling inspection by attributes' in 1925. In 1927, Average Outgoing Quality Limit (AOQL) sampling tables and the concepts of multiple sampling were developed. The demerit rating system joined the list in 1928.

By the mid-1930s, international interest in quality control had emerged. In 1935, Pearson developed the British Standards. The Institution Standard Number 600 entitled "Application of Statistical Methods to Industrial Standardisation and Quality Control." In the 1930s Scanlon put forth the concept of quality control through employee motivation and involvement, that was called the Scanlon Plan. The essence of this plan was bringing employees together with supervisors and managers so that they could collectively consider ways of improving the overall quality of work life (Feigenbaum, 1983). Along with this there were also some developments in the legal aspect of quality control. The United States Food, Drug and Cosmetic Act that came into force in 1938 was also concerned with practices in manufacturing, processing and packing.

Statistical Quality Control came into being in 1940s (Feigenbaum, 1983). Later with the identification and acceptance of consumer's risk, the notion of a risk of an opposite kind arose, that is the consumer's rejection of something good. Thus the notion of numerical producer's risk emerged and was incorporated with that of consumer's risk (Dodge, 1969). Second world war caused a rapid expansion in industries connected with the war effort. This led to the establishment of "Standard Inspection Procedures" in military of the United States and the development of sequential , variable and attribute sampling plans. (Schilling, 1982).

1950s saw an era of awareness of the importance of quality control not only in the United States but also in Japan and in certain European Countries. In 1955, Ischikawa introduced control chart techniques in Japan (Ishikawa, 1967). The growth in quality control systems resulted in the formation of the European Organisation for Quality Control.

1960s saw a new phase for the development of quality control activities with the introduction of "Total Quality Control" in Japan. Prior to 1960s, quality control activities were essentially associated with the shop floor. The Total Quality Control advocated the idea that, not only the quality control department, but also the other departments had quality control responsibilities. Therefore each department had some role in guaranteeing good quality. The concepts that attempted to involve all employees of the organisation in the quality control function began to emerge. Along with the concept of Total Quality Control, the concept of Zero Defects (ZD) was also born. The 1962 marked a formal beginning of Quality Circles, a major development in Total Quality Control and Management in Japan. At the dawn of the 1960s Japanese industries strongly felt the need for a more thorough education of the supervisor, who was the intermediary between management and workers. Like ZD programmes, Quality Circles were also an employee motivation and involvement programme. The central concept of the quality circle is that shop-level supervisors and their workers form groups that meet to discuss quality control issues and to train themselves in quality control techniques.

The Consumer Product Safety Acts and Regulations were passed in a number of countries to protect the consumers. In 1969, the U.S. amended the Food, Drug and Cosmetic Act to include practices in the manufacturing, processing, packing and holding of human foods. 1970s saw the development of "Company Wide Quality Control" (Ishikawa, 1976). Feigenbaum (1983) described it as "Total Quality Control Organisation wide". This phase was marked by emphasis on the involvement in quality control of every worker, from the company president to the machine operator. The important point here is that the highest level of management must be actively involved in quality control. Quality thereby became the responsibility of each individual. This system was in practice in Japan as early as 1950s (Deming, 1975). Feigenbaum (1983) defines quality system as the integrated approach of man and machine, aimed at planning in the best and most practical ways to assure customers quality satisfaction and economical costs of quality. Participative quality control emphasises the involvement of workers in those decisions concerning their workplaces, work environments, work processes and products.

Several organisations have defined quality from different angles. The American National Standards Institute (ANSI) defined quality as " the totality of features and characteristics of a product or service that bear on its ability to satisfy given needs".

Recently many workers recognised the importance of quality cost in the overall quality structure. Feigenbaum (1983) divided them into two broad categories: preventive costs and appraisal costs as belonging to costs of control, and internal costs and external costs as belonging to costs of failure of control. Wadsworth *et al.* (1986) classified these costs as preventive, appraisal, internal and external.

The laboratory accreditation programme was also promoted during this period. Another major development in the quality control front occurred in 1976 with the development of the use of "cause-and-effect diagrams" which is a formalised technique for the listing and consideration of factors and causes that have a direct bearing on a particular quality problem to be solved (Ishikawa, 1976).

The implementation of various statistical quality control methods in industry was enhanced by the use of computers. The general use of computers in quality control of seafood industry is relatively recent. In developed countries computers were in use for automated testing, in computer-aided design (CAD), in computer-aided manufacturing (CAM), in computer-aided process control, and in data acquisition, storage and analysis as early as late 1970s.

Later, in 1980s, more emphasis has been given towards quality management. This involves mainly human participation or workers' participation. Much of today's quality improvement lies not on the traditional inspection and test oriented quality control functions but also on the people handling the control systems. Quality management recognises the importance of the broad system issues of any organisation, and seeks effective ways to integrate the efforts of large numbers of people with large numbers of machines and huge quantities of information.

As in most other fields of technology, quality control and quality assurance have experienced tremendous growth in the area of computer applications. This has led to the emergence of Software Quality Assurance (SQA) and its importance in the 1980s. SQA is a relatively new concept that tends to bring greater level of discipline to the software development process (Grinath and Vess, 1983). Although SQA is a new field, several SQA specifications already exist. These include ANSI/IEEE 730, FAA-STD-018, MIL-STD-1679 and MIL-S-5277A. These specifications require that a contractor's SQA system be documented and subjected to audit. SQA specifications also require that quality assurance functions be an integral part of the design process (Grinath and Vess, 1983).

1. 1. Recent developments

Product design assurance, procurement quality assurance, production quality control and product quality audit are of very recent origin and are ongoing. Poor design may render manufacturing impossible or exorbitantly costly. Therefore, there is a great demamd within industry to design for manufacturability and for the integration of CAD with CAM into a unified set of functions that has come to be referred to as computer-aided design and manufacturing (CADAM). Poor design may result in erroneous specifications that ultimately leave their mark on the quality of the final product.

Procurement quality assurance aims at procuring and use of quality raw materials for the manufacturing of quality products. Production quality control consists of the entire range of activities that are performed in the production process to achieve the desired quality. Therefore, these activities include the use of computers in process control and manufacturing; preventive and corrective maintenance; process performance and capability tests; in-factory control of nonconformity; quality and quality control of in-process inventories; periodic survey of process control programmes and a system to establish and control applicable specifications and related instructions.

Quality Audit is basically the evaluation of an organisation's quality control programme. The evaluation proceeds from the point of view of the customer. In this respect, Feigenbaum (1983) describes the customer as the "Final Control Station." A product quality audit is instituted as the aspect of a quality audit that provides management with an early view of the product as the customer sees it. Product quality audit is therefore an essential part of the total quality system.

1. 2. Future trends

In the light of the public's awareness of quality, it is understandable that their demands for quality items are continually increasing. If individual industries are to survive, they must adjust to these higher demands. Feigenbaum (1983) has discussed three areas, stemming from the public's demand for quality, with which industries of the future will have to contend. The three areas are: (i) customers have been increasing their quality requirements sharply, (ii) as a result of this increased customer demand for higher-quality products, the present quality practices and techniques would be outmoded soon, and (iii) the costs of quality have become very high. For many companies, they may be much too high if these companies are to continue their manufacturing operations and improve their competitive position over the long run.

1. 3. Management of quality

Management of quality is the organisational function responsible for defect prevention. Feigenbaum (1983) has discussed activities that are accountable to quality management, in detail. The purpose of quality management is to manufacture a product, whose quality is designed, produced and maintained at the least possible cost, while still providing full customer satisfaction. According to Kivenko (1984) this aim can be achieved by (i) participating in design reviews, reliability analysis, environmental testing, and other defect-prevention tasks., (ii) helping to create an environment and culture of quality., (iii) keeping the costs within budgets and estimates., (iv) acquiring adequate personnel, equipment, and facilities to perform professional quality control., (v) establishing accurate, adequate and economical measuring techniques and obtain equipment for control of product quality., (vi) controlling the quality of purchased material as specified in engineering drawings, documents, and purchase orders., (vii) measuring product quality through process evaluation, product inspection, packaging, inspection and audit., (viii) diagnosing quality inhibiting situations and conditions and identifying the underlying causes., (ix) returning quality information to organisational groups and vendors requiring this knowledge., (x) initiating corrective action to eliminate poor design, material, processes, and worker skills., (xi) collecting quality data to assist in analysis and prevention activity., (xii) responding promptly to customer complaints and queries.

1. 4. Quality engineering technology

Quality engineering technology is a body of technical knowledge for formulating policy and for analysing and planning product quality in order to implement and support the quality system that will yield full customer satisfaction at a minimum cost. There are three major techniques used in quality engineering; namely, preparation of quality policy, product-quality analysis and quality operations planning (Feigenbaum, 1983).

1. 5. Strategic management of quality

The modern corporation, as described by Hansen and Ghare (1987), is a complex system in which decisions are made, communicated and implemented. The components of production, including quality, depend on the manner in which decisions are reached, the structure of the communication network, and the implementation system. Persons at all levels within the corporation, from chief executive officer to production line worker, eventually have some influence on the final quality.

The failure of management to plan for the future and to foresee problems causes waste of personnel, materials and manufacturing resources, all of which raise the manufacturer's cost and the product price that the purchaser has to pay. Management cannot learn by gaining experience on the job. Doing one's best is not the answer. Productivity should be increased with improvement of quality. Low quality means high cost. Measures of productivity do not lead to improvement of productivity. Measures tell management how things are proceeding, but they do not point out the ways for improvement. Best efforts are essential, but everyone is already doing his or her best. To be effective, best efforts require guidance to move in the proper direction. It is important that managers know what is required from them. Quality is everybody's job, but management must lead in quality control efforts. In order to help management improve quality, Deming (1982) suggested 14 points. Gitlow and Gitlow (1987) elucidate these points.

1. 6. Product appraisals

Product appraisal is a set of inspection and test functions that determine the value or quality of a product. The quality department is responsible for the appraisal functions relating to the acceptance of the company's products (Crosby, 1986). The data gathered by performing appraisals are the quality department's most significant product. The company uses these data to form its prevention strategy and to run a continuous check on the status of the output.

1. 7. Management programmes for quality

Motivation is an important stimulant for better productivity in an organisation. An important function of the quality manager is to act as a motivator. The manager can assist employees by helping them to set goals, helping them to attain these goals, and providing an atmosphere conducive to productive work. Other attempts to motivate include selecting and placing people in appropriate jobs, redesigning the work to include more motivating factors, and actually changing the behaviour of others.

According to Cash (1986) the following basic principles will provide managers with knowledge that will help them initiate motivation programmes.

1. Motivation is internal. A person must decide what factors create motivation.
2. Most goals are self-defined and often self-limiting. Encouragement cannot motivate an employee unless that person desires the goal.

3. Motivation and behaviour are learned. Employees can learn new behaviour or can be shown new ways of doing things.
4. Because behaviour is learned, it can be changed.
5. Motivation is specific to the individual; the selection of goals and the need to accomplish them may vary from employee to employee.
6. The strength or desire to achieve a goal depends on whether the employee sees the goal as achievable.
7. One way of making a goal more achievable is to break it into smaller, easier steps.
8. Positive or negative reinforcement and feedback can influence motivation.
9. Reinforcement and feedback should be given as soon as possible.
10. To be effective, positive reinforcement, especially when attempting to change behaviour, must be continuous.

1. 8. Organisation

Organisation can be defined as a system of authority, responsibility, and communication relationships with provisions for structural co-ordination, both vertically and horizontally, facilitating the accomplishment of work and objectives (Kivenko, 1984). According to him improved organisation of the quality control function has the following benefits.

1. Improved company returns on investment through better quality, less scrap and rework and improved sales.
2. Enhanced customer satisfaction.

3.Greater emphasis and concentration on quality cost-reduction opportunities.

4. Identification and resolution of conflicts among management objectives.

5. Development of better production plans.

6. Improved operating controls.

7. Reduction of costs associated with supporting redundant quality control procedures and systems.

The organisation chart shows the formal structure of the organisation, defines the hierarchy of positions; and identifies the flow of authority, responsibility and accountability from the top of the organisation to the bottom. The type of organisation chart used depends on the type of the company. Examples include the mullet-product plant chart, the chart of a basic production line, the chart of a plant with different manufacturing sections, the small-company chart, the large-company chart, and a multinational company chart. (Luthans, 1977; Szilagyi, 1981).

1. 9. Quality Circles

Quality Circles (QC) consist of individuals from different levels of a factory who meet regularly to define, select, and solve quality problems. Usually the individuals join the programme on a voluntary basis and are trained prior to their actual participation in a QC. The groups usually consist of 5 to 15 individuals. The philosophy behind the quality circle concept is that the people on the production floor know their jobs better than anyone else and should be involved in cutting waste and proposing solutions.

To the quality control engineer, quality usually refers to improving the quality of a product. However, QC is used for many other reasons, such as improving productivity and the work environment. QCs help people to feel that they are an important part of the company. The organisation and operation of QC are described by Patchin (1983). Most large firms begin QC by forming a steering committee. Its members have the responsibility of encouraging QC movements. Each circle has a leader, who is typically the supervisor of the circle members at their everyday work assignments. It is upto the leader to ensure that the goals of the circle remain in focus. Each circle also has a facilitator. This person assembles data for the circle or sees that members of the circle gather the data needed for studying a particular problem. One of the techniques used for sorting out problems by the QC is by brain storming. Data gathering is another part of the quality circle process. After the data are collected, they are converted into scatter diagrams, histograms, or simple trend analysis charts. Possible causes of the problem are then broken down into categories such as personnel, materials, machines and methods. Eventually the circle members make a presentation to management. The company implements the best suggestions evolved out of this process and the members will share the recognition. QCs have been in existence in Japan since 1962, and the concept is rapidly becoming more popular in the U.S. industries. Few companies in the U.S. had this type of programme in the 1970s. The advantages of QC are quality improvement; waste reduction; attitude change; cost reduction; safety improvement; improved communication; higher productivity; increased job satisfaction; team building and improvement in skills (Ingle, 1982). The success of this programme is attributable to three factors: use of basic statistics, group dynamics and job satisfaction.

Dey (1988) gives a description on the quality circle concepts and practices. The concepts of quality circle are essentially Japanese. QC in Japan was formalised in 1960 by K. Ishikawa. He succeeded in convincing the management about the potential of significant contribution from the large work force to quality, productivity and several work-related issues. The International Association of Quality Circle (IAQC) was formed in the USA in late 1977. In April 1982, the Quality Circle Forum of India (QCFI) was formed in Secunderabad. A quality circle always consists of a small group of employees. These members join in QCs voluntarily and meet regularly to identify, analyse and evolve ways and means to solve work-related problems. The ultimate objective of a QC is not only to improve the quality of performance of an organisation, but also to enrich the quality of work life of its employees. He discussed about the behavioral aspects of quality circles, training in quality circles, training tools, quality circle structure and issues in quality circle. Udapa (1983), Smith (1983), Rai (1984) and Chandrashekaran (1986) reported the need for workers' involvement in the productivity through QCs. Ramachandran (1990b) suggested the introduction of QC comprising of employees at various levels in the seafood processing industry in India. It will help to improve the productivity and quality of the products. Ultimately the quality and yield of seafood products lie in the hands of the workers.

Lal (1990) reported that QCs are one of the most effective means for involving shop floor workers in the quality improvement programme. Quality circle is meant for work, for which it should constantly strive. It should aim at making the work more meaningful and effective, and there by more ethically satisfying for the persons involved in doing it. It is people's movement for improvement of work culture that includes improvement of quality and productivity.

1.10. International organisations associated with seafood quality management

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. The committee has formulated standards for canned Pacific salmon, eviscerated and quick frozen Pacific salmon, canned shrimps or prawns, quick frozen fillets of cod and haddock, quick frozen fillets of scorpion fish, canned tuna or bonito in water or oil, canned crab meat, quick frozen fillets of flat fish, quick frozen shrimps or prawns, quick frozen hake fillets, canned sardine and sardine type products, quick frozen lobsters, and canned mackeral. They are also preparing more and more standards for other products (Mathen, 1979; Braekkan, 1982). Recommended International Code of Practice for eight fishery products are processing and handling of quick frozen foods, fresh fish, frozen fish, molluscan shellfish, lobsters, smoked fish and salted fish.

1.11. National quality standards

The Bureau of Indian Standards (BIS) which started functioning in 1947 is the National Standards Organisation in India. Its principal objective is to prepare standards on national basis and promote their adoption. These standard specifications are formulated after consultation with the traders, manufacturers, research institutes and all other organisations interested in seafoods. More than 50 standards are available at present. CIFT is giving advice on quality aspects to seafood processors. All export consignments are to be accompanied by a certificate of fitness for exports (Mathen, 1979).

2. History of Quality control and Inspection systems in India

When India started exporting frozen seafood in 1953, there was no scientific quality control system prevailing. Later, Govt. of India decided that the consignments exported from India have to meet certain pre-determined and specified standards of quality. Compulsory pre-shipment inspection of frozen shrimps was introduced on 1st September 1964 (Iyer, 1990) as per the provision of section 6 of the export (Quality control and Inspection) Act 1963. According to this system of inspection, the exporters willingly subjected their products to prescribed standards. Then, the export of marine products was brought under compulsory inspection system with effect from 15th March 1965. In 1969, the scheme was taken over by Export Inspection Agency (EIA). Bacteriological requirements were added in 1975 (Nair, 1995b). There were mainly four objectives for this inspection system. They were, (i) to ensure that the product had been prepared from quality raw material and it had never been grossly contaminated., (ii) to ensure that product was absolutely free from pathogens or toxins of public health significance., (iii) to ensure that the product was processed under ideal conditions., and (iv). to ensure that the product would have a reasonably extended shelf life (Iyer, 1990). In the consignment inspection, for a commodity to be inspected under this system, the exporter applies to the EIA for inspection and issue of export certificate. The inspection agency carried out inspection adopting laid–down techniques to ascertain whether they met the prescribed standards. Based on the inspection results, certificate of export worthiness was issued by the EIA. Mathen (1979) reported that at least 10 percentage of the products were found to be substandard. The end product might have been produced to the notified requirements and it cannot enquire into the conditions under which these products had been manufactured.

2.1. In-Process Quality Control (IPQC)

In 1977, a revised notification was introduced stipulating various requirements to be implemented by the processing units for ensuring hygiene and wholesomeness of the product. Under the provisions of the notification of the In-process Quality Control (IPQC) scheme of fish and fishery products, a panel of experts had been constituted to assess the facilities prescribed therein. Based on the recommendations of the panel, the units were declared as approved or non-approved. Iyer (1990) described the required minimum facilities in the processing factories and the In-process Quality Control checks in different stages of processing. Under the scheme, the following procedures of inspection were being followed. A day's production constituted a control unit having more subunits depending up on the type of the product. Those of the lots which met the laid down standard were treated as approved lots (Majumdar, 1985).

2. 2. Quality Control Inspection in Approved units (QCIA) and Modified In-Process Quality Control (MIPQC)

This modified system of IPQC scheme was introduced as per the notification of Government of India dated 9.4.1988. The IPQC system was re-titled as Quality Control Inspection in Approved Units (QCIA). Another change was the introduction of a new system- Modified In-process Quality Control (MIPQC) scheme. For the approval under this system of inspection, it is the sole responsibility of processors themselves to exercise total surveillance of their units under the guidance of Export Inspection Agency to ensure organoleptic and bacteriological quality of the product. However, in the case of all the above systems of inspection, the Export Inspection Agency issues certificate of export worthiness. The Pre-Shipment Inspection and Quality Control manual published by EIA from time to time gives the instructions and procedures to be followed under this scheme (Anon, 1985). Subsequent to the rejection of a few tonnes of Indian shrimps by Japanese Quarantine Authority due to the contamination of cholera germs, *Vibrio cholerae* detected in frozen shrimp consignments exported to Japan more stringent measures were taken by the EIA (Majumdar, 1985). Modified In-process Quality Control scheme is re-titled as In Process Quality Control, under this scheme. Only those processing units already approved under QCIA system and have some additional infrastructure facilities are allowed to export (Iyer, 1990).

3. Present status of seafood quality management

3. 1. U S A

The Health and Human services of the Food and Drug Administration (FDA) through the Federal Register proposes procedures for safe processing and importing of fish and fishery products which include mandatory requirements for the monitoring of selected process as per HACCP principles. The Food Advisor of the Committee to FDA's Centre for Food Safety and Nutrition recommended that FDA should encourage and eventually require HACCP for the entire food industry. FDA has also revised food code in 1993 making it compatible with HACCP concept. The Agricultural Ministry in 1993 announced plans to publish regulation making HACCP as part of the inspection standards for the meat and poultry industry (Nair, 1995a).

3. 2. Canada

The health Protection Branch under the Food and Drugs Act has proposed 'Good manufacturing regulations for foods stressing the importance of HACCP principles. Canadian Fish Processing is the first industry in the world to have adopted HACCP under the regulatory mechanism. Quality Management Programme (QMP) as it is called has stipulated minimum mandatory requirements for in-plant quality management enforced by the Fisheries and Ocean Department of Canada. The objective of the Quality Management Programme (QMP) is to ensure that all fish products, and the condition under which they are produced, meet the current Canadian regulatory requirements (Anon, 1990).

3. 3. Australia

The Quality Assurance System of the Australian Quarantine and Inspection Service (AQIS) gives option to the food industry like fish, dairy, processed fruit, vegetable, plant products and quarantine related activities for adoption of HACCP concepts. AQIS is developing a new inspection system known as Food Hazard Control System (FHCS) based on HACCP. Under this system, the industry is to document HACCP programme for export commodities and once the system is approved by AQIS, the company is free to export the products without compulsory end product inspection, subject to monitoring by the AQIS (Nair, 1995a).

3. 4. European Union

Free movement of food stuff in European Union implies confidence in the standard of safety of food stuffs for human consumption and in particular in their standards of hygiene through out all stages of preparations, processing, packaging, storing, transportation, distribution, handling and offering for sale or supply to the consumers. The Council Directive No.93/493/EEC of 14 June 1993 on hygiene of foodstuff requires that the food business operators should develop HACCP based system for ensuring food safety. This Directive further suggests that the member states may develop codes of practices for specific food industry and adopt EN 29000 series in order to implement the general rules of hygiene and the guides to good hygienic practices (Nair, 1995a).

3.5. Japan

Japan, traditionally an exporter of fish, is the single biggest market for Indian seafood. Imports to Japan come from a large number of countries from all over the world both from capture and culture source. Hence Japan has to evolve a satisfactory procedure to assure the safety of the imported fish and fishery products. In order to promote food safety, the Ministry of Health and Welfare (MHW) has established the Food Sanitation Law and other related laws and regulations, which also contain all regulatory requirements for fish and fishery products. The purpose of the Food Sanitation Law is to protect the people from health hazards caused by the consumption of contaminated food which in turn helps the general betterment of public health. The MHW has set up standards and specifications for one general and twenty four individual classification. Five of the classifications relate to fish and fishery products. Additionally, frozen processed food including fish and/or fishery products shall comply with bacterial specification. Also packed food, heat-sterilised under pressure (retort) shall comply with bacterial specifications and standards of manufacture. These standards and specifications are based on Food Sanitation Law (Article 7). Currently food for which standards of manufacture are established must be manufactured accordingly and to increase the variety of products, the MHW introduced an approval system for comprehensive safety/sanitation controlled manufacturing process. The approval standard is based on HACCP and pre-requisite programme. A food producer, who conducts HACCP system and has effective pre-requisite programme, can modify manufacturing methods as long as the products meet the specification prescribed in Food Sanitation Law. This system was enforced from

24th May 1996 and the MHW encourages industries to introduce HACCP based food safety assurance system (Toyofuku, 1997).

4. ISO 9000 series

During the period of use of BS 5750:1979 as a result of trade interfaces and technical links with overseas countries, other national quality standards were introduced in various parts of the world. Many of these standards were substantive copies of British standard; some contained amended or additional requirements. This much wider interest in quality standards led to the International Organisation for Standardisation (ISO) initiating, in 1983, work on an international standard. The work was completed in 1987 with the publication of the ISO 9000 series having five standards as follows (Anon, 1993).

ISO 9000 Series

ISO 9000: Selection of the appropriate ISO 9000 standard

ISO 9001: Quality system requirements of product development, production and delivery and after sales functions

ISO 9002: Quality system requirements for production and delivery

ISO 9003: Quality system requirements for final inspection and testing.

ISO 9004: Guidelines for ISO 9000 quality systems elements.

ISO 9000 standards contain nineteen quality system requirement elements, namely, 1. management responsibility, 2. quality system, 3. contract review, 4. product development, 5. document control, 6. purchasing, 7. product identification and traceability, 8. process control, 9. inspection and testing, 10. inspection, measuring and test equipment, 11. inspection and test status, 12. control of non conforming products, 13. corrective actions, 14. handling-storage-packaging and delivery, 15. quality records, 16. internal quality audits, 17. training, 18. cleaning and disinfecting, 19. personal hygiene (Huss, 1993). ISO 9000 standard require documented quality system. Huss (1993) also described the establishment and implementation of ISO 9000 quality system and reported that the time required to get certification of the system in a medium size company was between 1-2 years. De beer (1994) discussed about the importance of ISO 9000 and the significant achievements the company is getting after obtaining certification of ISO 9000. Bogason (1994) studied about the implementation of ISO 9000 quality system in a European seafood company and found out that seafood industry need to take quality management very seriously for successfully competing in the global food market.

5. Hazard Analysis Critical Control Point (HACCP)

The concept of HACCP originated in 1960 to help to reduce the risk of *Salmonella* infection in food by the work done in quality assurance system by NASA (National Aeronautical Space Agency) and US Military Tactics Laboratory. The HACCP system as we know it today took form at the 1971 National Conference on Food Protection where risk assessment was combined with the Critical Control Point (CCP). Seafood safety in the US is regulated at the Federal level by the Food and Drug Administration (FDA) which operates a comprehensive, mandatory programme under the authorities of the Federal Food Drug and Cosmetic Act and the Public

Health Service Act. In addition to this mandatory programme, the states operate mandatory seafood regulatory programmes designed to meet their regional needs. The National Marine Fisheries Service (NMFS) operates a voluntary, free-for all service inspection programme under the authorities of the Agricultural Marketing Act of 1946 and the Fish and Wildlife Act of 1956. A Memorandum of Understanding (MOU) exists between FDA and NMFS relating to this programme. Under that MOU, NMFS ensures that industry participant's operations and products meet the requirements of the FD & C (Food, Drug and Cosmetic) Act, as well as NMFS quality and identity requirements. In 1991 FDA and NOAA/NMFS began the design of a new, jointly operated inspection programme and enlisted the co-operation of the seafood industry to the extent that industry trade groups and individuals would participate. This joint programme is based on the principles of the HACCP concept. This system requires the industry to develop and maintain records of control points in their process that have been determined critical for the control of product's safety, plant/food hygiene, and economic fraud hazards associated with the particular product. Industry and government then become partners in the business of food inspection (Hoskin and Wilson, 1990).

Farquhar (1991) reported that fish marketing institution strongly endorses the voluntary FDA/NOAA inspection programme for seafood based on the HACCP concept. And they believe that this programme will quickly realise consumer acceptance and assurance that fishery products purchased from the retail establishment will meet their expectation for safe, wholesome, quality seafood, which is properly labelled. Larusson *et al.* (1991) reported that HACCP system is being accepted world wide for the management of preventive food safety in an increasing complex food production technology. And he also reported the design and development of a computer-based expert system for quality evaluation of shrimp. Warne (1991) points out that HACCP approach is error prevention rather than detection of faulty finished product. Lee (1991) discussed about HACCP concept and Hazard Analysis (HA) and Critical Control Points (CCP). Balakrishnan (1992) discussed about inexpensive labour intensive quality control methods at different CCPs in seafood industry in India. Marti and Rodriguez (1992) discussed the application of the HACCP system to monitor the quality of fish sticks and peeled shrimp tails during the various processing procedures and determined operations which possess possible risk of microbiological contamination.

Flick *et al.* (1992) studied about integrating HACCP based inspection with quality assurance in re-circulating production and processing facility. According to him the stored information in computer could be used to identify changes in operating procedures that had an impact on production efficiency and quality. Suwanrangsi (1992) discussed about the traditional fish inspection system in Thailand and pointed out that HACCP is the best system available for improving the safety of food.

James (1993) discussed about the current situation in the fish inspection and quality control in various countries in the world. According to him a new regulation is required to introduce HACCP based quality assurance programme in the food industry. Ramos (1993) discussed about the implementation steps of the HACCP in a fish processing industry and also gave an account of the sanitary aspects of processing. Taliat (1993) discussed about the CCPs in the seafood industry as handling and storage in fishing vessels, auctioning, pre-processing, processing and shipment. He also gave emphasis on the improvement of the general condition to meet these standards in seafood industry. Kim (1993) discussed about the application of HACCP system in seafood industry, and suggested the need to develop a HACCP training programme for the seafood industry, for the safety, quality and other attributes of the food products.

Anon (1994a) reported that HACCP is a preventive system of hazard control that can be used by food processors and importers. FDA is proposing these regulations because a system of preventive controls is the most effective and efficient way to ensure that these products are safe. According to the study of Asean-Canada Fisheries Post-Harvest Technology Project, under HACCP system, hazards are analysed through the regular monitoring of Critical Control Points. Instead of detecting problems that may compromise the safety of food after they have occurred the study suggests to prevent problems before they occur (Anon, 1995c). Even though the HACCP system originated in the U.S., a similar system in the name of "Own Checks" was in existence in EEC and in the name of "QMP" in Canada. Regardless of the nomenclature of the system, the objectives are the same and the methods similar. HACCP can be compatible with quality management systems, such as ISO 9000 series. HACCP is intended to address high-risk operations specifically. This system is useful for food safety and for non-safety hazards such as the prevention of economic fraud in relation to labelling, grading, weights, etc., as required by import inspection agencies. Now it has become mandatory that anyone exporting fish products to

Europe or to the U.S have to have HACCP system implemented. If the processors fail to demonstrate to the satisfaction of regulating agencies in importing countries that they have an effective programme operating in their processing plant(s), importers will not be permitted to accept the products.

The United Nations food standard group (Codex Alimentarius) adopted HACCP as an international inspection standard. Similarly GATT (the General Agreement on Tariffs and Trade) is expected to do the same. Anon (1994a) identifies seven steps to set up an effective HACCP-type programme:

1. Identify all possible food safety and non-safety hazards that are likely to occur in the processing operation - based on the species being processed and the process used and analyses the risks related to those hazards.
2. Establish critical points in the process, at which a failure of some sort could make food unsafe if proper control is not exercised; each point may be identified as a Critical Control Point (CCP).
3. Establish Critical Limits for every CCP - that is, set maximum /minimum limits (parameters) for every Critical Point, so that employees will know when the process or the product (at that Critical Point) fails to meet criteria required to ensure food safety.
4. Set up monitoring procedures to keep track of how all required tasks are performed at each CCP.
5. Put a Plan in place, to ensure that corrective action is taken quickly whenever the monitoring procedures show that there is a problem at any CCP.

6. Set up verification and review procedures to ensure that your system of monitoring is working effectively.
7. Establish an effective system of keeping records to document how every aspect of the system is working (to satisfy regulators, importers, etc., that you are operating your plant in accordance with HACCP, "Own-Check" or QMP principles).

Anon (1994b) developed a sampling plan and rejection numbers for the inspection of fish. Pawsey (1994) studied on the application of HACCP principles to the transportation chain of frozen fish products and to identify the hazards and also to find out the CCPs. McEachern (1995) discussed about the basic principles of HACCP and their importance of achieving safe food and its impact on international trade. He also discussed the Government's and industry's role in implementing HACCP and how the Canadian Department of fisheries and Ocean adopted the principles in the development and application of the Quality Management Programme. HACCP system was and still is primarily aiming at guaranteeing food safety but can easily be extended to cover spoilage and economic fraud (Huss, 1993). Further development and introduction on the HACCP system into the general food production has been very slow. However in recent years, the system has been widely discussed and a number of new quality systems have been introduced for achieving all aspects of quality, such as ISO 9000 series and Total Quality Management. One reason for this development is that a number of national food legislation today is placing full responsibility for food quality on the producers like EEC Council Directive 91/493/EEC (Anon, 1991c). Anandavally (1995) discussed about the importance of HACCP concept in the field of seafood quality assurance and its connection with EC

Directive 91/493 and also pointed out that it is a systematic procedure to verify and audit the facilities in a system. Virulhakul (1995) studied about some of the problems of traditional fishery products and suggested some critical quality criteria for the traditional fish processing in order to assure reliable product quality and safety. Otwell and Garrido (1995) discussed FDA proposal for the nation's seafood industry following HACCP as mandatory quality assurance system. Price (1995) pointed out that HACCP system gives a systematic approach to identify and monitor possible sources of microbiological, chemical and physical contamination in seafood and to control the potential hazards.

Hood and Flick (1995) described about the preparation and implementation of operational plan that complies with state and federal food regulation. He says that this is the first step towards the production of wholesome, high quality product free from disease causing micro-organisms and also gives basis for developing a Total Quality Assurance and HACCP system. Huss (1993) discussed about the HACCP based system in Europe and is used to provide high degree of assurance of safety and quality. He also pointed out that the anticipation of hazards and identification of control points are the key elements of HACCP. Ostergard (1995) described in detail about the record keeping and verification in HACCP concept and suggested that these are the key elements for ensuring safe food products to the consumers. Avault (1995) discussed about the quality control, quality assurance and HACCP, and pointed out that the basic idea of HACCP is to identify hazards during processing of a product and to establish CCPs. It also meant to develop a plan for controlling, monitoring and recording the CCPs.

5.1. EC Directives

Garrett and Hudak (1991) discussed about the US seafood inspection and HACCP concept and its application in the food industry. Howgate (1994) narrates the details regarding the evolution of a single European market to cater the needs of all member countries. The single European market came into effect on Ist January 1993. Food laws were included in this programme with the aim that member states could have confidence in the safety of foods produced any where within the EC. In Principle, and ultimately in practice, foods produced in any member state can be traded throughout the Community without any hygiene and safety checks at borders, although there will be a brief period while member states introduce national legislation when some foods might still be subjected to checks. The harmonised regulations also impose a single set of criteria for the entry of imported products, and once a food product has entered a country within the EC, it can be distributed without further checks at internal borders. Tall (1995) discussed about the public health aspects of seafood consumption, handling, quality assessment of fresh fish and the import standards and regulations for seafood sold in the EEC and also the HACCP concept and its use.

6.Total Quality Management (TQM)

Quality management started with simple inspection-based systems where traditionally a company would employ teams of inspectors to examine measure or test a product and compare it with a product standard. This would be applied at all stages of manufacture, covering goods inward, work in progress and despatch. The objective here is to segregate the poor quality material from that of good quality. This would then be scrapped, reworked or sold as lower quality. In this system the inspectors often failed to find the poor quality items and the customers were left with the consequences. Another drawback is that the inspection-based system is costly because someone is engaged to look for the bad product or bad work and someone to repair it. It is also inefficient in the sense that it does not prevent the production of a bad lot but helps in identifying the bad lot at the end. Inspection-based systems had been in existence since the Egyptians built the pyramids. The first evolutionary change was noticed during the Second World War when aircraft technology became more complex and the costs, in both people and equipment, of relying on inspection-based systems for such things as military aircraft were seen to be unacceptable. The change was to a system of quality control. Under this system product testing and control became the ways to ensure greater process control and reduced non-conformance. Data were also collected on performance. Self-inspection was another improvement of this system. Here final inspection was still regarded as the customer's final safeguard. The third evolutionary change was the shift from concentrating on product quality to improving the quality of the systems. Here the company sets in place a system for controlling what is done and the system is audited to ensure that it is adequate (Kanji and Asher, 1995).

According to Lal (1990) Total Quality Management (TQM) deals with the product in its totality. It has been recognised that the quality is determined by the combined efforts of various departments such as design, engineering, purchase, production and inspection. TQM is an across the company, management function which co-ordinates and control wide spread quality activities with a view for achieving the desired quality of the end product. The quality control begins and ends with user. It starts when the user's need is analysed to design a product for its fulfilment. During the development and manufacture of the product, various departments and sections of the company make their contribution in building quality. The cycle ends with user, because the final product quality comes during its service with the user, whose satisfaction is the ultimate aim. He also emphasised that quality of production in company depends upon the variety of factors, the most important being the human factor. The quality culture in a company is determined by the broad policies of the management, and the extent to which the management is able to influence the mental attitude of the production staff. It is also determined by establishing good quality culture, where the workers take pride in their job and strive for work excellence. Thus, proper motivation of work force is an essential part of any quality improvement programme.

While it is apparent that traditional quality control is unable to eliminate quality problems, a preventive strategy, based on a thorough analysis of prevailing conditions is much more likely to provide assurance that objectives of the quality assurance programme are met. This point became very clear in the early days of food production and research for the U.S space programme (Bauman, 1992).

Corlett (1994) pointed out that TQM is a people system that provides the opportunity for individual employee to effectively contribute to planning, implementation, operation and continuous improvement of company operations. Felter (1994) gave an account of the current status of quality certification in the French and European markets. He also discussed the organisation of French market. Balakrishnan (1993) emphasised the requirement of a systems approach in quality management in seafood industry in India. He highlighted the technical, administrative and human factors affecting the quality of the products and recommended the use of ISO 9002 and 9004 for maintaining quality in seafood industry. Delvin (1994) described the development of Quality Management Programme (QMP) in Canada. According to him, the Department of Fisheries and Oceans and the Canadian fish processing industry have jointly worked together to develop the QMP. On Ist February, 1992 it became mandatory and is now a condition of federal registration for fish-processing plants. He also described the background of the development of the Canadian fish inspection programme and explained the basic principles of their new QMP and clarifies the Government and industry's roles under QMP.

In recent years, the HACCP system has been widely discussed and a number of new quality systems have been introduced to achieving all aspects of quality, such as ISO 9000 series and Total Quality Management. According to EC Directive 91/493/EEC one reason for this development is that a number of national food legislation today are placing full responsibility for food quality on the producer

(Anon, 1991c). Iyer (1998) emphasised that world over, in the seafood processing industry; there is a shift from the traditional system to the HACCP concept.

According to Dahlgaard *et al.* (1995) the concept of TQM is logical development of total quality control, a concept first introduced by A.V. Feigenbuam in 1960. TQM was a hit in Japan, on the other hand, where the first quality circle were set up in 1962, which later developed into what the Japanese themselves call company wide quality control. This is identical to what people in the Western World today call TQM. He described about the inadequacy of traditional management and the so-called management pyramid. A new management pyramid was developed based on the principle of Total Quality Management, and he called this the quality pyramid. He also described Deming's 14 points to achieve TQM.

Fernandez (1996) described about total quality in purchasing and supplier management and its systematic approach. He emphasised about how to build a solid supplier-customer relationship and presented a method for finding suppliers who will best align with the purchaser's organisation. He also emphasied that the various methods are involved in the purchaser/ supplier continuous improvement process and suggested systems for prioritizing the deployment of commodities, products, services and suppliers. All these along with a feed back mechanism that track supplier performance how show that a system must become an integral part of any quality programme for successful implementation of TQM.

According to Sadgrove (1996), Total Quality Management is a blue print for tomorrow's business. It improves quality, boosts productivity and cuts costs. TQM companies are twice as profitable as ordinary firms. TQM increases customer satisfaction by boosting quality. The five principles of TQM are - concentrate on customer, do it right first time, quality is an attitude not an inspection process, communicate and educate, measure and record, do it together. He suggested that egalitarian leadership is a much more liberated place to work. Here people communicate both up and down their own department and across to other departments. Teams can be formed to solve particular problems. Because the structure is flexible, it can grow and contract in response to the market. This is the TQM culture.

According to Kume (1996), type of organisational set up for promoting TQM is completely irrelevant, but its usefulness lies in making the existing organisations operate more efficiently. For implementing TQM, deficiencies in existing organisation are to be exposed and organisational changes implemented. He also discussed about the TQM promotional office and the role of TQM steering committee for implementing TQM. Total Quality Management is a management technique that emphasises quality. When it is properly implemented, every decision of a company from product planning to sales and service and all employees at every level from top management to shop floor workers and sales representatives are involved in continuously improving their work and ensuring that quality is reliably achieved.

Hosotani (1996) gave a detail account of the QC (Quality Control) problem solving approach. Solving problems rationally, scientifically, efficiently and effectively using three powerful features: the QC view point, the seven-step QC problem solving formula and the QC tools. He also described that solving problems in the areas of quality, cost, delivery, safety, and morale is the essence of Total Quality Management (TQM).

7. Scope of the study

India has been exporting frozen seafood since 1953. Now the country has 439 seafood factories of which 33% of them are located in Kerala. In fact seafood-freezing industry originated in Cochin, Kerala. The technology used in these factories was mainly plate freezing and some factories had blast freezing facilities. Individually Quick freezing technology (IQF) was introduced in the country for the first time in Kerala in 1984. At present there are 48 IQF factories in Kerala. And the remaining 80 factories are having block freezing or blast freezing facilities or both. The freezing capacity of the state is 1838 tonnes per day of which the IQF factories have 335 tonnes per day. However, Iyer *et al.* (1982) reported that the capacity utilisation of the seafood freezing industry in Kerala was very low during 1978 and capacity utilisation was worked out to be only 30%. The main reasons for low capacity utilisation were reported to be due to non-availability of raw material, high cost of production, shortage of power, scarcity of ice and potable water. Labour trouble was also reported to be a reason for low productivity during peak season. Later studies conducted by

Ramachandran (1988) also showed low capacity utilisation and productivity in the seafood factories in Kerala.

The freezing factories in Kerala are broadly concentrated in two region, Cochin and Quilon. The Cochin region comprising of factories located in the old Cochin town and the northern part of the Alleppey district like Aroor, Eramalloor, Chandirur and Ezupunna has 90% of the new IQF factories in the state showing heavy concentration of the new installations. The seafood constitutes 4.5% of the total export earnings of the country contributing Rs.4500 crores to the foreign exchange (Anon, 1997). However, severe competitions from countries like China, Taiwan, Indonesia, Philippines and Thailand have posed great threat to major Indian markets. This is very clear from the declining exports to Japanese markets (Shassi and Ramachandran, 1998). 2.2 million people are directly or indirectly involved in this industry or various ancillary industries supported by the seafood industry in India (Sathiadas, 1998). The coastal population in Kerala are mainly depended on fishing and fish processing activities. Due to the low productivity of the sea and in the processing factories, the employees are subjected to frequent layoffs and unemployment.

The country is exporting seafood to over 50 markets worldwide. The main markets for the factories in Kerala during 1995 were Europe, Japan and the United States (Shassi and Ramachandran, 1998). With the expansion of the markets and the increase in the number of suppliers, product variation became a major problem. Contamination with harmful microbes is one of the major problems associated with seafood export from India. George (1979) discussed the crisis in the seafood industry faced by the rejection of Indian seafood by USFDA due to the reported presence of *Salmonella* in the consignments exported to the US. This has led to more stringent inspection by USFDA. Shassi and Ramachandran (1998) while studying the changing market demand for Indian seafood found out that the main reasons for rejection of Indian seafood in the overseas markets are due to *Salmonella* contamination, decomposition and the presence of filth. They reported an estimated detention of 228 consignments of Indian seafood by USFDA during 1994-95. Their study also revealed the details of detention by European countries. The main reasons for detention of Indian products in European markets were short weight, over count, and poor quality. Rejection and block listing became a common phenomenon and this has ultimately resulted in imposing stringent regulation for exports to Europe and USA.

In the initial days India was following a system of quality inspection that was vague and the methodology followed for assessing quality was only product based, ie., end product inspection. The major shortcoming of the system is the blocking of capital in the form end product rejection, which subsequently leads to dislocation of shipment schedules and loss on account of labour, and capital. This paved the way for a better quality assurance system known as Process Control System in which the quality of the material to be processed is subjected to stringent quality measures at every stage of production. The advantages claimed by this system include the control and access at each stage of processing. This forms the foundation stone for a HACCP concept of quality control, EC Directives and ISO 9000 series of quality standards. All these new quality management concepts and directives aimed at providing the consumer a safe product at a reasonably affordable price. These new quality management concepts and measures will not be successful if it is not applied in a proper medium with a work climate having motivated human resource. After all, any process control aimed at preventing hazards has to be done by human beings. It is at this juncture that a study on the applicability of introducing Total Quality Management System in the seafood industry for the smooth and efficient implementation of HACCP concept becomes imperative. This will help the seafood exporters from Kerala to sustain and expand their markets abroad.

8. About the study

The European commission had given directives to introduce the new quality management guidelines before 31st December 1995 (Nair, 1995b). This shows that system of quality assurance system prevailed in the country was inadequate to cater the changing needs of the major markets. Hence the present study is proposed to analyse the existing quality management system in seafood processing industry in Kerala and to suggest ways to implement the Total Quality Management System. This is to effectively implement the Hazard Analysis and Critical Control Concept which has been suggested and made mandatory in many countries including India as a system to be adopted in place of the existing quality control system to sustain and develop seafood markets.

8.1. Aims and Objectives

Quality related problems have become dominant in the seafood processing industry in Kerala. This has resulted in the rejection of seafood sent from India to many destinations. The latest being the total block listing of seafood companies from India from being exported to Europe and partial block listing by the US. The quality systems prevailed in the seafood industry in India were outdated and no longer in use in the developed world. According to EC Directive discussed above all the seafood factories exporting to European countries have to adopt HACCP. Based on this, EIA has now made HACCP system mandatory in all the seafood processing factories in India. This transformation from a traditional product based inspection system to a process control system requires thorough changes in the various stages of production and quality management. Hence the study is conducted with the following objectives:

1. To study the status of the existing infrastructure and quality control system in the seafood industry in Kerala with reference to the recent developments in the quality concepts in international markets.

2. To study the drawbacks, if any, of the existing quality management systems in force in the seafood factories in Kerala for introducing the mandatory HACCP concept.

3. To assess the possibilities of introducing Total Quality Management system in the seafood industry in Kerala in order to effectively adopt

HACCP concept. This is also aimed at improving the quality of the products and productivity of the industry by sustaining the world markets in the long run. Study includes:

a. Analysis of various inputs used for the production of seafood in the seafood factories in Kerala with reference to their applicability to the newly suggested quality concept (HACCP).

b. Layout analysis of the existing seafood factories and the development of a suitable layout based on the new quality management concept.

c. Analysis of the process control parameters like production flow, sequencing and CCPs for the production of various seafood products. Based on the study, to propose standard flow charts and to establish CCPs. Also to analyse Production pattern in the factories selected for the study.

d. To carry out Method Analysis and Work Measurement of the processing of important IQF products and to estimate the normal time and standard time of each and every activity involved in the production of these products. To establish Process Cycle Time for the production of these products.

e. To analyse the Oraganisational Structures and Design of the seafood factories and to recommend suitable organisational structure for the effective functioning of the Total Quality Management System in seafood factories.

f. To analyse the various Human Factors in the seafood factories to study the present leadership styles, motivational measures and communication systems prevailing in the factories and to suggest required changes and recommendations to introduce TQM principles.

g. To study the Quality Assurance systems followed in the seafood factories and to assess its suitability for the implementation of the newly recommended quality management system.

In the light of the main objective of introducing TQM in seafood factories in Kerala for effectively implementing the HACCP concepts, various management measures have been suggested.

CHAPTER 2

DATA AND METHODOLOGY

The study was mainly based on the primary data collected from seafood factories and specific experiments and observations conducted in selected factories. The primary data required for the study were collected from the various divisions of the seafood processing factories in Kerala. The secondary data from various sources like Marine Products Exports Development Authority (MPEDA), Cochin; Central Institute of Fisheries Technology (CIFT), Cochin; Central Marine Fisheries Research Institute (CMFRI), Cochin and other fisheries organisations were also made use of for this study.

There were 120 seafood processing factories in Kerala during 1995-96 period. The list of processing factories provided by Marine Products Export Development Authority, Cochin was made use of for this study. 60% of the processing (Block freezing and Individually Quick Freezing) factories during the study period were located in Cochin Region and 20% in Quilon Region. Only the remaining were located in few other localities like Alleppey, Calicut and Cannanore. This region wise classification is based on the study of Indian Institute of Management (Anon,1984). Stratified Random Sampling Technique was used for selecting the processing factories for the study. Twenty (20% of the total seafood factories in Cochin region) processing factories from Cochin and four (20% of the seafood factories located in Quilon region) factories from Quilon region were selected for collecting primary data for the study. Among the factories thus selected, eight from Cochin Region and one from Quilon Region were having facilities for Individually Quick Freezing (IQF) and block freezing. The other factories included twelve block freezing factories from Cochin region and three block freezing factories from Quilon region. During 1997-98 ten seafood processing factories in Kerala were approved by European Commission (EC) for exporting to Europe. Out of these ten factories, two factories (20%) were again selected for comparison with other factories. Since all the factories in Kerala follow similar types of processing methods, this sample size selected gives a good representative picture of the seafood processing (freezing) factories in Kerala.

The primary data regarding the various inputs, layout, quality control of raw material purchased, quality control of manufacturing processes, present quality control system followed in seafood processing, major markets, organisational design and structure, human factor analysis, quality costs and general aspects of the production in the selected factories in Kerala were collected through pre-tested questionnaires (Appendix-I and Appendix-II). The data which could not be collected through the questionnaires were collected by personal discussion with the concerned authorities and from the records and registers maintained in the various divisions of the selected factories.

Out of the 24 factories (20% of the total), 10 factories were further selected at random for detailed study on organisational design and structure, leadership style, communication, human factor analysis and motivational aspects. In addition to this, the following specific studies were also carried out.

1. Layout studies

2. Process control and production details of important IQF and block frozen products.
3. Method analysis and Work Measurement of IQF Products.
4. Bacteriological quality of the raw materials and in-process materials at different work stations including at Critical Control Points (CCP) of important IQF products.
5. Swabs from different workstations were analysed for Total Bacterial Counts (TBC) to ascertain the sanitary condition and hygiene practices followed in the factories.
6. Bacteriological Quality of the water used in the factories.
7. Experiments on the standardisation of Sodium tripolyphosphate (STPP) treatment.

Source of data, materials and methods used for the above mentioned specific studies varied with the studies and are described in detail under the respective chapters for the sake of convenience and to avoid repetition.

Some sensitive information like those pertaining to the quality cost , rejection, etc., could not be collected from all the factories selected due to the unwillingness on the part of the management to part with those details. Similarly experiments on microbiological assessments of the products, swabs and water quality were carried out only in factories were permission was granted for the study. Work Measurement of the IQF products was carried out in factories where sufficient quantity of a particular product was produced. Some of the factories were found to have very little production to apply Work-Study.

The data were statistically analysed based on standard statistical procedure described by Dixon and Frank (1983).

CHAPTER 3

INPUT ANALYSIS

1. Introduction

Facility available in any industry is termed as input. Every kind of production requires physical facilities in the form of building, machine and equipment (Moore and Hendrick, 1978). These facilities should be located advantageously, considering the sources of company's physical inputs, such as material, labour, and other costs. Inputs such as labour, land, capital, or management resources are changed by a conversion process into goods or services (Adam and Ebert, 1995 ; Moore and Hendrick, 1978).

Inputs into any particular production or manufacturing system can be identified generally as direct and indirect inputs. The direct or visible inputs include capital in the form of plant, premises, machinery, and labour force. Apart from that one of the most important aspects which goes indirectly into selection of these direct factors is the 'decision' or 'thinking' aspect which ultimately determines the performance of the whole system.

Capacity is the rate of productive capability of a facility and productivity is a ratio of outputs to inputs. Total Factor Productivity is the ratio of outputs to the total inputs of labour, capital, material and energy. Productivity can also be termed on the basis of Partial Factors. Adam and Ebert (1995) described Partial Factor Productivity as the ratio of outputs to one, two, or three of these inputs.

The human element is the most important input in any factory, which is most difficult to control. This factor operates at all levels, from the lowest worker who actually produces the goods by use of manual efforts, right to the chief executive who controls the whole complex system (Lal, 1990).

Seafood processing industries in Kerala is still highly labour intensive. Ramachandran (1988) while discussing on the availability of labour pattern of the sea food industry in Kerala also observed the same trend. Ample supply of efficient employees is essential for any factory. But in most of the cases the lack of skilled labour is a major problem, so a lot of quality loss and energy wastage is accompanied. Most factories expect to train new employees because jobs are so varied and so highly specialised that a company will never find very many new employees who already know how to do most of its jobs. An effective new labour force cannot be recruited quickly. When a factory moves into a new community, it will take time to build up a good work force. In fact, it is better to build up employment slowly and thus not to have to hire too many marginal people (Moore and Hendrick, 1978).

As per Good Manufacturing Practices (GMP) any worker who is having contagious disease, open wound or who is a carrier of pathogenic organism shall not be allowed to work in any of the food handling areas. A medical certificate, clearly showing that the personnel working in the food handling area are fit to work in food processing plant and they are not carriers of pathogenic organisms is essential (Anon, 1995a).

The management of production includes providing and maintaining the building and services needed to house and serve the people and machines used to make products and provide services. Productive facilities should be flexible and easily adaptable to make changes in operations. Built-in-flexibility is the best way to make changes easily. The plant is also designed to appeal employees, with higher motivation and productivity being the objective. Campus type factories have a pleasant, leisurely feeling, but they need ample ground space and they are expensive to build. This kind of plant is best suited for light, heavily engineered products (Moore and Hendrick, 1978).

According to Zugarramurdi *et al.* (1995), market information is necessary to define production level, type of products, required technology, type of packaging, etc. Three markets are involved in a distribution system, market for inputs, for fresh fish, including intermediate products, and for final products. In the first market, variable inputs such as ice, bait, labour and fixed input such as fishing gear and engines are brought by fisherman, who convert them into fishing effort, which result in a quantity of landed fish. The fishermen's demand for inputs such as ice and bait is derived from the anticipated sale of fish.

2. Materials and methods

The primary data required for the study were collected from the seafood processing factories in Kerala through a pre-tested questionnaire (Appendix-1). The details regarding the sampling, sample size and the analytical methods are described under the Chapter 2 on Data and Methodology. The secondary data required for the study were collected from Marine Products Export Development Authority and other Governmental Agencies as described in Chapter 2.

Human resource in the seafood factories in Kerala is the most important and decisive input as the seafood industry in Kerala is highly labour intensive and the people working there have to play a great role in the successful implementation of the proposed quality management system. For this reason the details of the study on Organisational Structure and Human Factor Analysis have been reported under separate chapters (Chapter 7 and 8). The methodology adopted for these studies have been incorporated in these respective chapters.

Layout design and positioning of the various equipments and facilities are other important areas to be looked into for the efficient functioning of the seafood factories and the methodology of the study on layout and its results and discussion have been discussed in detail in Chapter 4.

3. Results and Discussion

3.1.Plant and surroundings

22% of the factories studied in Kerala were established either in the early period of the introductory stage of seafood freezing industry in India or in the late1970's. 52 % of the seafood factories were established between the late1970's and late 1980's. 26% of the factories were established after 1980s. As far as the sizes of the factories were concerned 42% of the factories were small-scale factories, 38% were medium-scale and 19% large-scale. The small-scale factories were mainly proprietary concerns and medium-scale factories partnership concerns. The large-scale companies were mainly public limited companies and were of recent origin. The factories had one or more units or branches. 38% of the factories had only one sister unit, 4% of the factories had two sister units, 13% had three sister units and 22% had four sister units, and the remaining had no sister units at all. 90% of the seafood processing factories had area for the future expansion of the buildings. 30% of the factories had collaboration with international markets like USA, Japan and Saudi Arabia.

3.2. Buildings, Machines and Equipment

A factory is constructed with a layout to facilitate easy production flow and to avoid cross contamination. The Chapter 4 gives details of the layout facilities available in the seafood processing factories in Kerala.

All seafood processing factories studied in Kerala had adequate facilities of raw material receiving, processing, freezing, frozen storage and personnel hygiene. 50% of the seafood processing factories had the facilities for peeling or pre-processing. This is mandatory according to the EC Directive (Anon, 1991c). All seafood processing factories had a separate raw material receiving division. There were different types of equipment or machinery commonly used in the raw material receiving division of seafood factories. They were weighing balance, ice crusher, squid ring cutting machine, squid washing machine, shrimp grading machine, squid agitator and filth washing machine for shrimp. 20% of the factories use computers in this division. Larusson *et al.* (1991) emphasised the application of computer vision to evaluate the seafood quality. Other utensils such as stainless steel nets, plastic crates, plastic tubs, plastic boxes, basins, etc., were also used in this division. 70% of the pre-processing centres were having cemented floorings and asbestos roofing. In the remaining factories the roofing was made of reinforced concrete and flooring with mosaic tiles. The wall of the pre-processing division of all factories studied were cement plastered and doors were all made of wood except 30% of the factories where they were made of other materials. There were different types of equipment or machinery used in this division for pre-processing. The commonly used equipment or machines were filth washing machine, weighing balance, insectocutor, ice crusher, shrimp grading machine, water filter, etc. and utensils used in this division were stainless steel nets, tubs, plastic boxes, plastic crates, plastic trays, seaplast (insulated), etc. Figure 1 shows the number of tables used in peeling or pre-processing division of the seafood processing factories in Kerala. 14 % of the factories had 2-4 tables, 14% of the factories had 5-8 tables, 36% of the factories had 9-12 tables, and other 36% of the factories had above 12 tables. 77% of the factories had a capacity of less than 5 tonnes/day in the peeling/ pre-processing division and 23% had 5-10 tonnes/ day. Anon (1995a) has prescribed that the entire processing area shall have proper drainage facility so as to prevent contamination of food by seepage, food-born filth, or by providing a breeding place for filth. All pre-processing centres evaluated had adequate drainage facility. Type of drainage used for pre-processing centres of the seafood processing factories are described in Figure 5 of Chapter 9.

A processing factory shall have a clearly defined perimeter free from accumulation of rubbish, unused equipment to free from sanitary problem or chances of contamination (Anon, 1995a). 95% of the processing factories had adequate facilities of fly proofing, vermin and rodent control facility. All seafood processing factories had self-closing doors and hand washing and leg dipping facilities. 60 % of the factories had non-hand operable type taps. 82 % of the factories studied had facilities for washable type ceiling. Wall to wall and wall to floor joints in the factories were rounded off and free from projections to prevent accumulation of dirt and dust. All factories had adequate facilities for proper lights, adequate ventilation and are fitted with exhaust fans.

According to Anon (1995a), seafood factories shall have adequate lighting in all areas where food is examined, processed or stored and where equipment and utensils are cleaned. The hand washing area, dressing and changing rooms, locker rooms and toilet rooms are also to be properly lit. There shall be safety types of light bulbs, fixtures, skylights or other glass suspended over exposed food in any stage of preparation to protect against food contamination in case of breakage of glass. Adequate ventilation or other control mechanism to minimise odours and vapours, in area where they may contaminate food and to fix and operate fans and other air blowing equipment in a manner that minimise potential for contamination of food, food packaging material and food contacting surfaces. Wherever necessary adequate screening or other type of protection devices has to be provided against pests.

According to Anon (1991c), waterproof flooring, which is easy to clean and laid down in such a way as to facilitate the drainage of the water or provided with equipment to remove water, has to be provided. Wall and ceiling shall be easy to clean, durable and impermeable. Doors of the factory shall be made of durable material, which are easy to clean. Factory shall have adequate ventilation and, where ever necessary proper vapour extraction facilities. Factory shall have adequate facilities of artificial or natural lighting. Adequate facilities are to be provided for cleaning and disinfecting hands. In workrooms and lavatories taps must not be hand operable. These facilities must be provided with single use hand towels. Appropriate facilities for protection against pests such as insects, rodents, birds etc. have to be provided.

The equipment and machinery used in the processing division of factories in Kerala were shower washing machine, filth washing machine, drum washing machine, agitator machine for squid and cuttlefish treatment, weighing machine, ice crusher, grading machine, squid ring cutting machine and insectocutor.

The utensils used in this division were insulated tubs, plastic boxes, plastic trays, plastic crates, large tubs, and stainless steel nets. All the factories had stainless steel tables in this division. According to Anon (1995a) all the instruments and working equipments such as cutting tables, containers, conveyor belts and knives shall be made of corrosion resistant material that can be easily cleaned and disinfected. According to Zugarramurdi *et al.* (1995) an assessment must be made of all the equipment and its technical features in order to determine limitations or bottlenecks which might hinder efficient utilisation of an existing factory. This includes calculating the size and type of the different equipments and installations, and specifying construction material. According to Temri (1994), whole industry is affected by technological changes and restructuring movements, production rationalisation and automation seem to become the main requirements for competitiveness. He emphasised on the technological changes in the seafood industry and obstacles to the automation in relation to the constraints threatening the firm's production.

Different types of freezers were used in the seafood factories, namely blast freezers, plate freezers and indigenous and imported Individually Quick Freezing Freezers (refer Figure 7 of Chapter 9). The capacity and other details are given in Table 2 and Figure 8 of Chapter.9. The number of cold storages available in the factories, their capacities and other details are given in Figure 9 and 10 of Chapter 9. According to Anon (1995a) freezing equipment shall be sufficiently powerful to achieve a rapid reduction in the temperature at –40°C and frozen storage room must have a temperature-recording device kept in a place where it can be easily read.

According to Jose and Sherief (1993), the inherent problems with the ordinary glazing practice include slow freezing and clumping of the product. These, to some extend can be avoided by the use of glaze hardener, a new recruit in IQF production line of seafood industry.

There were different types of packing machines/equipments used in the seafood processing factories in Kerala. They were strapping machine, packing machine, vacuum pack, sealer, tighter, electronic balance, mutivac machine, etc. For packaging the products, packing materials such as master carton, waxed carton, baby carton, polythene sheets, and polythene bags, gar straps etc were also used. All these materials were purchased locally. Packaging materials and products liable to have any contact with fishery products must comply with all the rules of hygiene and in particular, they must not impair the organoleptic characteristics of the fishery products (Anon, 1991c). They must not be capable of transmitting to the fishery products substances harmful to human health, they must be strong enough to protect the fishery products adequately, they may be reused after cleaning and disinfecting. Adams and Otwell (1982) reported that development of a retort pouch operation for seafood could minimise the impact of rising utility and transportation costs in their marketing of energy intensive frozen or refrigerated products. Moor and Nickleson (1982) reported the effect of packing on the changes in bacterial count, temperature during shipment and suggested the use of best packaging to ensure the representative counts on seafood samples after shipment. Oberlender *et al.*(1982) discussed about controlled atmosphere packaging of fish and reported that CO_2 is effective to extend the shelf life of fish and other shellfish products. According to him inhibition of psychrotrophic, aerobic, gram negative spoilage bacteria are the main reason for improving the shelf life.

3.3. Raw material, water, electricity

The main direct inputs used in the factories were different types of fish and shellfishes as raw material, labour force, utilities, and packaging. The abundance and the regularity of supply of raw material are the most important consideration in the selection of plant location. Raw material availability, purchase pattern and its quality assurance are described in the Chapter 9.

Water is an indispensable input in all production activities and its availability can influence plant location. This influence is minimal if there is water in the required quantity and quality in the vicinity of possible sites. The percentage use of water from different sources of water in the pre-processing division in seafood processing factories in Kerala is given in Figure 3 of Chapter 9. The main sources of water were bore well and municipal/corporation supply. Water was also brought in tanker lorries during summer seasons and when the factories experience water shortage. Since this input influences the quality of ice and products being produced in the factories, detailed discussion has been given in Chapter 9 on Quality Assurance. Badonia *et al.* (1988) discussed the various quality problems associated with fish processing in Gujarat and stated that the important input which contaminate and influence the quality of the products is water available in Gujarat Region. According to them most of the samples of water collected from the seafood factories in Gujarat showed higher bacterial counts. They also reported higher values for chemical parameters than stipulated by the Pollution Control Board. According to Anon (1991c), drinking water or clear water must be used for the processing of fishery products. The Kerala State Pollution Control Board is administering the Water (Prevention and Control of Pollution) Act, 1974 and The Water (Prevention and Control of Pollution) Cess Act 1977. The Board is responsible for implementing the set standards for water used for various purposes in Kerala (Pillai, 1996). 20% of the processors reported about the acute shortage of potable water in recent years.

All seafood processing factories in Kerala had the same opinion about the availability of electricity; ie., fluctuation in the voltage and power failure was the main problem facing the seafood processors. It adversely affects the quality of the product and productivity of the factories.

The human resource is another important input in the seafood processing factories in Kerala. The organisational structure and design, leadership styles, motivation, communication, strength of the employees, age pattern, wage structure, incentive pattern, employees participation in the production process and quality improvement, etc are discussed separately in detail in Chapters 7 and 8.

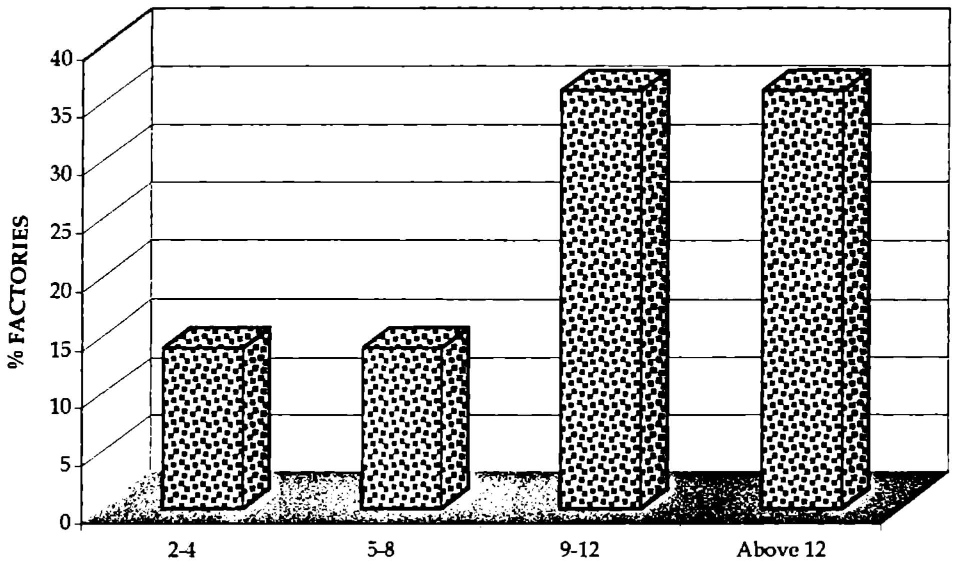


Fig 1. NUMBER OF TABLES USED IN PEELING OR PRE-PROCESSING DIVISION OF THE SEAFOOD PROCESSING FACTORIES IN KERALA (1995-96).

CHAPTER 4

LAYOUT STUDIES

1.Introduction

Layout is the spatial arrangement of physical resources used to create the product (Adam and Ebert, 1995). There are three types of lay outs: process layout, product layout and fixed position layout (Adam and Ebert, 1995). In seafood industry, process layout is common. Some factories also show combination (process and product) and product layout. Process layout is the arrangement of a facility so that work stations or departments are grouped together according to their functional type. In product layout the arrangements of facility are made in such a way that work centers or equipment are in a line to afford a specialized sequence of tasks. Fixed position lay out is the arrangement of a facility so that the product stays in one location while tools, equipments, and workers are brought as needed.

The general layout and arrangements of rooms within a processing establishment is important to minimise the risk of contamination. During the time of raw material reception the raw material get contaminated with large number of bacteria. To avoid such cross contamination of semi-processed material or finished product, the process line should be streamlined. Mayer (1975) described about the different types of process flow line. They are straight line, serpentine, U-shaped and circular. In straight-line process flow, the receiving division is at one end of the factory while packing, storing and shipment area on the other side. Serpentine pattern is having zigzag arrangements. In U-shaped and circular line, the receiving and shipment areas are nearer to each other. The straight line process flow is reported (Hayes,1985) to be most efficient to avoid cross contamination.

A clear physical segregation between high risk area (clean) and low risk area (unclean) is of prime importance. Unclean areas are those areas where raw materials are handled and often a cleaning operation is marking the point, where the process flow goes from unclean to clean areas (Huss, 1993). A clean area is defined by ICMSF (1988) as an area where any contaminant added to the product will carry over to the final product, ie., there is no subsequent processing step that will reduce or destroy contaminating microbes.

Time and temperature conditions for the products during processing are extremely important Critical Control Points (CCP) in order to prevent bacterial growth. Johney (1985) discussed the problems of fish handling at three heads, namely temperature control, rational handling within minimised time and hygienic and mechanical careful handling. A steady and uninterrupted flow of the production process is essential for the full control of this CCP. In case of any delay in the production process, the products should be kept in chilled storage (Anon, 1991c). The material should be kept in ice at a minimum possible time. The quality changes in iced storage of commercially important fishes in India have been studied by many workers (Govindan, 1971; Shenoy and James, 1972; Surendran and Iyer, 1976; Joseph *et al.*,1977; Joseph *et al.*,1980). In addition to this, Velankar *et al.* (1961) reported on the losses of extractives from prawns during ice storage due to leaching. Nair *et al.* (1962); Solanki and Venkataraman (1978); Sastry and Srikar (1985) and Surendran and Iyer (1985) have also established loss of nutrients during ice storage.

A seafood processing factory should have adequate facility for installation and storage of material, space for equipment, separation of operations that might contaminate food, lighting and ventilation and protection against pests (Troller, 1983). Walls, roofs, doors and windows of the seafood processing industry should be water, insect and rodent proof, internal walls should be smooth, corrosion and wear resistant impervious, easily cleanable and light coloured. Floor should be provided with slope to drain and resistant to disinfectant and chemicals used. Earlier workers (Troller, 1983; Imholte, 1984) have studied the technical requirements, choice of material and cost of production in food industry. Ramachandran (1988) developed a standard layout suitable for block freezing in seafood factories in Kerala. The characteristics of this layout design include

1. Reduction in holding time and handling of materials.
2. Better manpower utilisation.
3. Better utilisation of facilities.
4. Avoidance of cross contamination of products with raw materials and processing waste.
5. And reduce processing cost and wastage.

According to Lal (1990) design is the basic criterion for the creation of quality product. Unless quality is designed into the product, it cannot be achieved during manufacture. The prime aim of the designer is to create a product that will satisfy a customer's need at a price, which he is willing to pay. General consideration of a good design of seafood factory is appearance, functional efficiency, safety, reliability, maintainability, and ease of production and flexibility.

The present study aims to develop a suitable layout adaptable in the seafood industry in Kerala which helps to optimize the production by utilising all the available inputs at the most appropriate combinations and helps to implement the modern Quality Management concepts to the fullest possible extent.

2. Methodology

The primary data needed for the study were collected from 24 randomly selected seafood processing factories out of the total 120 factories in Kerala through a pre-tested questionnaire (Appendix I). In addition to this, first hand information was collected by personal observation on the material flow and by discussion with concerned authorities in these factories. Secondary data were collected from the documents maintained in the factories. (The details of materials and methods regarding sampling method, sample size, etc. are described in Chapter 2).

An improved layout (combination layout) suitable for seafood processing (IQF and Block freezing lines) factories in Kerala was developed based on the primary and secondary data. "Travel Chart or Load Path Matrix Method" as described by Moore and Hendrick (1978) was used to design the layout. The special aspects of the seafood industry as listed by Ramachandran (1988) and Huss (1993) for standardisation of the layouts in seafood factories were also taken into account while placing various work stations and for classifying risk areas.

3. Results and Discussion

The analysis of the layouts of the existing factories showed that none of the factories had a balanced layout. This had resulted in under-utilisation of some facilities in these factories. The capacity utilisation of the various facilities in the factories has been discussed in Chapter 5. Most of the factories developed their plant facilities at their will and pleasures, without taking into account the scientific principles of a proper layout. This has resulted in, excess handling and cross movement of materials and men, which in turn resulted in contamination and bottleneck in workstations. An improper layout would lead to cross movement and contamination (Huss, 1993). Ramachandran (1988) while studying on the layout of seafood plants existed in 1984-86 in Kerala also reported these problems due to faulty layouts. Such layout leads to variation in the process quality and quantity of production. These aspects have been dealt with in detail in Chapters 5 and 9.

Fifty percent of the existing factories had no peeling or pre-processing facility integrated into the system. They depended on different peeling sheds or pre-processing centers for their raw material. According to the EC Directive, (Anon, 1991c) shore facilities are classified as establishments and this means to any premises where fishery products are prepared, processed, chilled, frozen packaged or stored.

The working areas should be sufficiently big for work to be carried out under hygienic conditions. Their design and layout shall be such as to preclude contamination of the products and keep quite a separation for clean and contaminated parts of the buildings. Those factories that are intended to export products to Europe have initiated integrating pre-processing operations also into their production system.

Cold rooms are mandatory as per the EC Directive and the study showed that only 43% of the factories had cold room/chill room facility with all requirements recommended by EC (Anon,1991c). All factories had adequate number of dress changing rooms for workers. Waste disposal facility is another important aspect to be looked into. The EC Directive stipulates an efficient waste disposal system for the seafood processing factories. Only 50% of the factories studied had a satisfactory waste disposal system.

Wide variation was noticed in the arrangements of facilities and sequence of processes in different factories due the non-standard layout and inefficient arrangement for the sequence of operations. This had also resulted in the establishment of different Critical Control Points for the same products in different factories. The details of this study are discussed in Chapter 5.

According to the study, 62.51% of the seafood factories in Kerala during 1995-96 had process layout. 33.33% of the factories had a combination of process and product layouts. Only 4.16 % of the factories had product layout. Ramachandran (1988) reported that during 1984-86 period all the seafood factories in Kerala had only process layouts. The reasons cited for this were the availability of cheap and sufficient labour, vast variations in fish landings of a particular species of fish, variation in the fish availability during different seasons and insufficient landing of a particular species throughout the year. This in turn hindered processors from establishing specific product line for each product due to economic reasons. Other reasons cited lack of indigenous product line machinery and most of the products produced at that time were industrial products. But the present study showed that 37.5% of the seafood factories had modern IQF lines. This was all established after the middle of 1980s with the change in the export-import policy of the Govt. of India. Some of the latest additions to the IQF lines are imported, fully automatic product lines. Most of the indigenously fabricated IQF lines had combination layouts with some of the activities carried out manually and some automatically. Study revealed that with the development of IQF lines, a combination layout is best suitable for seafood industry in Kerala due to the following reasons:

1. Raw material available in the seafood factories in Kerala is multi-species and multi-size during different seasons, ie., consistency of species and size are lacking which results in uneconomic utilisation of the product line facility.
2. Labour in Kerala is comparatively cheaper and easily available (detailed in Chapter 8 on human factor analysis). A fully automatic product line requires huge investment that too in foreign exchange. Since the product lines are product specific, it may not be possible for the processors to use it in all seasons due to the seasonality in the availability of a specific species and size of raw material to be fed to the product line.

3. Combination layout is flexible as it helps the management to use it to produce a variety of products using the same facility. Most of the machines and facility are general purpose and hence it can be used in all seasons. Capacity utilisation of flexible layouts and facilities will be higher in uncertain situations like the one experienced in the seafood industry in Kerala.

Taking into account all the above mentioned factors and the shift in the market demand from block frozen products to IQF products, an improved layout (Figure 1) has been designed to suit the conditions now prevailed in Kerala. The proposed layout has a total work area of 1900 sq. m. All the requirements mentioned in the EC Directive (Anon, 1991c) are also taken into account in this layout.

The study showed that the present level of capacity utilisation of most (50%) of the seafood processing factories in Kerala was only 5-10 tonnes per day as against the existing capacity of 20-30 tonnes per day in majority (56%) of the factories. This has been taken into account while deciding the capacity of the proposed layout. In the improved layout a 10 tonne IQF facility and 10 tonne Block freezing facility are proposed and a combination layout is designed.

The entire production facility is divided into three areas, as per the specifications of quality management (Huss, 1993).

1. High risk area
2. Risk area

3. Low risk area.

In high risk area, the cooking process and further activities of processing of IQF products are suggested and the workers of this section are not allowed to enter this area through any entrance other than the one specified for their entry to avoid contamination. In low risk area, the raw material receiving and pre-processing are concentrated. In addition to this boiling room also come under this area. All other processing areas come under the risk area mainly block freezing, pre-treatment, raw material feeding in IQF line, cold store, packing room, etc.

High-risk area of the processing factory is clearly separated from the low risk and risk area to avoid any cross contamination of the cooked material with raw material. In addition to this, the movement of men and any other material from low risk area to high-risk area is completely prohibited in this improved lay out. Huss (1993) reported the requirement of a clear physical segregation between clean and unclean area. The process flow is suggested from an unclean area to clean area and not in the reverse direction.

Individually Quick Freezing line in the proposed layout is mainly oriented on specific products whereas the block freezing line is meant to maximise the resource utilisation during different seasons. In block freezing cum Individually Quick Freezing factory as proposed in the improved layout (combination layout), the idle capacity if any in the block freezing section can be effectively utilised in freezing the raw materials meant for the IQF line at the time of peak landings. These frozen blocks can be used as the raw material of IQF line during slack season.

3.1. Work stations in proposed layout

3.1.1. Low risk area

3.1.1.1. Raw material receiving station

Raw material receiving station is the first station in this improved layout. Raw material received from the landing centres and suppliers, is washed and weighed at this station. The quality of the material is also checked before washing the raw material. If the material quality is not up to the standard, the material is rejected other wise accepted. Then it is iced in the ratio 1:2 (fish to ice). The material is then kept ready at this station lot wise. Raw material coding has to be done at this stage to mark the lot number, species, grade, time of arrival, date, time of icing, quantity of material, etc. This station must be provided with platform balance for weighing the material, water facility for washing the raw material and crushed or flake ice.

3.1.1.2.Pre-processing section

Lot wise material is taken from the raw material receiving station for pre-processing. At the entrance of this room, a sanitizing zone is proposed for the purpose of following hygienic practices before entering this division. The raw material is pre-processed or peeled in this division and washed for the purpose of removing unwanted parts, and other foreign materials. Drinking water must be used for the purpose of washing the raw material (91/493/EEC). Washing the raw material caused 52-98% reduction in the Total Bacterial Count (Thampuran, 1988). After the completion of pre-processing of each lot, floor, table, and utensils used for pre-processing must be washed for preventing the cross contamination. Grading, sorting, quality checking etc., are also done here. Then material is to be iced in plastic boxes and kept in the chilled storage. Standardised plastic boxes must be used for storing the material, because it helps in directly taking the material in trolleys from one work station to another without further transferring or human handling (Ramachandran, 1988). 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.

3.1.1.3. Raw material Passage

The raw material used for block freezing is passed through a material passage suggested on the wall in-between the pre-processing station and processing hall at one end of the pre-processing division. After emptying, the box is taken back through the raw material passage section and it is washed and stored there.

3.1.1.4. Cold room or Chill room / temporary storage of raw material

The pre-processed material after proper washing and icing is temporarily stored in chill room. Chill room or cold room is mandatory as per the EC Directive (Anon, 1991c). A small material passage is provided on the wall between the chill room and the processing hall at one side of it to move the material required for Individually Quick Freezing. Chill room in the layout is placed in-between the pre-processing section and ice storage room. This helps to reduce the material handling and movement considerably. Since the ice plant and ice storage sections are placed close to the cold room, it is easy to bring crushed or flake ice to this room.

3.1.1.5. Ice storage/ Ice crushing station

Ice storage / Ice crushing station is situated in between ice plant and chilled storage. This helps in unloading the ice produced in the ice plant directly at this station by a chute. If block ice is manufactured, the station should have the provision to crush the ice to the required size. If flake-icing unit is installed, this station can be used directly to store the flake ice. Since it is located between ice plant and cold room, handling of ice is kept at a minimum. A door is also provided towards outside from this station which helps the ice to be taken in insulated trucks for the collection of raw materials from fishing harbours or landing centres. This also helps the crushed or flaked ice to be taken to the raw material receiving station.

3.1.1.6. Ice plant

The need of an ice plant of 20 tonnes (calculated for block ice) capacity is suggested in this layout. Alternately flake ice unit of similar capacity can be installed here instead of block ice. Flake ice is more effective as a chilling medium for fish as it has more surface area for contact with fish. This is considered as an optimum capacity for the ice plant taking into account the seasonality of the industry. With this capacity there will be shortage of ice only during peak season which can be compensated at lower cost by procuring it from outside. Since the ice plant is placed adjacent to the ice storage room and processing hall, it is easy to transport the ice to these workstations. In the case of processing hall for IQF line, ice can be taken directly to the processing site by providing a chute between the ice storing room and processing hall without any human movements or handling.

3.1.1.7. Boiler

This is provided for steam cooking in IQF line and it is situated nearer to the cooking chamber of the IQF line. Placement of the boiler close to the cooking chamber reduces the cost of installation and pipes required for drawing the steam to the cooking site.

3.1.2. High risk area

Workers of the Individually Quick Freezing section are advised to enter only through the hygienic facilities provided in the clean room (9). The room has provision for the workers to change their dress. It is also provided with a sanitation section. Before entering into the cooking area a windscreen is also placed at the entrance of this room. The workers of the cooking area have to enter and exit through this clean room of the factory. Main activities expected in this area (IQF Line) are cooking, chilling, freezing, glazing, glazo freezing and packing. A "U" shaped flow process is suggested in this line of production. To avoid cross contamination with the semi-processed material or finished product with the raw material, a straight line or "U" shape process flow is most efficient (Hayes, 1985). Pre-cooking stage such as treatment and raw material feeding section (section-12) were clearly separated from the cooking section by glass paneling. A clear separation or physical segregation between high risk area (clean) and low risk area (unclean) is of prime importance.

Processed food is then packed and stored in the cold storage through ante-room. Ante-room and cold store with a capacity of 150 tonnes for the IQF products were separately designed in this layout for preventing cross contamination with block frozen products. Packing of the processed food is desirable to be carried out in the ante-room. Side of the anteroom has a shipment chute for the exit of the material for shipment. Provision of the chute to carry the materials rather than a door for shipment helps in reducing the temperature fluctuations in the cold store and in the products. This will also reduce excess handling and movement of men and materials. Moore and Hendrick (1978) also reported that if handling and movement of the material is minimum, it will help in reducing the possibility of cross contamination, minimisation of cost of production and better utilisation of facilities.

A quality assurance section is suggested in this section for effective process control under HACCP system. Machine cum generator room is placed next to the IQF facility and cold store to reduce cost of installation of cooling system. Pre-cooking stage such as treatment, raw material feeding, quality assurance section, hygienic facility for clean room, machine cum generator room, cold store and ante-room fall under the category of risk area.

3.1.3.Risk area

This area is earmarked mainly for processing of block frozen products. The raw material used for block freezing is taken in plastic boxes from pre-processing hall through the material passage provided in the wall between the pre-processing hall and the processing hall. This will help preventing unwanted handling and human movements. Once emptied, these boxes can be taken out for cleaning through the raw material passage provided in the layout. In block freezing process also, the flow is "U" shaped. Here also workers entry is recommended only through a hygiene and sanitation zone to reduce contamination. A dress changing facility is provided here. Two 'ninety minutes' freezers with a capacity of 5 tonnes each /day are suggested for block freezing. Once frozen, the semi-finished material can be packed in a separate site provided for the purpose. A separate ante-room and store with 150 tonnes capacity are provided for block frozen products.

3.1.3.1. Packaging section

Packaging of IQF and block frozen products are done in separate packing sections, (packing section 14 for IQF products and packing section 15 for block frozen products). An automatic packing machine is suggested for IQF and an automatic master carton sealing machine for block products. This can reduce exposing the frozen materials at higher temperature for a longer time. In the case of IQF products, any delay in packing after freezing leads to clubbing of the materials. In the case of frozen blocks, it leads to deformation of the blocks affecting consumer appeal. Ramachandran (1988) reported that manual master cartoning and sealing are tedious, labour intensive and affects the quality of the products due to rough handling, non-uniformity and delay in sealing. The machine helps in retaining the shape of frozen blocks as well as master cartons. It reduces wastage of strap and requires only little space. Packaging sections of the IQF line and block frozen line are situated nearer to the ante-room and cold store of the respective lines.

3.1.3.2. Cold Stores

There are two cold stores suggested in this layout, one for IQF line and other for block frozen line. Both are designed to have a capacity of 150 tonnes. This is sufficient to carry the entire production in full capacity for 15 days. This particular capacity is suggested to absorb the normal lead-time of 10 to 15 days for shipment from Cochin Port. The cold store is recommended to be maintained at a temperature of $-18^{o}C$ or below. EC Directive also recommended the same temperature for maintaining the temperature of cold store (Anon, 1991c). From the study of the storage capacity of the existing processing factories, it is found that capacity of the processing factories were not enough and they were depended on outside stores for keeping the finished products. More details on these aspects have been discussed in Chapter 9. Ramachandran (1988) reported that doors of the cold storage of the seafood factories existed during 1984-86 period were big and while opening for stocking or unloading the products led to considerable loss of coolness in the stores.

To prevent temperature fluctuation he suggested a mini door to be fixed at the centre of the main door. For shipment, the material can be taken from the cold store through this mini door instead of the main door. In the proposed layout a shipment chute is provided in the ante-room of the cold stores for transporting the products during shipment to containers.

3.1.4. Movement of the material / semi-processed material in the IQF and block frozen section of the processing factory

Raw materials enter into the factory at the raw material receiving section. Then quality of the material is checked, after that, the material is washed, weighed, and iced. Iced material is kept ready lot wise for pre-processing. Later it is taken to the pre- processing hall for pre-processing. The pre-processed material is then taken for block freezing through the material passage provided on the wall between the pre-processing section and processing hall or it is kept temporarily in the chilled storage. If the material is taken for block freezing, the material is processed for freezing and then frozen in plate freezer and packed. The packing materials are taken from the packing material store provided close by for block frozen line. Then the packed material is stored in the cold store.

In the case of IQF, the pre-processed material is taken to the processing hall from the chilled storage through the material passage provided between the chill room and the processing hall. This arrangement considerably reduce human handling and human movements for transporting the material. The pre-processed material after chemical treatment is fed into the feeder of the IQF line. Fed material is then cooked, chilled, frozen, glazed and then glaze hardened. This glaze hardened material is packed in the packing machine. It is recommended to have a fully automatic line at this section to maintain high quality for the product. The packing materials required for the IQF production can be stored in the packing material store provided closed to IQF line. The packed IQF material can be further stored in the cold store provided separately for the purpose. For shipment, the material can be taken through the shipment chute of the ante-room. This helps in maintaining the temperature in the cold store. Since the cooking area is clearly separated from the raw material section by glass paneling this will avoid cross contamination of the in-process material with raw materials.

CHAPTER 5

PROCESS CONTROL

1. Introduction

The production of good quality product is the ultimate aim of any industry. The quality is very often determined by end product inspection. But actually the process that produces the product is the deciding factor. As in any other organisation, a seafood factory is also a conglomeration of so many small sections or departments, where the raw material is processed. The work process at each step has to be controlled and production system should be improved to meet the quality of the product.

Production is the resultant of "flow of activities" and when production is designed as per an "order" they are said to be in "control". When a series of activities are going on in a controlled and systematic way there is said to be a rate of flow for production or the process control is established. The process control can begin with the decision taken for manufacture of a particular product with prescribed specifications. An effective process control involves detection, analysis, correction, feed back and corrective action (Lal, 1990). Aptly, the process control is defined not merely choosing results but paying attention to the process, controlling this and improving the working systems and methods (Hosotani, 1996).

Besides the process planning, which includes the machinery and schemes of production of the product, the quality of the initial raw material, which gets transformed into a final product, as well as the quality of the product is important in process control. It is the integrated effect of man, machine and material that decides the product quality.

The process capability - both over-capability and under-capability, selecting appropriate process of production, regulating mechanical, electrical and environmental changes so as to optimise the product quality and in process control system are all important in the effective process control. Quality is actually built into the product during its production process. The production of a product needs a host of activities involving different departments of the factory, having the common aim of achieving required quality and quantity targets. All processes are subjected to various influences such as mechanical, electrical and environmental changes, which deviate the process from its initial settings (Lal, 1990). The process control aims to regulate the process to counteract these changes, so that process quality remains within the acceptable limit. A process going out of control may result in the production of a large number of defective pieces. For the process control, all organisations must have a flow process chart for each product. This is in fact the backbone of HACCP, which is now the mandatory quality control system for the seafood industry in India, and a number of other countries. Ramachandran *et al.* (1992) gave a detailed account of the process control parameters to be monitored in seafood freezing units for improving the productivity and quality of the products. Status of quality control system in India, International quality standards and Total Quality Management are discussed in detail in Chapter 1.

With lots of quality standards adopted world-wide the point of importance at the moment is to find out which system is most suitable for the efficient functioning of seafood industry in India. In this chapter an attempt has been made to find out the variation in the existing arrangements of facilities and sequence of processes of Individually Quick Frozen and block frozen products in order to measure the adaptability of introducing TQM principles in the industry. Attempts have also been made to develop standardised flow charts and identify CCPs for important IQF and block frozen products for effective process control as envisaged under the HACCP Concept.

2. Materials and Methods

The primary data required for the study of process control and production were collected from the seafood processing factories in Kerala through a pre-tested questionnaire (Appendix 1). The methodology of the sampling of the processing factories and sample size selected for the study is described in Chapter 2.

For a detailed study on the process control in seafood factories, five factories in Cochin region were selected at random. Out of the five factories selected for the study, two were having block freezing lines and three IQF (Individually Quick Freezing) lines. Methodology described by Kanji and Asher (1995) were used for analysing the sequence of operations and process flow charts. Their method was also used to standardise the process flow and for preparing the standard material flow charts. The procedure described by Huss (1993) was used to identify and establish CCPs for the production of various products under standard conditions.

Wide variations were noticed in the Sodium tripolyphosphate (STPP) treatment process in the factories as far as the concentration of STPP to salt and duration of treatment are concerned. Since it is a very critical step, which affects the quality and yield of the products, a separate experiment was conducted on the weight gain in shrimp during treatment with STPP. Peeled and undeveined *Parapenaeopsis stylifera* meat of 80/120 count was used for the study. STPP and salt in the concentrations of 2:1, 2:2, 3:1, and 4:1 were used for dip treatment for different durations of 1 h, 2 h, 3 h and 4 hours. Experiment was also conducted with STPP: salt concentration of 2:1 with continuous stirring to find out the effect of stirring on the weight gain. In all the experiments temperature of the iced water was kept very low to prevent any spoilage.

For a detailed study on the production pattern in processing factories, three factories in Cochin were selected at random - two factories having IQF facility and one having block freezing facility. The data on the production of Individually Quick Frozen and block frozen products were collected from these factories on 5th, 10th, 15th, 20th, 25th and 30th of every month for a period of two years during 1995-97.

3. Results and Discussion

Study shows that arrangements of facilities and sequencing of processing were having wide variation in different factories. Similar variation is also noticed in the CCPs established in different factories. Figure 1 shows comparison of the flow charts for the production of the same product, namely block frozen peeled and undeviened (PUD) shrimp, with CCPs in two different factories in Kerala. It is clear that there was no standardisation of the production methods and in the establishment of CCPs in these factories. In Factory 1, two CCPs were identified and established by the management in the processing of block frozen PUD shrimp but in the case of Factory 2 only one CCP was identified and established and that too only at the receiving activity. HACCP system gives a systematic approach to identify and monitor possible sources of microbiological, chemical and physical contamination in the seafood processing industry and to control the potential safety hazards (Lee, 1991; Suwanrangsi, 1992; Ramos, 1993; Anon, 1994a; Price, 1995; Huss, 1993). But this type of faulty identification of CCPs will defeat the very purpose of process control.

Figure 2 shows the standardised flow chart recommended for the production of block frozen PUD shrimp under the conditions prevailing in the seafood factories in Kerala and with its suggested CCPs. The raw material is to be received under the standardised process flow chart only in the form of head-on shrimp. This is as per the EC Directive (Anon,1991c) and the instructions given by the EC Team who visited various seafood establishments in Kerala in 1997 regarding the integrated processing units. This was based on their observation on the peeling sheds and centres maintained separately from the processing factories without proper sanitary conditions. The raw material receiving activity is considered as a CCP. Hazard at this stage is the substandard and contaminated raw material entering the processing hall and its preventive measure is to ensure reliable source and sensory evaluation (Huss, 1993). Freezing is another CCP. The hazard envisaged at this activity involves chemical/autolytic spoilage and its preventive measures are the control of time and temperature. If the material is not properly frozen, survival of pathogenic bacteria during freezing is common. George (1985) found that 99% of the viable count of bacteria was destroyed by freezing and subsequent storage for a period of 44 weeks. She also reported that the pathogenic bacteria like *E.coli* and Feacal *Streptococci* were completely destroyed during freezing and subsequent frozen storage. Thampuran (1988) reported drastic reduction in bacterial counts during freezing and subsequent storage. She reported 70-80% reduction in the Total Bacterial Count (TBC) during freezing at –40°C. Licciardello (1990) studied the effect of freezing and frozen storage on bacterial count and reported that freezing may destroy 50 – 90% of the bacterial count on fish and during frozen storage there is continued slow steady die off of the bacteria. The rate of decrease in bacterial count during freezing and frozen storage is reported to be dependent on the temperature and bacterial species. Iyer and Srivastava (1989) conducted studies on the incidence of low temperature survival of *Salmonella* in fishery products and reported that all the serotypes of *Salmonella* tested were resistant to freezing at –40^{0}C. He also reported that during subsequent storage at –20 °C, there was some difference between the serotypes with regard to their viability.

Reily and Hackney (1982) reported the survival of *Vibrio cholerae* in frozen and refrigerated storage.

Figure 3 shows comparison of flow charts and CCPs of the block frozen peeled and deveined (PD) shrimp in two factories. In this case also wide variation was noticed in the processing steps and in the establishment of CCPs. CCPs of Factory 1 were raw material receiving and freezing and CCPs of Factory 2 were raw material receiving, deveining and labelling. A standardised flow chart has been developed (Figure 4) for this product taking into account the conditions and facilities prevailing in the seafood factories in Kerala. CCP for this process is also suggested. The raw material receiving and freezing have been considered as CCPs as in the case of the processing of block frozen PUD shrimp.

Figure 5 showed the comparison of flow charts and CCPs of block frozen squid whole cleaned in two different factories. From the chart, it was found out that there was a wide variation in the process flow and the established CCPs. For the purpose of standardisation, a standardised flow chart (Figure 6) was developed for this product with established CCPs. The raw material receiving activity is considered as a CCP. Hazard at this stage is substandard quality of raw material entering the processing hall and its preventive measure is to ensure raw material from reliable source and proper sensory evaluation. The washing activity after the sorting of the material is recommended as another CCP because, if the cleaning and final washing is not proper, the remnants of the viscera can cause serious quality problems. Thampuran (1988) reported that washing of material leads to 52-98% reduction in the bacterial count. The study shows that due to higher concentration of heavy metals in the liver and other intestinal portions of squid and other molluscan species, the EC stipulates the complete removal of the gut as a safety measure (Anon, 1992). Freezing itself is also considered as a CCP. Its hazard is chemical/autolytic spoilage and its preventive measures include time and temperature control.

Figure 7 shows the comparison of flow charts and Critical Control Points of block frozen cuttle fish whole cleaned in two different factories. There was a wide variation in the process flow and the established CCPs. Figure 8 shows the standardised process flow chart with CCPs for the production of block frozen cuttlefish whole cleaned. The raw material reception stage is considered as a CCP. Hazard at this stage is substandard quality of raw material entering the processing hall and its preventive measure is to ensure reliable source and sensory evaluation. Washing after sorting and freezing as in the case of the production of block frozen whole cleaned squid is considered as CCPs.

Figure 9 shows the comparison of flow charts and Critical Control Points of block frozen squid tube in two different factories. Wide Variation was noticed in these two factories in the production process as well as in establishing CCPs. A standardised flow chart developed for this product with established Critical Control Points is shown in Figure 10. The CCPs recommended for this process are reception of raw material, washing and freezing.

Figure 11 shows the comparison of flow charts and CCPs of block frozen squid whole in two different factories. Variations were noticed in the process flow and CCPs in these two factories. Figure 12 shows the standardised flow chart developed for this product with established CCPs. Here the raw material reception is considered as a CCP and its hazard is substandard quality of raw material enter into the processing hall and its preventive measure is ensure reliable source and sensory evaluation as reported by Huss (1993). Another CCP recommended is the freezing activity with proper time-temperature control.

Figure 13 shows the comparison of flow charts and established CCPs of the same product, namely Individually Quick Frozen (IQF) peeled, undeveined and cooked shrimp in three different factories. From the figure, it is clear that wide variation existed in the process flow and the CCPs in the seafood factories in Kerala. In Factory 1 and Factory 3 there were two CCPs, Factory 2 had only one CCP. Another variation was that in the case of Factory 1 the CCPs were raw material receiving and cooking where as in the case of Factory 3 they were cooking and freezing. For the purpose of standardisation, a standardised flow chart for the product is developed with suggested CCPs as shown in Figure 14. Since raw material reception is a very crucial activity, it is considered as a CCP.

The treatment process in the production of IQF product is very significant and it requires effective control. Sherief and Kumar (1994) discussed the application of phosphate in food preservation and for maintaining product quality.The chemicals used for the treatment in the factories in Kerala were sodium tripolyphosphate (STPP) and common salt. It was observed that no standard concentration or ratio was maintained for treatment of shrimp meat in the factories in Kerala. There was a general impression that higher the concentration of STPP higher would be the weight gain or weight retention. The duration of the treatment also was found to vary from half an hour to 8 hours in some factories. The higher concentration of the chemical will deteriorate the quality of the product in addition to adding cost to the production. Similarly longer duration of treatment will result in loss of water soluble and salt soluble proteins and other nutrients. Hudak *et al.* (1991) has studied the economic fraud taking place in seafood industry as a part of his observations carried out under Model Seafood Surveillance Project (MSSP) to design a new mandatory seafood inspection system based upon the Hazard Analysis Critical Control Point concept. The prevalence of fraud, along with the cost to the consumer, was estimated and placed in proper perspective with other hazards to be controlled in the new system. During the conduct of the MSSP testing, team evaluators made observations related to economic fraud such as shrimp soaked in a phosphate solution (to enhance moisture absorption) for more than 12 hours; shrimp double soaked, ie. soaked in phosphate solution, removed and soaked again; and scallops soaked in a phosphate solution for more than 24 hours, resulting in not only water absorption but an increase in count size as well.

In order to standardise the treatment process, treatment experiments were carried out as described under the materials and methods. The result of the study is given in Figure 15. The maximum weight gain of about 25% was noticed in one hour in shrimp meat dipped in the STPP to salt concentration of 2:1(% w/w) with continuous stirring. In the case of treatment with 3:1 (STPP:salt) solution, the weight gain was only 20% in the first hour and the maximum gain was noticed on the fourth hour. The treatment with 4:1 concentration had the least gain in weight. The treatment with 2:1 solution was having higher weight gain in the first hour itself and it declined gradually on continuing the treatment process. From the study it was found that the concentration of STPP and salt in the ratio of 2:1 (% w/w) and treatment duration of one hour with continuous stirring is the most effective. However, the treatment in the same ratio for the same duration without stirring is also equally good and this method is recommended in the seafood factories as this is more convenient for the factories when they handle huge quantity of raw material.

The cooking step in this process is considered as the CCP, the hazard is the attack of spoilage bacteria due to improper cooking and variation in yield due to variation in cooking time. Time and temperature control is the remedy. The next activity, ie. chilling is also considered as a CCP. The hazard is growth of spoilage bacteria due to poor quality of water and ice used for chilling and time and temperature control. Huss (1993) also reported the same hazards and remedial measures at this activity. Freezing is the last CCP recommended in this process. Its hazard is expected to be the same as in the block frozen products processing, ie. chemical/autolytic spoilage and its preventive measures involve time and temperature control as reported by Huss (1993).

Figure 16 shows the comparison of flow charts of Individually Quick Frozen peeled, deveined and cooked shrimp and established CCPs in three different factories. The study showed that these factories had wide variation in the process flow and the established CCPs. In Factory 1 the CCPs were raw material receiving and cooking whereas in Factory 3 the CCPs were cooking and freezing. But in the case of Factory 2, only cooking was considered as CCP. For the purpose of standardisation, standardised flow chart for the product was prepared and with suggested Critical Control Points (Figure17). The CCPs recommended in the case of the production of IQF peeled and undeveined shrimp is considered to be equally applicable to this product also.

3.1. Production

There was regular production in 86% of the factories studied, 56.25% of the factories had >20-30 tonnes capacity/ day, 37.5% of the factories had >10-20 tonnes capacity / day and 6.25% had a capacity of above 30 tonnes/day. Figure 18 shows the average daily freezing capacity utilisation in seafood factories having different installed capacities. None of the factories had full capacity utilisation. The factories having an installed freezing capacity of >5-10 tonnes/day were found to have the best capacity utilisation among all the factories studied. The average capacity utilisation of these factories was 50%. The capacity utilisation of the factories having an installed freezing capacity of upto 5 tonnes/ day is 20%. The capacity utilisation of the factories having installed capacity above 15 tonnes/day was very poor. Iyer *et al.* (1982) reported that idle capacity of the seafood processing factories in India during 1978 and 1979 was about 70% and this was mainly due to non availability of raw material, high cost of production, shortage of power, scarcity of ice and potable water. Other reason reported by him was frequent labour trouble. Ramachandran (1988) reported that capacity utilisation of freezing plant in Kerala varies from nil to 45% and the reasons in addition to the ones mentioned above were reported to be the lack of knowledge and insufficient information about the various resources which could be processed in the existing process lines.

Figure 19 shows the percentage number of factories showing loss of raw materials and finished goods due to different reasons. 40% of the factories had 2% loss of raw material and finished products due to the spoilage, discolouration, broken and damage or rejection. 33 % of the factories had 2-5% loss and 27% of the factories had above 5% loss due to the same reasons. There were different methods used for fixing the priority for taking the raw material for processing. Figure 20 shows the priority order for processing of raw materials. 48 % of the factories used first-in-first-out method, 22% of the factories used first worked out on with high value items and 13% depended on the expiry of buyer's order. 9% of the factories schedule the priority for processing according to the quality of the incoming raw material. Ramachandran (1994) developed a simple priority rule for processing plants in India.

Study on the production pattern of the selected factories showed very high fluctuation in block as well as IQF products. Figure 21 shows the average daily production of total block frozen products in three factories (Factories 1,2 and 3) during 1995-97. No factory achieved full capacity utilisation in any month during the study period. Block frozen production capacities of Factory 1, Factory 2 and Factory 3 were 14 tones/day, 18.5 tones/day and 20 tones/day respectively. Wide fluctuation in production during all the months was also noticed. The main reasons noticed for this fluctuation in production and under utilisation of capacity were raw material shortages, seasonality of fish landings, and trade restrictions imposed by some of the major buyers like EC and the US. The working capital shortage was also observed to be a contributing factor. Ramachandran (1988) reported raw material shortage and seasonality are the main reasons for fluctuations in production and lower capacity utilisation in factories in Kerala during 1984-86. Kume (1996) pointed out the shift in consumer demand towards high quality. Gopakumar (1993) suggested some measures to improve this situation by producing value-added products. Severe competition in purchase site, extra payment given to the fish suppliers by factories producing value added products reduced the opportunity of the conventional factories from obtaining raw materials. The uncontrolled expansion of the processing capacities in some factories and uncontrolled increase in the number of processing units were also the reasons for the poor overall performance of the industry. Ramachandran (1988) reported the existence of 90 factories during 1984-86 period whereas now it has gone upto 120.

Among the factories selected for the study, two of them in Cochin region obtained EC approval at the final stage of the study period. The Figure 22 and 23 show the pattern of daily production in the seafood factories approved by EC for export to Europe from Cochin region after they obtained EC approval. These factories had better capacity utilisation and lesser fluctuations in production when compared to other factories. Figures 22 and 23 also show the installed and EIA approved capacities in these factories. The study showed that EIA approved only a lesser capacity than the installed capacity as a measure of safety and to maintain good quality for the products. This is also to impose restrictions to misuse of the sanctioned production capacity.

Out of the three factories studied, Factory 2 and Factory 3 also had IQF facilities. The installed capacities of the IQF lines in these factories were 8 and 12 tonnes/day respectively. Figure 24 shows the average daily total production of Individually Quick Frozen products in Factory 2 and Factory 3. Production and capacity utilisation in Factory 2 was better than those in Factory 3. Factory 3 showed wide fluctuation in daily production and on some days showed no production at all. The reason for low production in Factory 3 was due to lack of product diversification when compared to Factory 2. In Factory 2 they were producing 50 different products in the same line whereas in Factory 3 only 2 products were being produced. Lack of buyers' orders for the IQF products and the loss of their permanent buyers due to quality problems also contributed to their low productivity. Saralaya (1979) gives detailed account of the seafood processing and its diversification.

A detailed analysis of the production of various block frozen and IQF products produced in these factories were carried out. Figure 25 shows average daily production of block frozen peeled and undeveined shrimp in three factories during 1995-97. Maximum production of this product was in August 1995 in Factory 2 (7477 kg) but the very next month ie. in September there was no production at all. Other factories exhibited similar trend during other months. This shows the rate at which raw material availability fluctuates in the seafood factories in Kerala. In some months when one factory in the same locality was having peak production, namely Factory 3 in December, there was no production at all in Factory 2. This shows that raw material availability alone was not the reason for fluctuating productions in these factories. Inefficient Management Information System and inefficient raw material purchase systems might have contributed to this poor performance. 24% of the total block frozen production of Factory1 was block frozen PUD shrimp. It was 37% in Factory 2 and 45% in Factory 3.

Figure 26 shows the average daily block frozen production of peeled and deveined shrimp in three factories during 1995-96. Even though Factory I showed wide fluctuations in the average daily production, the production was better than in other two factories. During majority of the months these factories had nil production or negligible production. Out of the total block frozen production, Factory 2 and Factory 3 contributed only 3% and 1% towards block frozen PD shrimp respectively. This is mainly due to the lack of demand from the buyers and the raw material price of the PD meat (raw material price of PD meat was comparatively higher than the PUD meat, which in turn requires higher working capital for PD). Ramachandran (1988) also reported higher raw material cost for PD meat than for PUD meat.

Figure 27 shows the average daily production of block frozen Headless shrimp in three factories during 1995-97 period. Among the three factories studied Factory 3 showed better production of frozen HL shrimp with maximum production of 1373 kg during June 1996. Factory 1 and Factory 2 showed nil or very less production during the entire period of study. Their contributions were only 1% and 3% of the total block frozen production. This is mainly due to the fact that the purchase price of HL material was very high and requires immediate payment. The purchasing power of Factory 1 was the lowest and hence it could not purchase enough material due to the shortage of working capital. The confidence in handling high value products like HL shrimp to meet buyers' quality requirements was also a consideration for not producing this product. Any delay in the processing of HL shrimp will lead to shell loosening and black spot formation. This will result in heavy failure cost due to rejection at various stages of production and export. 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 control the quality of the finished product.

Figure 28 shows the average daily block frozen production of Cuttlefish Whole (CFW) in three factories during 1995-97. Maximum production of 3372 kg of block frozen CFW was noticed in Factory 3 during September 1995. Among the three factories, Factory 2 and Factory 3 showed very little or nil production on most of the months during the study period.

Cuttle Fish Fillet (CFFT) is a cuttle fish based product. Figure 29 showed the average daily block frozen production of CFFT in three factories during 1995-97. Among the three factories studied, Factory 3 showed better production during 1995-97 period and nil production in Factory 1. Maximum production of 1472 kg was noticed in Factory 3 during October 1995. This was mainly due to the higher demand for the product during this period.

Figure 30 shows the average daily block frozen production of Cuttle Fish Whole Cleaned (CFWC) in three factories during 1995-97. Maximum production of 2400 kg of block frozen CFWC production was found in Factory 3 during September 1995. Among the three factories studied Factory 3 had better production of this product. Factory 1 showed nil production during the entire period of study except December, 1996 and February 1997. A study conducted by Hotta (1982) states that

Japan is the most important market in the world for squid and cuttle fish with over 600000 tonnes live weight being used for consumption.

Figure 31 shows the average daily block frozen production of Cuttlefish Tentacles (CFTN) in three factories during 1995-97 period. This is also a cuttlefish based product. Factory I had no production at all. In the other two factories also the production was negligible with a maximum average daily production of only 178 kg in October in Factory 3. The production of CFTN depends directly on the production of Cuttlefish Fillet; it is a byproduct of the production of Cuttlefish Fillet.

The important squid based products produced in the three factories studied were squid whole, squid whole cleaned, squid tube and squid tentacles. Figure 32 shows the average daily block frozen production of Squid Whole (SQW) during 1995-97. Maximum production was observed in Factory 1 during January 1997 and it was followed by Factory 2 in October 1995. In all the three factories, production of this product was negligible on majority of the days during 1995-97. This was mainly due to the shift in demand from the block frozen whole squid to value added products like IQF squid products. Shassi and Ramachandran (1998) reported that in European markets, IQF squid and cuttlefish varieties are consumed in large quantities and value added items have very good demand in the world markets.

Figure 33 shows that average daily production of block frozen Squid Whole Cleaned (SQWC) in three factories during 1995-97. The production of this product also shows wide variation in Factories I and 3. Factory 2 did not have any production of this product except for a negligible quantity in November 1995, December 1996 and March 1997. This was mainly due to the increasing demand of value added products produced from this material as reported earlier (Gopakumar, 1993; Shassi and Ramachandran, 1998). Among the three factories, the maximum production of 2294 kg was observed in May 1996 in Factory 1 and the overall better production was observed in Factory 3.

Figure 34 shows the average daily production of block frozen Squid Tube (SQT) in three factories during 1995-97. Factory 1 showed nil production during the entire period of study and Factory 2 and Factory 3 showed nil or very little production in most of the months. Maximum production of 8766 kg was noticed in Factory 3 in May 1996. The peak production of squid and squid products coincided with the peak landings of squid in Kerala during this period. It was thesame with cuttle fish and cuttle fish products.

Figure 35 shows the average daily block frozen production of squid tentacle (SQTN) in three factories during 1995-97. Among the three factories studied the Factory 1 showed no production during the 1995-97 period. Maximum production of 452 kg was observed in Factory 3 and comparatively better production was observed in Factory 2. This was due to the fact that Factory 2 had a better production of Individually Quick Frozen squid tube and the tentacle formed a byproduct being produced from the waste of the former product. Various studies show that there is a great potential to expand the export markets for squid and cuttlefish products. The Marine Products Export Development Authority (MPEDA) received trade enquiries from potential buyers of squid and cuttlefish during its participation in Sial International Food Products Exhibition in 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. Reports shows that although this is not an enormous market, there is opportunity to expand in the coming years (Anon,1986b).

In addition to the shrimp, squid and cuttle fish based products as mentioned above, a number of other products are also being produced using the same process lines in the factories in Kerala. Other minor block frozen products produced during the study period in the factories are shown in Table 1. Figure 36 shows the average daily production of other block frozen products in three factories during 1995-97 period. Factory 1 produced only two products such as frozen ribbon fish and frozen octopus whole cleaned, Factory 2 produced twenty one products and Factory 3 produced six products in addition to the above mentioned major products. From the study, it was found out factory 2 had comparatively better resource utilisation and capacity utilisation and it is followed by Factory 3 and Factory 1. Ramachandran *et al.* (1993) gave a detailed account of the raw material purchase pattern in seafood industry in Kerala. It is very clear from the study that the factory, which produces, diversified products and with highest product range has better productivity.

Factory 2 produced 50 IQF products of which major products were IQF PUD shrimp, IQF PD shrimp, IQF CFWC, IQF SQRING, IQF Reef cod scale less, and IQF Reef cod gutted. Factory 3 had only two IQF products. It was found that Factory 2 with higher product width and diversification had better capacity utilisation and resource utilisation. Ramachandran (1988) studied the capacity utilisation of block freezing factories and reported low capacity utilisation in factories, which had not adopted product diversification.

Figure 37 shows the average daily production of IQF peeled and undeveined (PUD) shrimp in three factories during 1995-97. Factory 1 (Factory 1 mentioned here is different from that of Factory 1 mentioned in process control section.) had no facility for IQF and Factory 3 had no production of IQF PUD during the study period. But Factory 2 had continuous production of this product during 1995-97 with maximum production of 2959 kg in March 1997. Fluctuation ranging from nil production to 2959 kg was noticed in the daily production of IQF PUD shrimp. This was mainly due to the seasonality in raw material availability, pattern of raw material purchase, demand from the buyers, etc.

Figure 38 shows the average daily production of the Individually Quick Frozen Peeled and Deveined (PD) shrimp in three factories during 1995-97 period. Among the three factories, only Factory 2 had a little production during 1995-97 with maximum production of 785 kg in September 1996. This was mainly due to the lack of demand from the buyers.

Figure 39 shows the average daily production of individually Quick Frozen Squid Whole Cleaned (SQWC). In this case only Factory 3 produced this product. Even in this factory there was production only for four months with maximum quantity of 1148 kg in May 1996. This was mainly due to lack of demand for this product due to the shift in consumer preference to value added product such as IQF squid ring, IQF squid tube etc. (Gopakumar, 1993; Shassi and Ramachandran, 1998).

Figure 40 shows the average daily production of Individually Quick Frozen Squid Ring (SQRING) in three factories during 1995-97. Among the three factories, only Factory 2 showed production of this product in some months. Wide fluctuation in the production was also noticed in this factory.

Figure 41 shows the average daily production of Individually Quick Frozen Cuttlefish whole cleaned (CFWC) in three factories during 1995-97. Factory 2 and Factory 3 had the production of IQF CFWC during the study period and better production was noticed in Factory 3 with maximum production of 4395 kg in October 1996. Fluctuation in the production of IQF CFWC was also noticed.

Figure 42 shows average daily production of Individually Quick Frozen Reef Cod Scale less (IQF RFSCL) in three factories during 1995-97. Among the three factories, only Factory 2 showed the production of IQF RFSCL with the maximum production of 1511 kg in August 1995.

Figure 43 shows the average daily production of Individually Quick Frozen Reef Cod Gutted (IQF RF GT) in three factories during 1995-97.Among the three factories; Factory 2 only showed the production of IQF RF GT that too only in little quantity. Low production of this product was due to the shortage in the availability of this fish. Figure 44 shows the average daily production of other Individually Quick Frozen products in three factories during 1995-97. In addition to the above mentioned Individually Quick Frozen products, there were a number of other products, which was produced in Factory 2. Table 2 shows the percentage composition other IQF products produced in these factories. Factory 2 had maximum diversification of IQF products with a product range of 50 products.

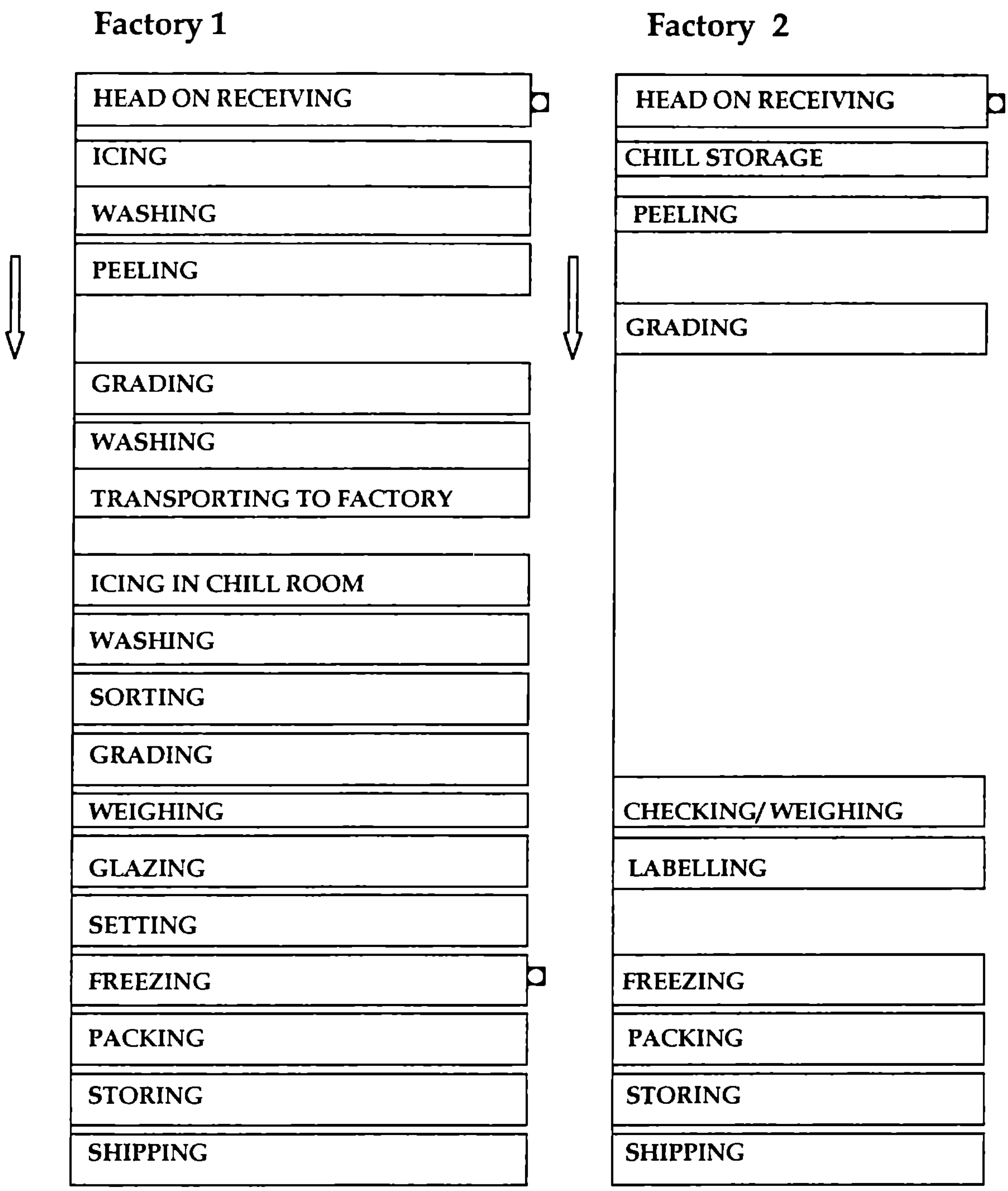
Among the three factories studied Factory 2 showed comparatively better product diversification and resource utilisation. For this reason it also showed better capacity utilisation in the case of both IQF and block freezing lines.

Table 1. Percentage composition of other block frozen products produced in three factories during 1995-97

Type of other block frozen products	Factory 1	Factory 2	Factory 3
Squid wing	-	5.2	0.643
Squid ring	-	0.99	0.075
Squid tube assorted	-	4	
Cuttlefish wing	-	0.0011	0.183
Octopus assorted	-	0.0056	
Reef cod scale less	-	6.349	
Puzha thelly	-	1.515	
Anchovies	-	0.536	
Cuttlefish egg	-	0.021	
Squid tube and wing	-	0.264	
Squid fillet	-	1.386	1.47
Snapper	-	0.0005	
Ribbon fish	2.0	10.71	0.815
Mackeral		0.0712	0.678
Head on karickadi		0.00107	
Green mussel		0.0145	
Barrakuda		0.569	
Squid tube flower		0.022	
Cuttle fish head		0.635	
Cuttlefish flower		0.896	
Octopus	5.3	0.0073	

Table 2. Pecentage composition of other IQF products produced in three factories during 1995-97

Type of other IQF products	Factory 1 (%)	Factory2 (%)	Factory 3 (%)
Headless	-	1.3	-
Squid tentacle	-	2.3	-
Squid ring	-	4.6	-
Barakkuda pan ready	-	0.11	-
Squid wing	-	2.1	-
Squid tube assorted	-	.22	-
Cuttlefish fillet	-	.23	-
Ribbon fish whole	-	.3	-
Emperor fish scale less	-	.14	-
Mackeral pan ready	-	.33	-
Nacked bream travally	-	.66	-
Scad	-	1.2	-
Squid ring and tube	-	.79	-
Anchovies	-	.057	-
Pearl spot whole	-	.362	-
Anchovies pan ready	-	.745	-
Seer fish gutted	-	1.5	-
Emperor gutted	-	.99	-
Pomfret black	-	4.02	-
Mackeral whole	-	2.1	-
Snapper gutted	-	.12	-
Pomfret whole	-	.022	-
Snapper	-	.026	-
White snapper	-	.627	-
Snapper fillet	-	.35	-
Seer fish whole	-	.096	-
Shark	-	.145	-
Head on tiger	-	.003	-
Reef cod fillet	-	.19	-
Emperor fish fillet	-	.27	-
Varal whole	-	.1	-
Emperor whole	-	1.39	-
Ribbon fish whole	-	.64	-
Parot	-	.255	-
Veloori pan ready	-	.306	-
Head on white	-	.001	-
Thread fin bream	-	.295	-
Cuttlefish wing	-	1.12	-
Barakkuda	-	.17	-
Stuffed squid	-	.03	-
Headon scampi	-	.005	-
Octopus	-	.0006	-
Crab whole	-	.128	-
Headless peeling type	-	0.481	-



□ -CCP; ⇩- PROCESS FLOW

Fig 1. Comparison of flow charts and critical control points(CCP) of block frozen peeled and undeveined (PUD) shrimp in two different factories in Kerala.

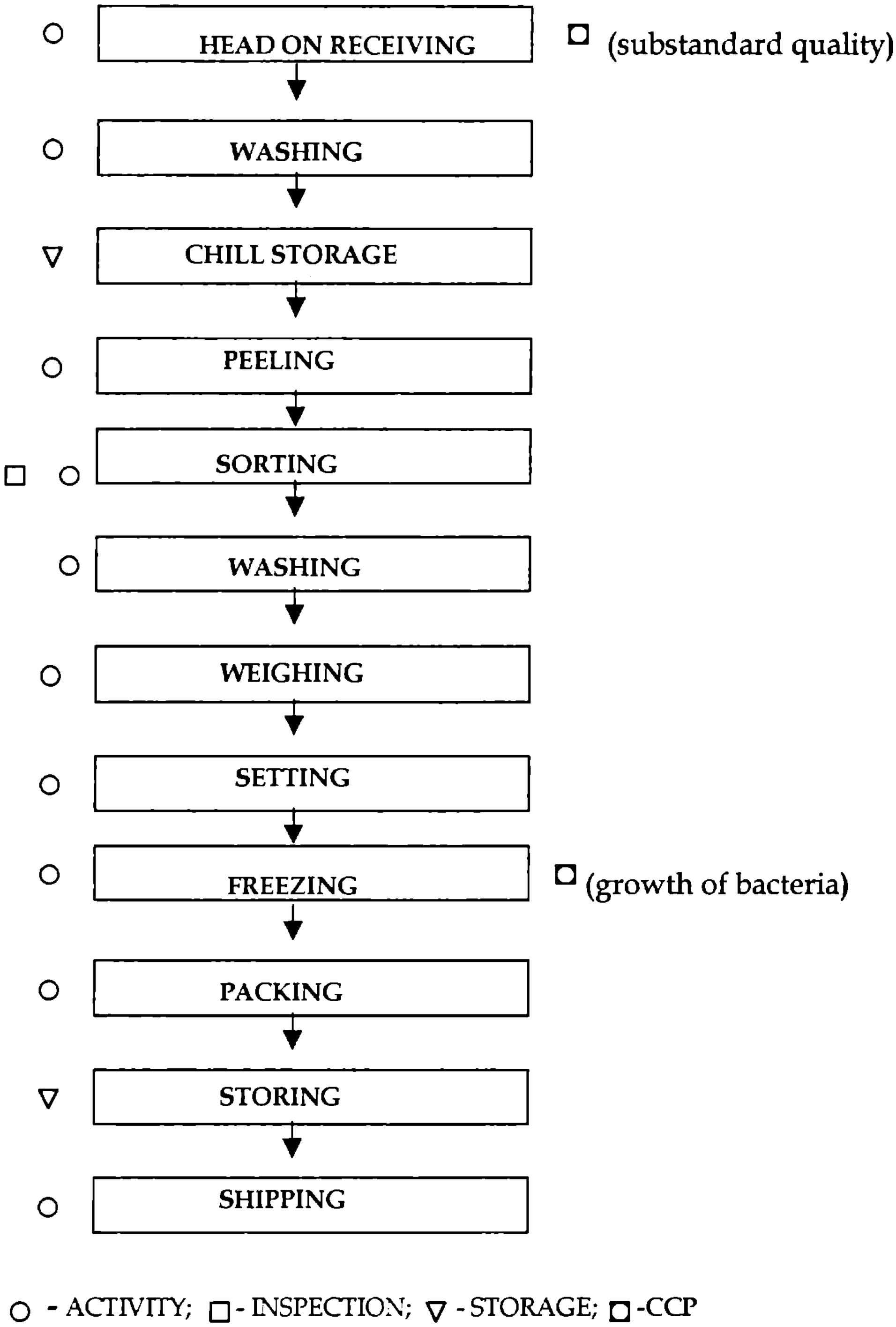


Fig 2. Standardised flow chart for the production of block frozen peeled and undeveined shrimp and suggested critical control points (CCP)

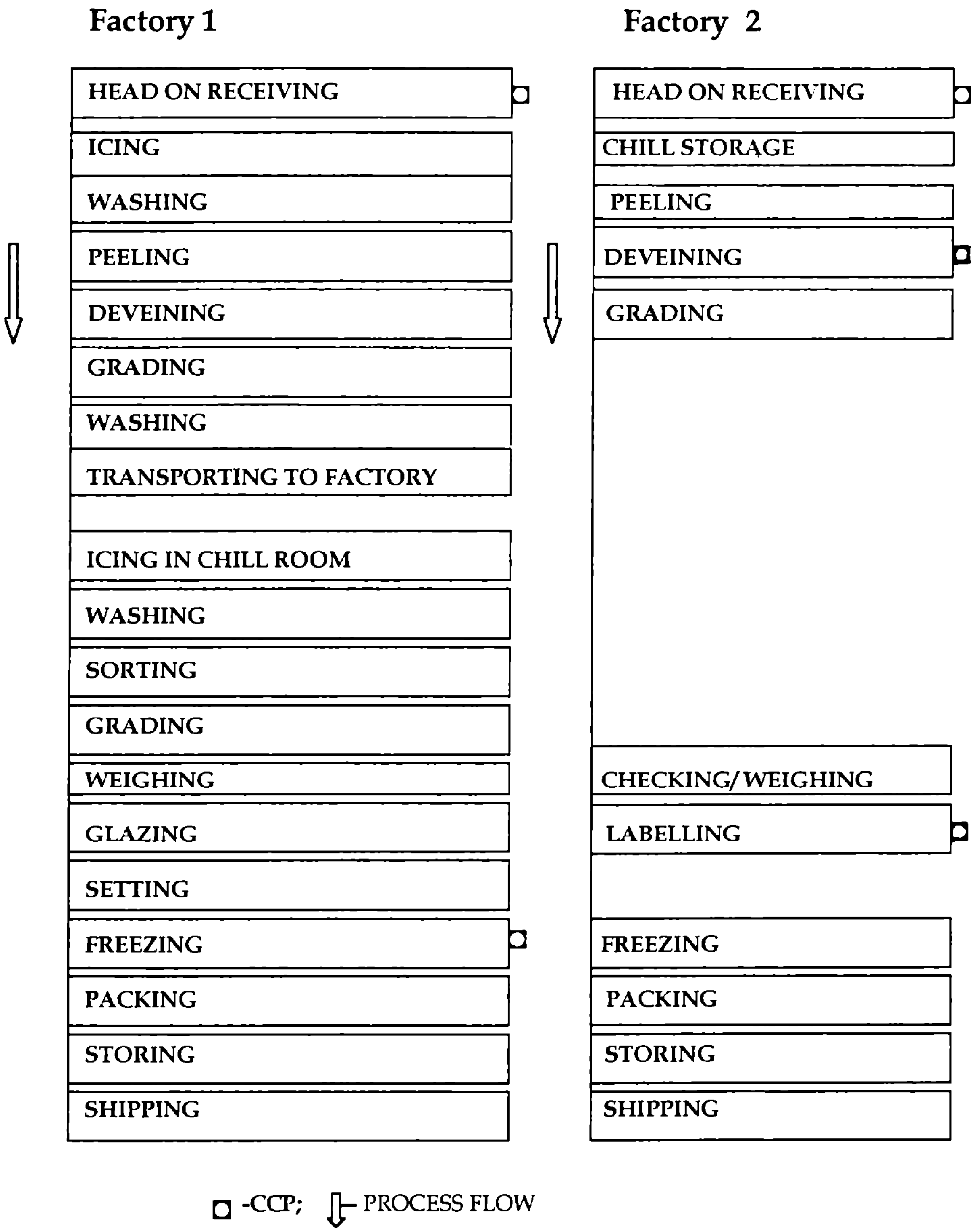


Fig 3. Comparison of flow charts and critical control points (CCP) of block frozen peeled and deveined (PD) shrimp in two different factories in Kerala.

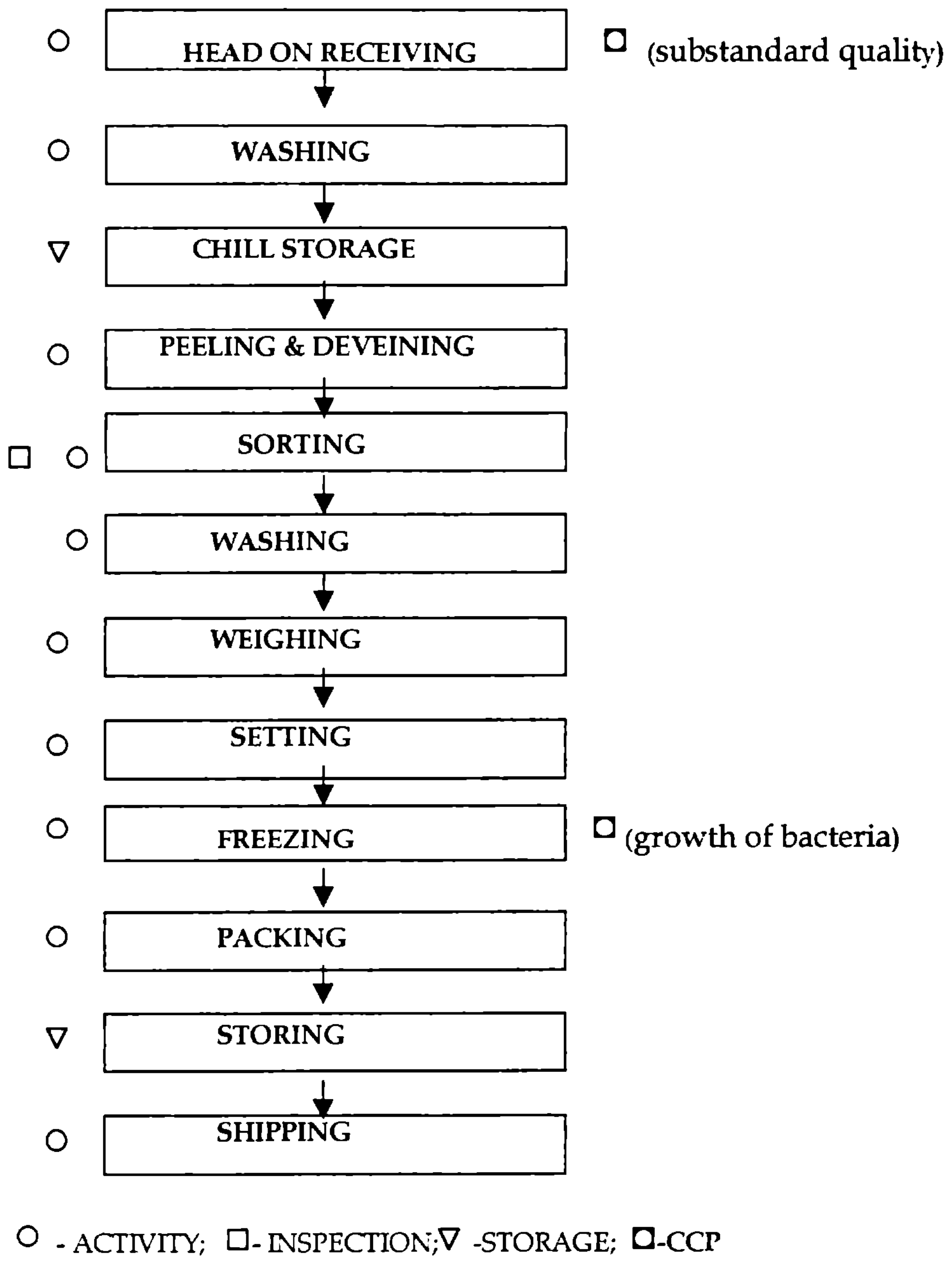


Fig 4. Standardised flow chart for the production of block frozen peeled and deveined shrimp and suggested critical control points (CCP)

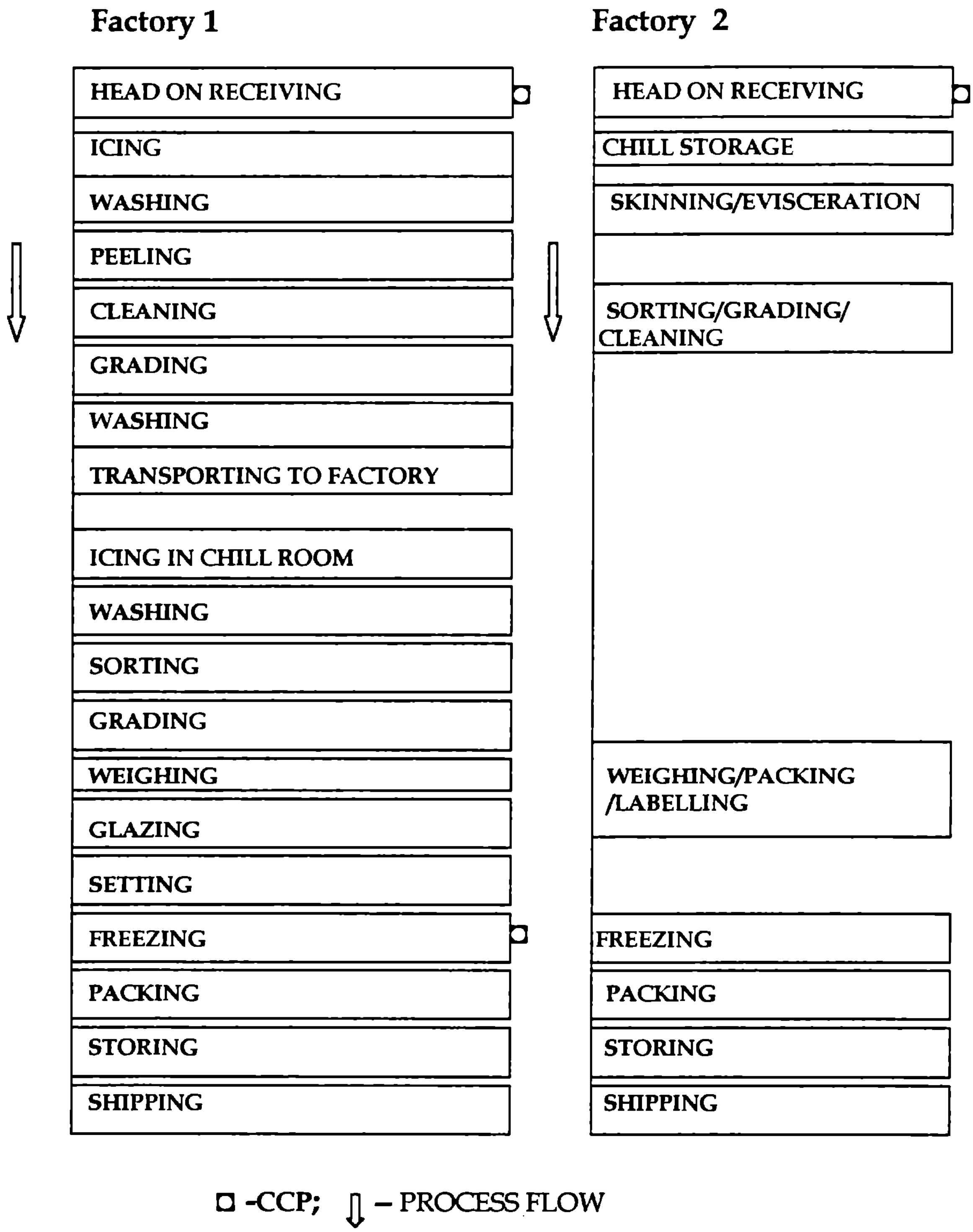


Fig 5. Comparison of flow charts and critical control points(CCP) of block frozen squid whole cleaned (SQWC)in two different factories in Kerala.

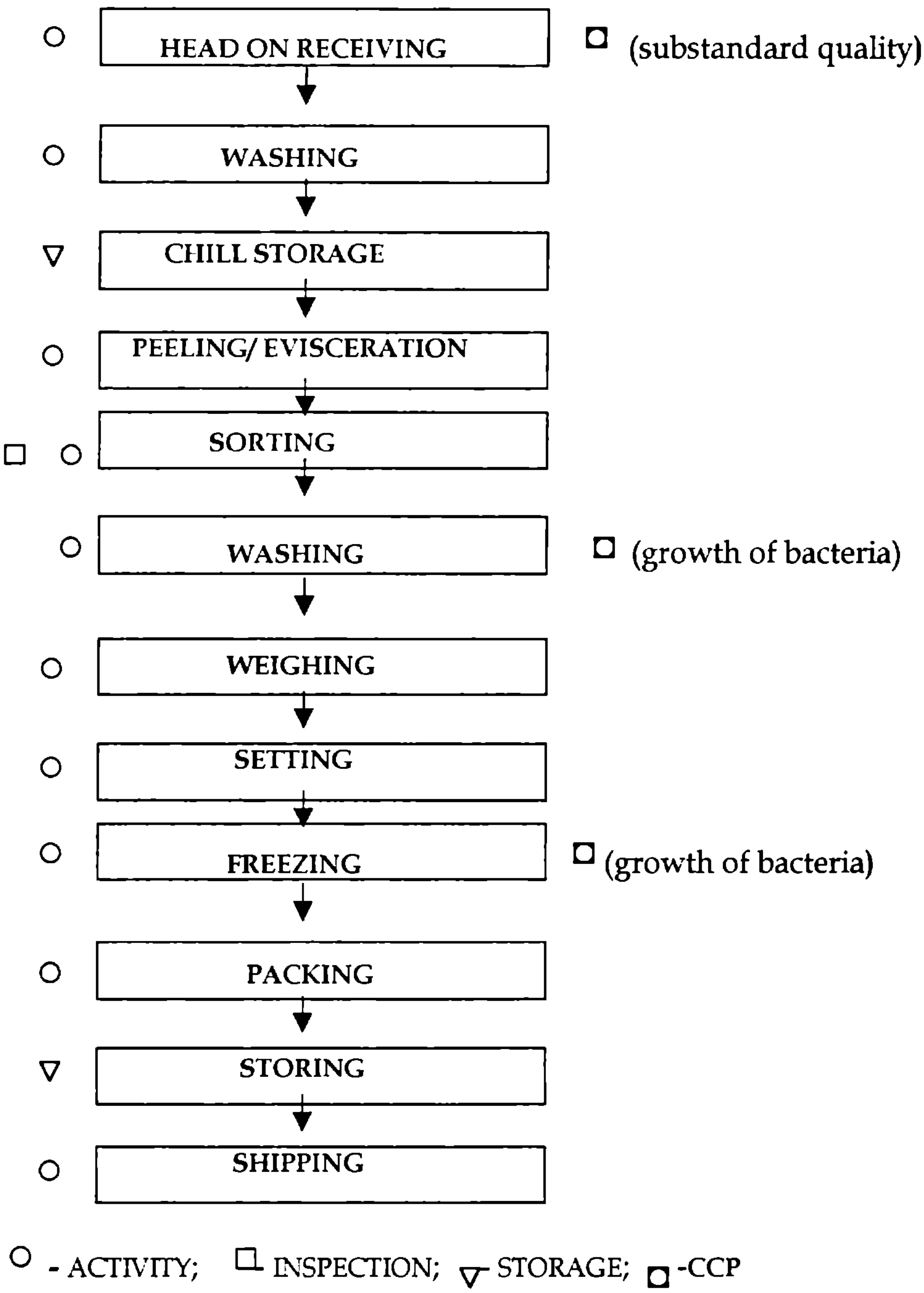


Fig 6. Standardised flow chart for the production of block frozen squid whole cleaned (SQWC) and suggested critical control points (CCP)

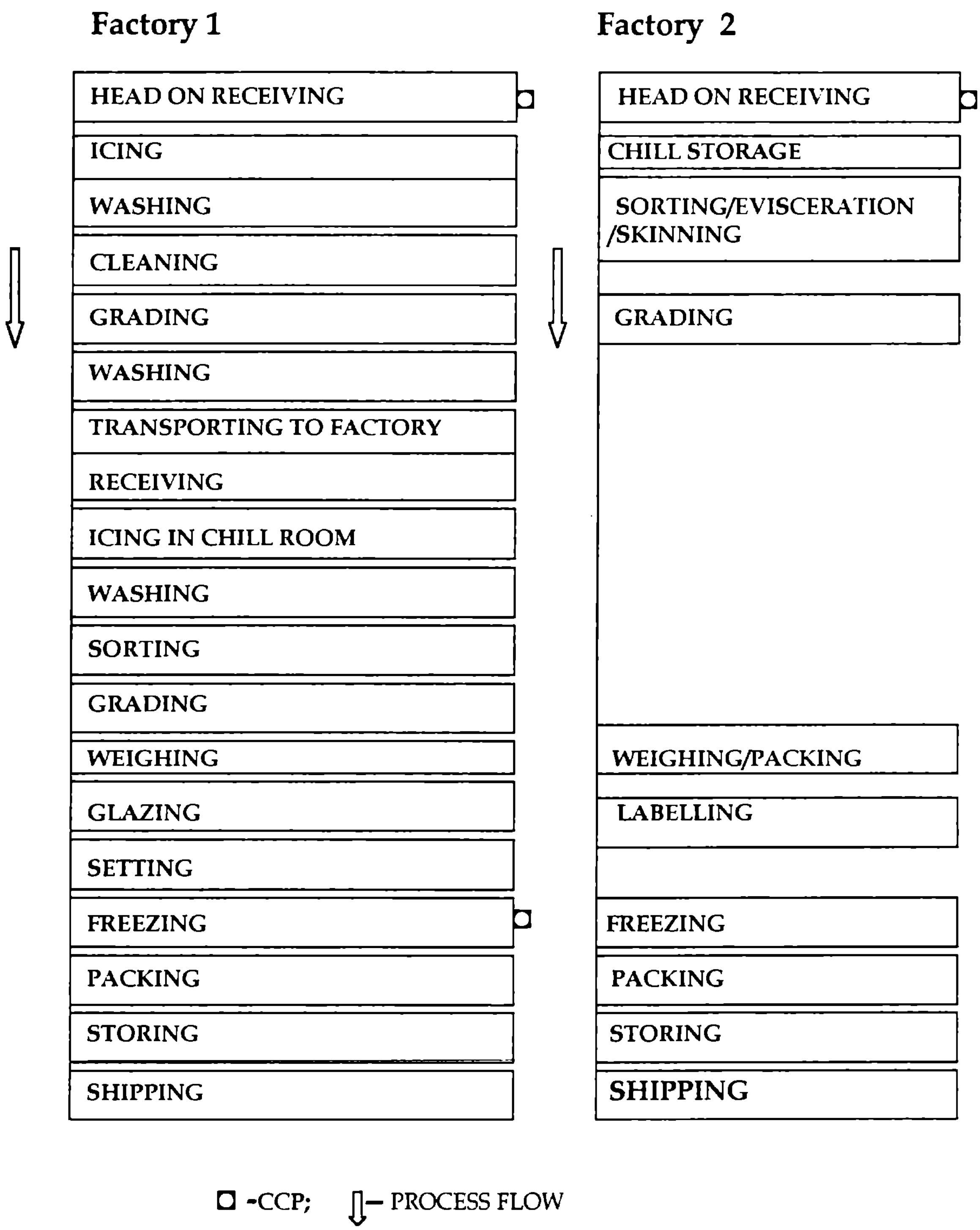


Fig 7. Comparison of flow charts and critical control points(CCP) of block frozen cuttlefish whole cleaned (CFWC) in two different factories in Kerala.

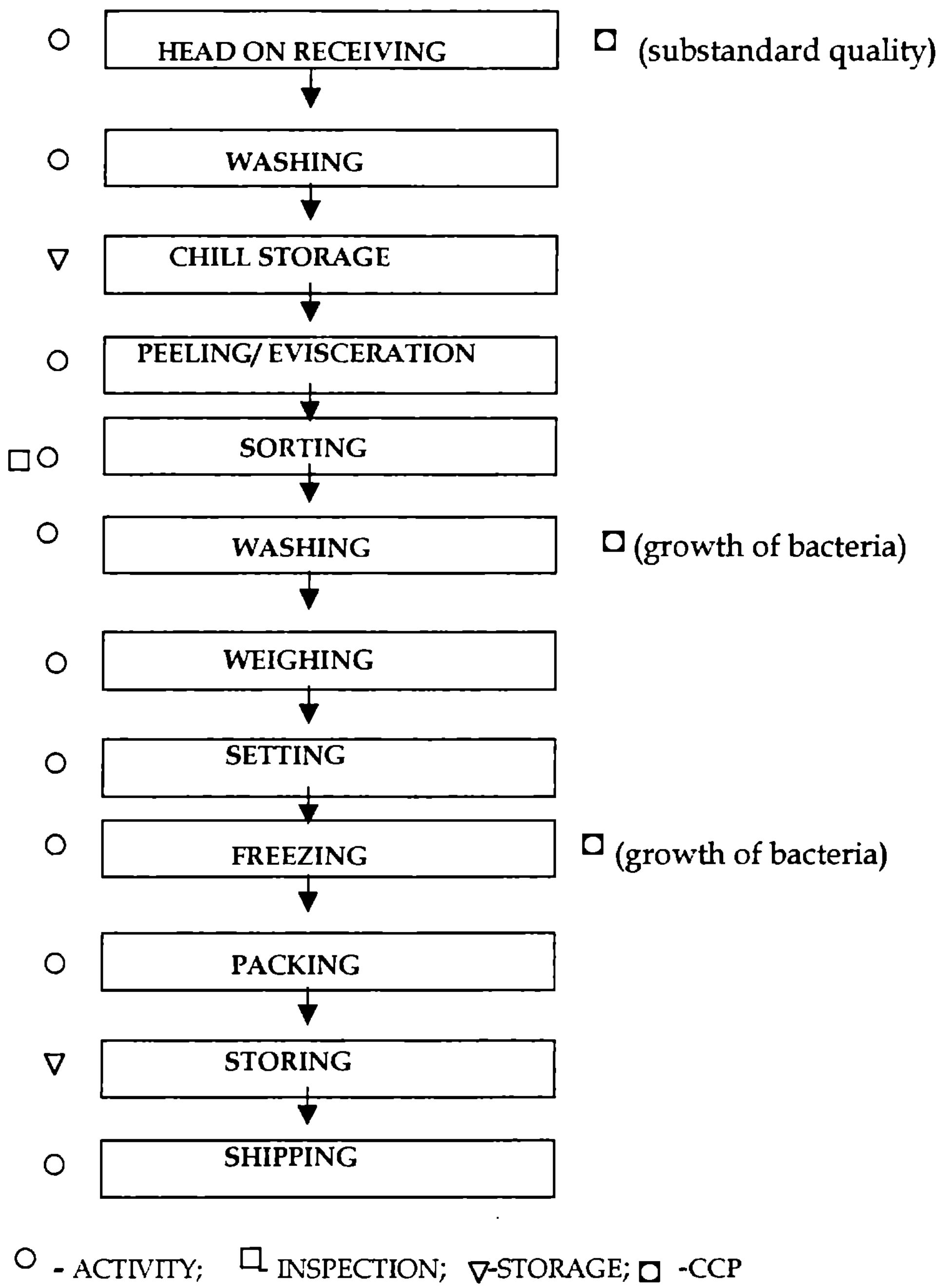


Fig 8. Standardised flow chart for the production of block frozen cuttlefish whole cleaned (CFWC) and suggested critical control points (CCP)

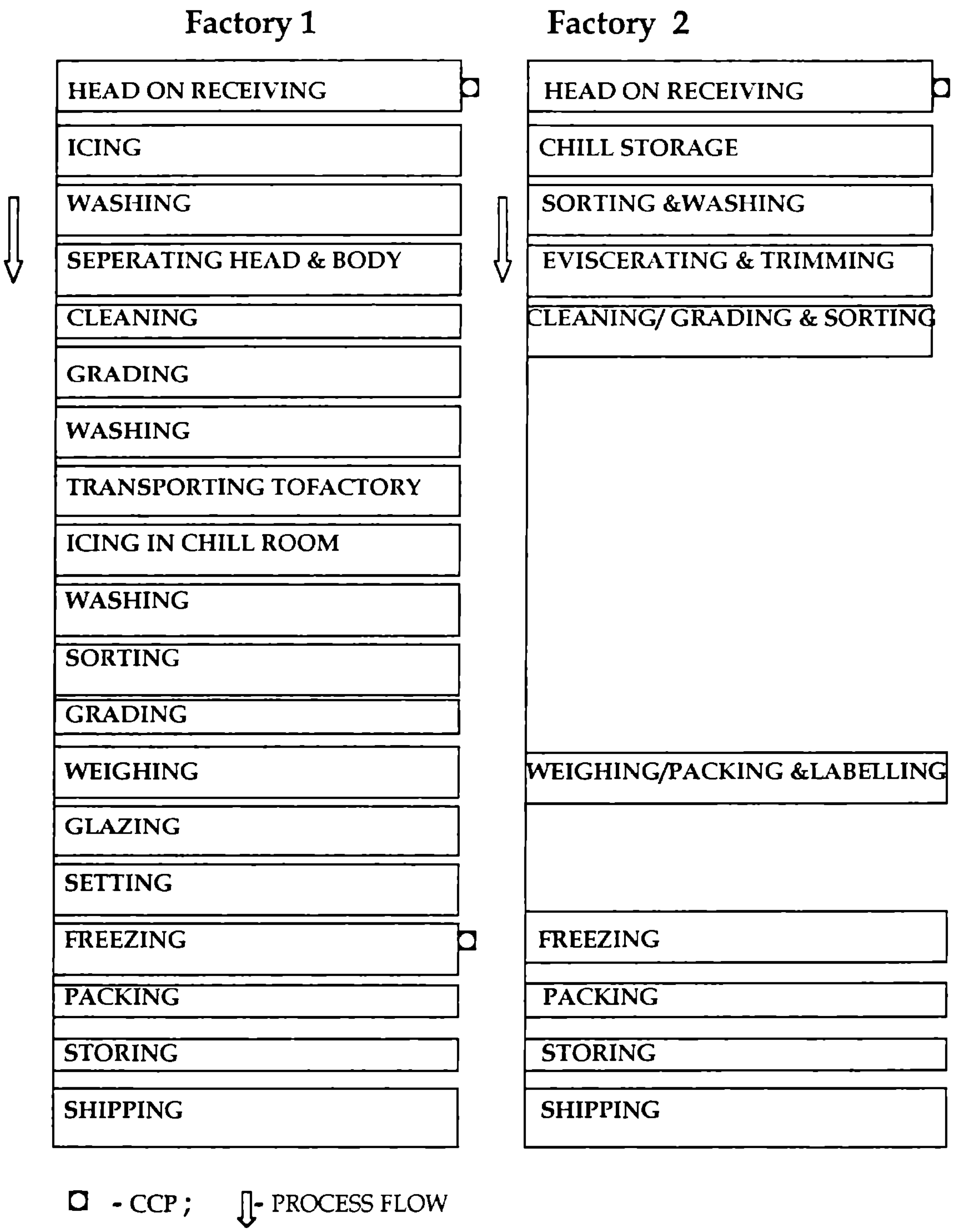
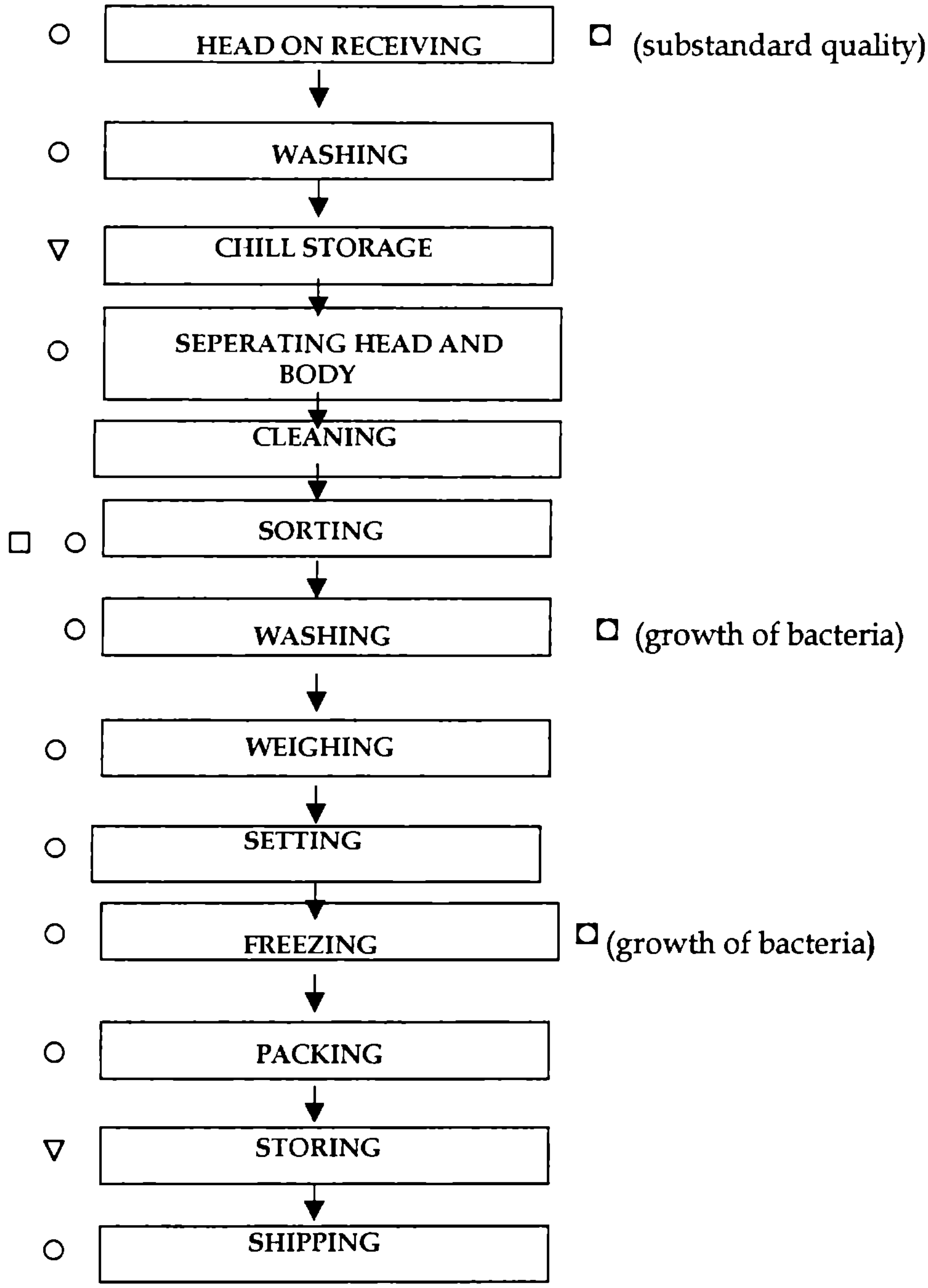


Fig 9. Comparison of the flow charts and Critical Control Points (CCP) of block frozen squid tube (SQT) in two different factories in Kerala .



○ - ACTIVITY; □ - INSPECTION; ▽-STORAGE; ◘-CCP

Fig 10. Standardised flow chart for the production of block frozen squid tube (SQT) and suggested critical control points (CCP)

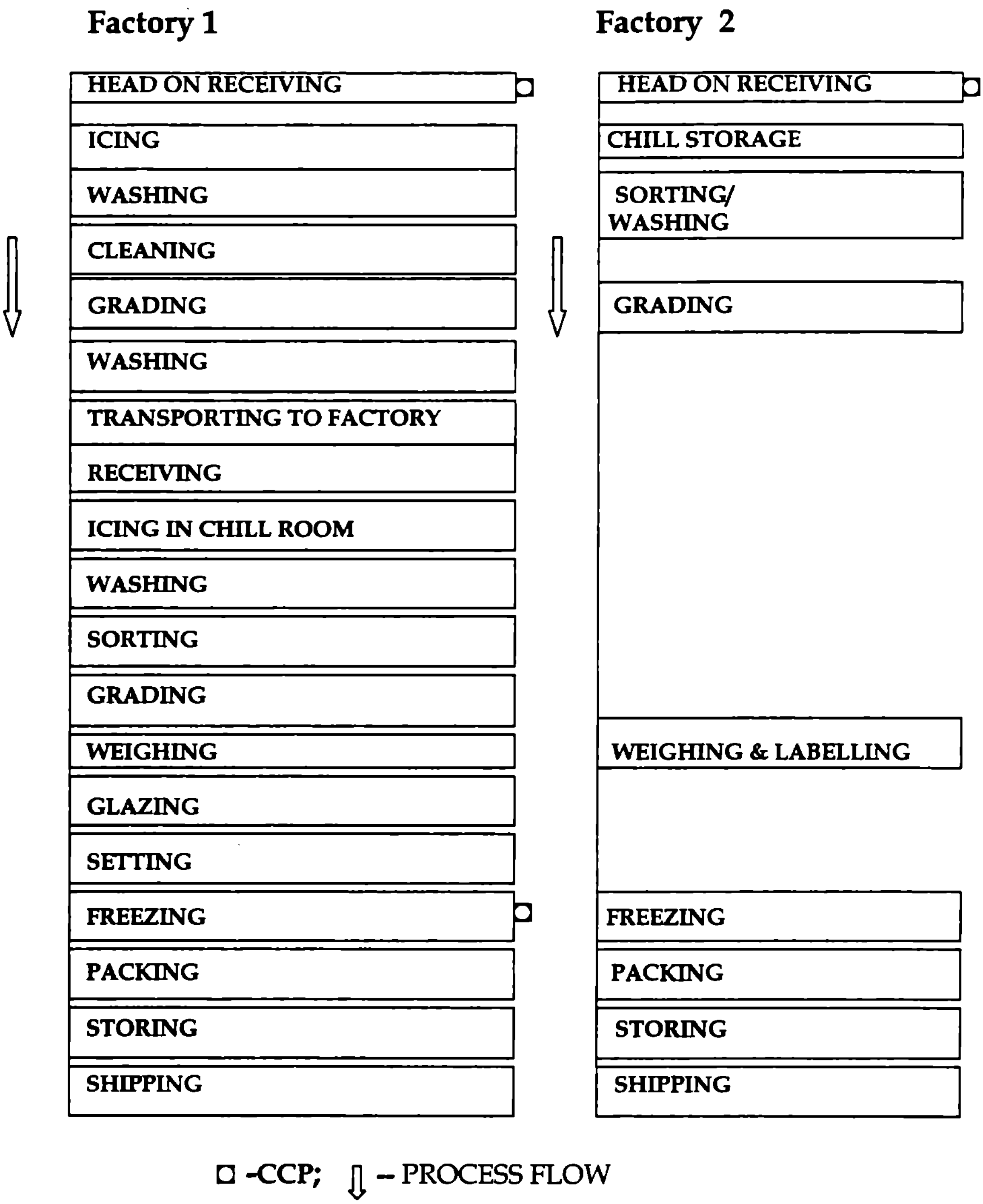
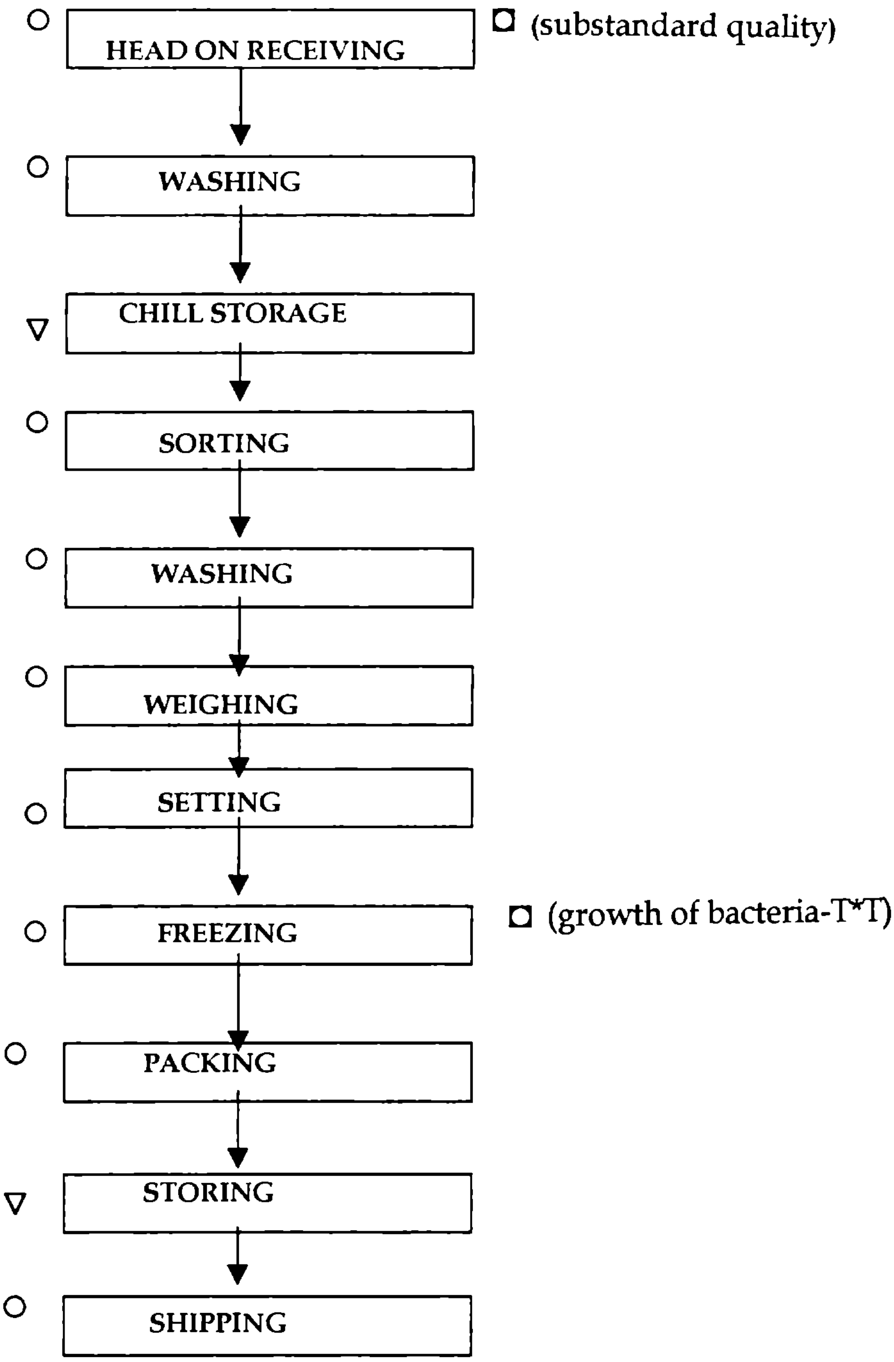


Fig 11. Comparison of flow charts and critical control points (CCP) of block frozen squid whole (SQW) in two different factories in Kerala.



○ - ACTIVITY; □ - INSPECTION; ◘ - CCP ; ∇ - STORAGE

Fig 12. Standardised flow chart for the production of block frozen squid whole (SQW) and suggested Critical Control Point (CCP).

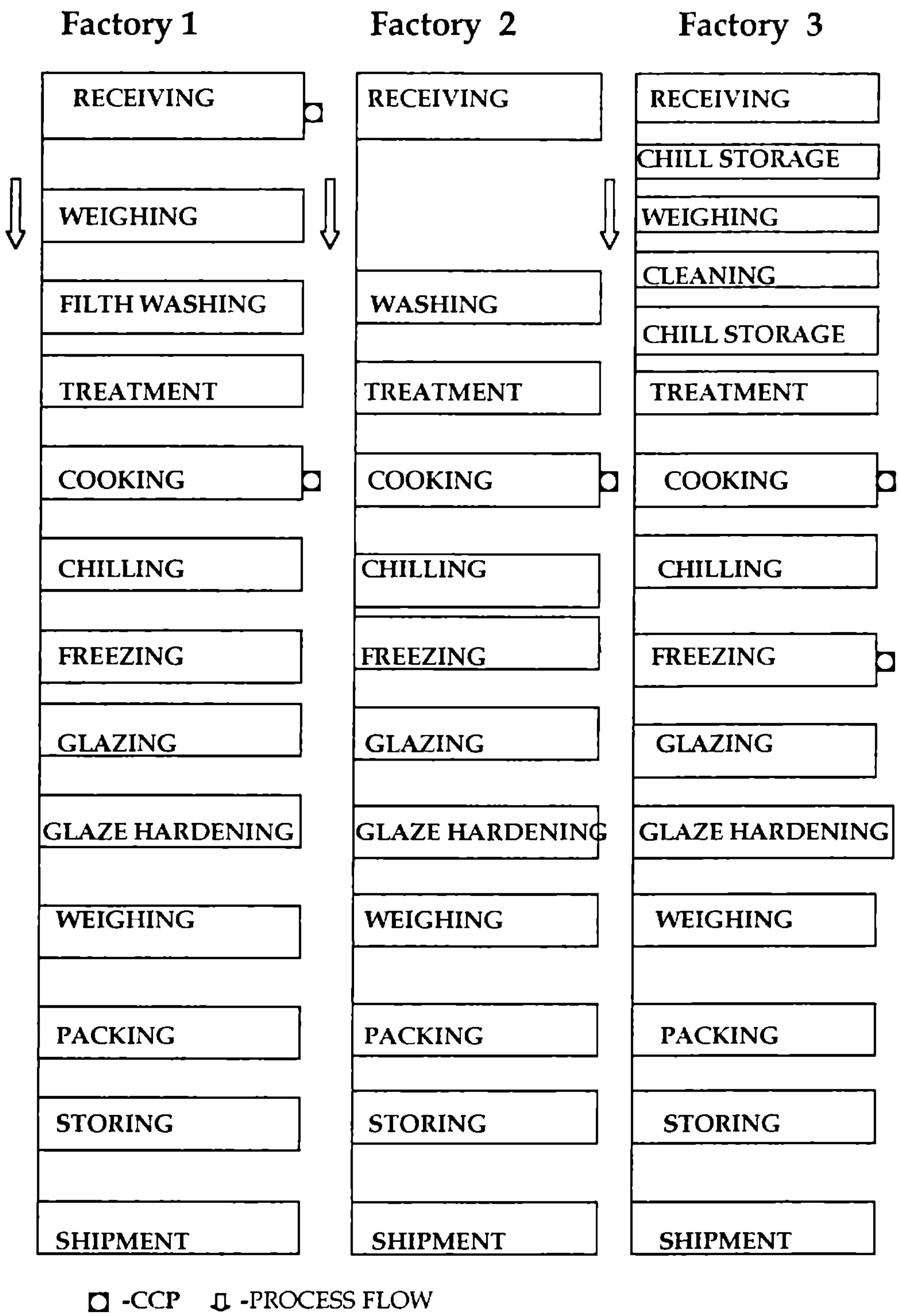


Fig. 13. Comparison of flow chart showing the estsblished critical control points (CCP) of the Individually Quick Frozen peeled, undeveined and cooked (PC) shrimp in three factories in different Kerala.

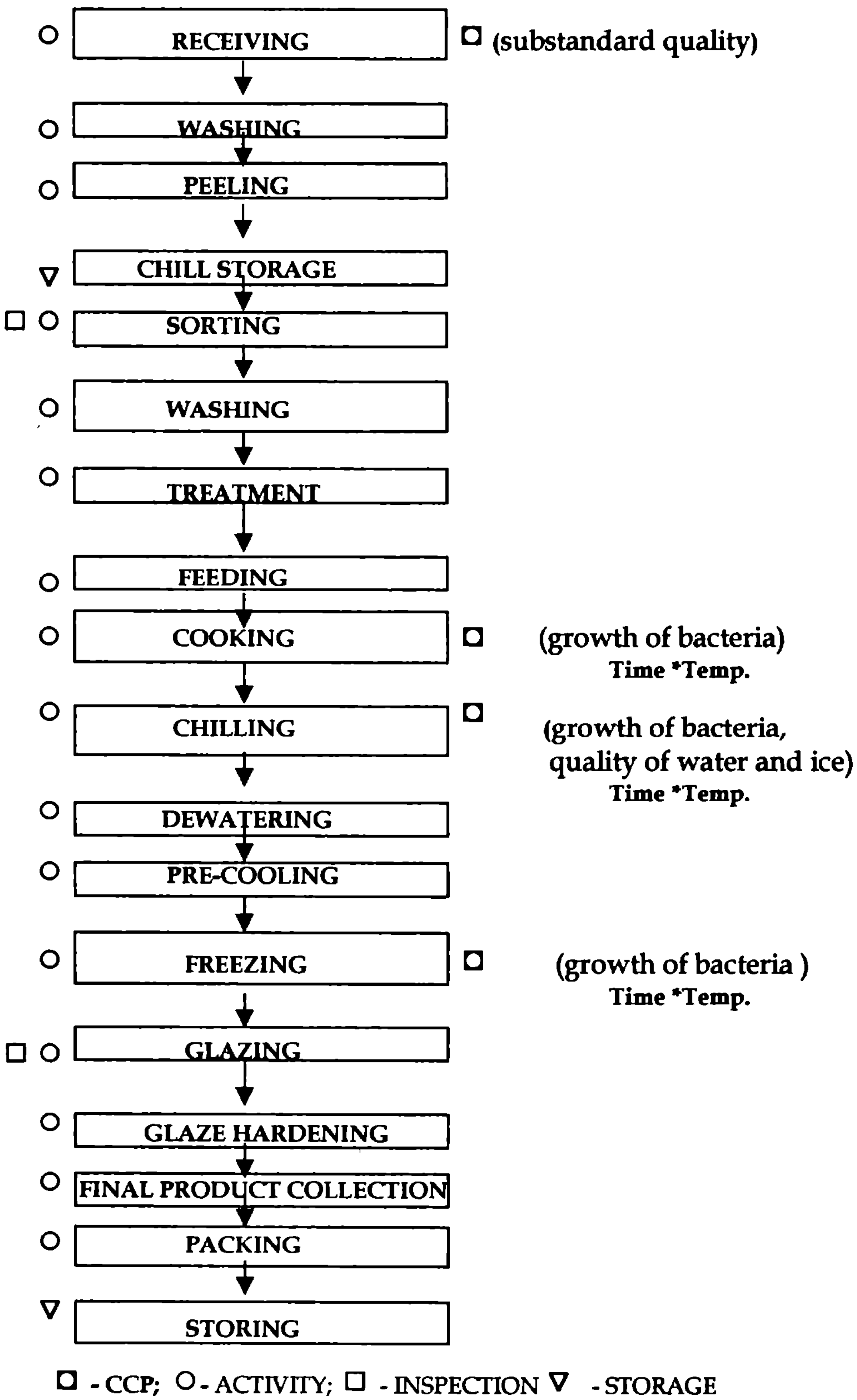


Fig 14. Standardised flowchart and suggested critical control points for the production of Individually Quick Frozen (IQF) peeled, undeveined and cooked (PC) shrimp

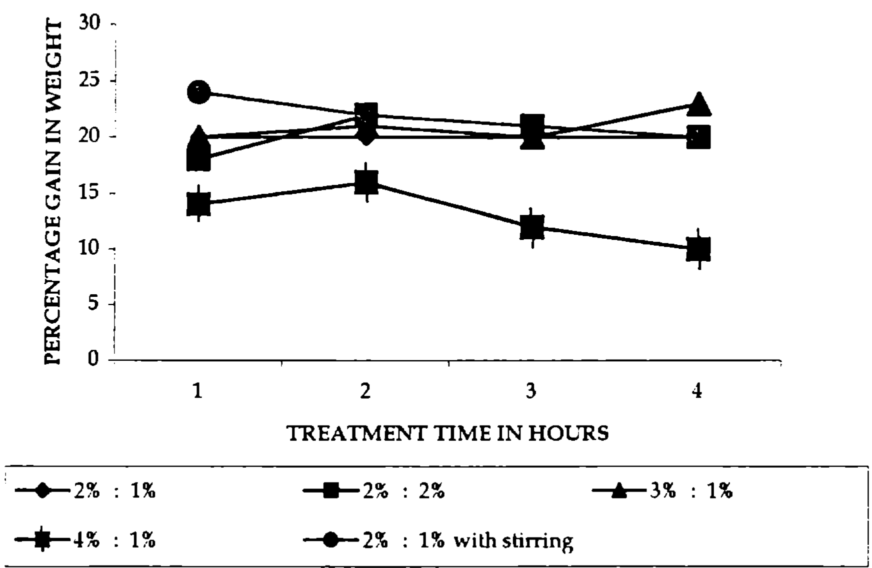


Fig 15. TREATMENT OF PUD SHRIMP (PARAPENAEOPSIS STYLIFERA) WITH DIFFERENT COMBINATIONS OF SODIUM TRIPOLYPHOSPHATE AND SALT(STPP:SALT)

Fig. 16. Comparison of flow chart showing the established critical control points (CCP) of the Individually Quick Frozen peeled, deveined and cooked (PDC) shrimp in three different factories in Kerala.

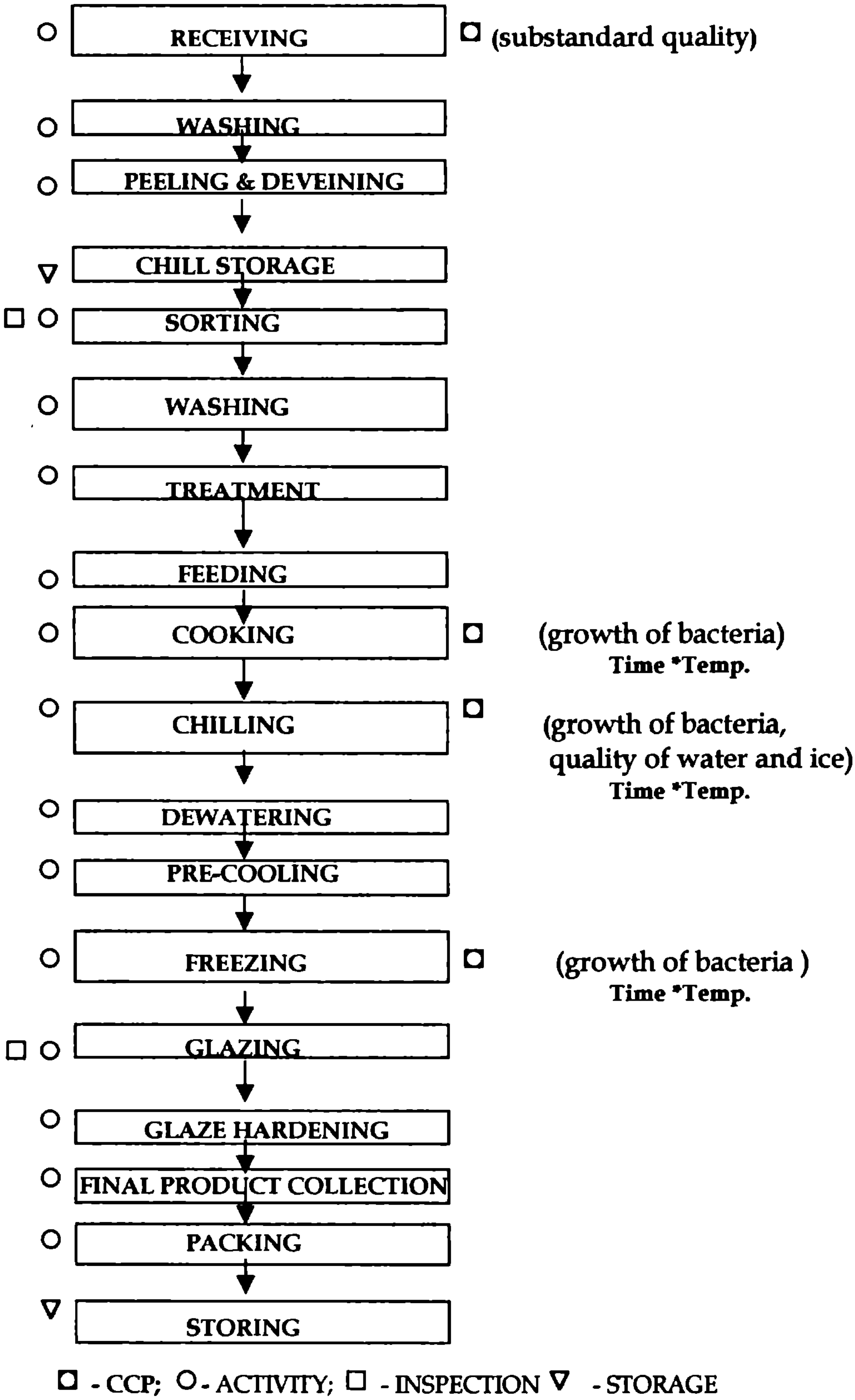


Fig 17. Standardised flowchart and suggested critical control points for the production of Individually Quick Frozen (IQF) peeled, deveined and cooked (PDC) shrimp.

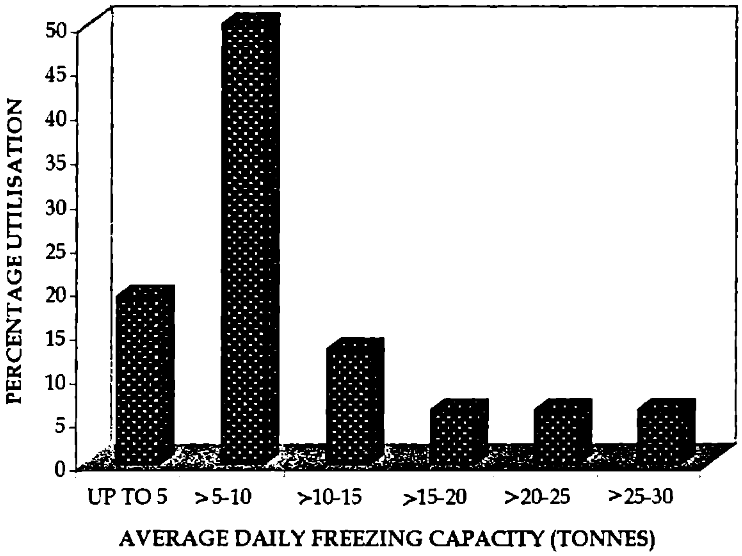


Fig 18. AVERAGE DAILY FREEZING CAPACITY UTILISATION IN SEAFOOD FACTORIES IN KERALA HAVING DIFFERENT FREEZING CAPACITIES

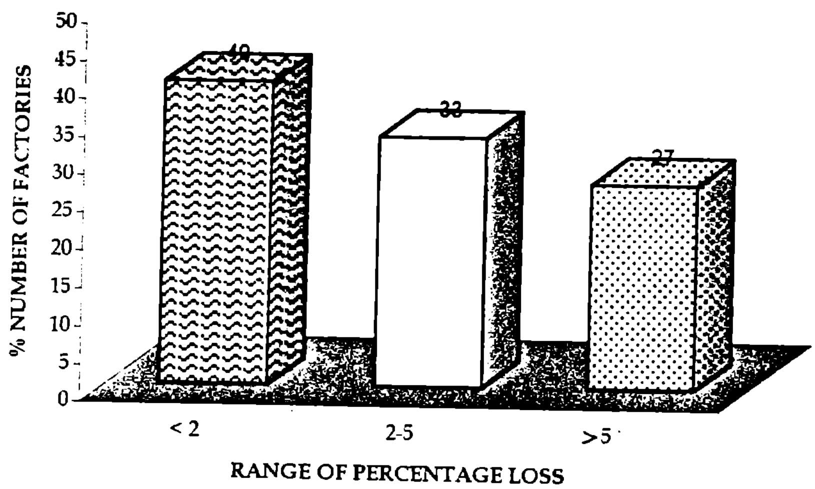


Fig 19. PERCENTAGE NUMBER OF FACTORIES SHOWING LOSS OF RAW MATERIALS & FINISHED GOODS DUE TO DIFFERENT REASONS

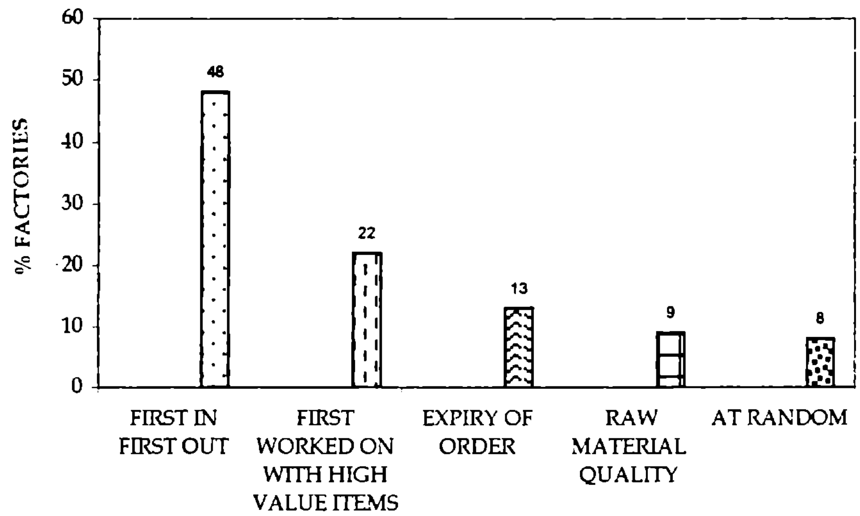


Fig 20. PRIORITY ORDER FOR PROCESSING OF RAW MATERIALS

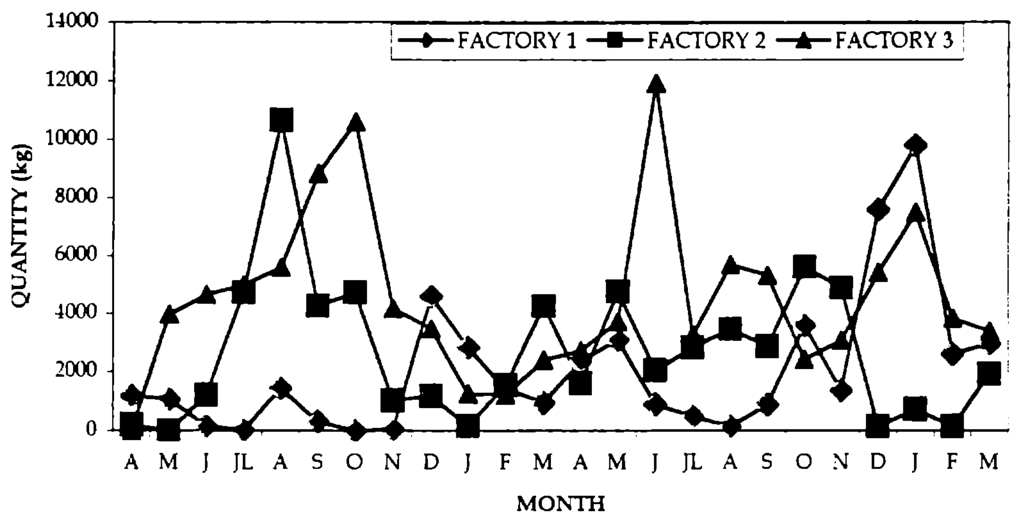


Fig 21. AVERAGE DAILY TOTAL BLOCK FROZEN PRODUCTION IN THREE FACTORIES (1995-97)

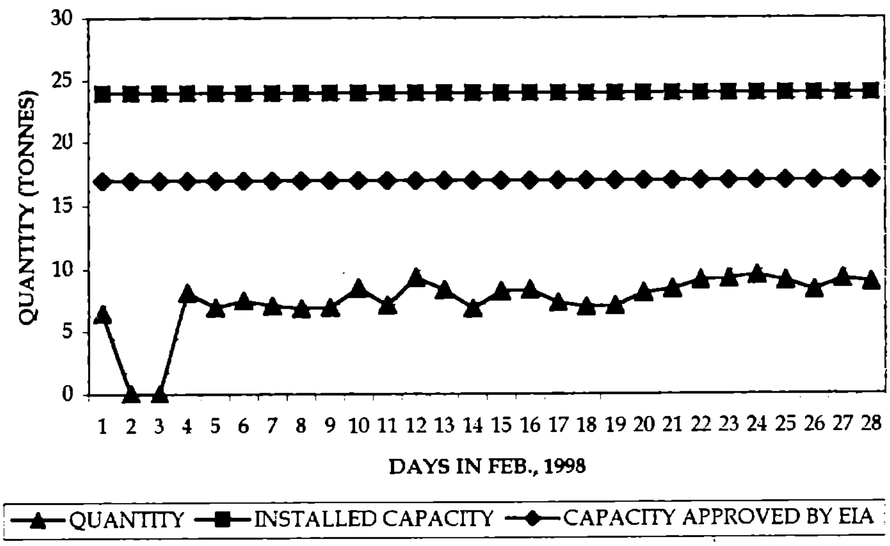


Fig 22. PATTERN OF DAILY PRODUCTION IN A SEA FOOD FACTORY APPROVED BY EUROPEAN COMMISSION FOR EXPORT TO EUROPE FACTORY 1

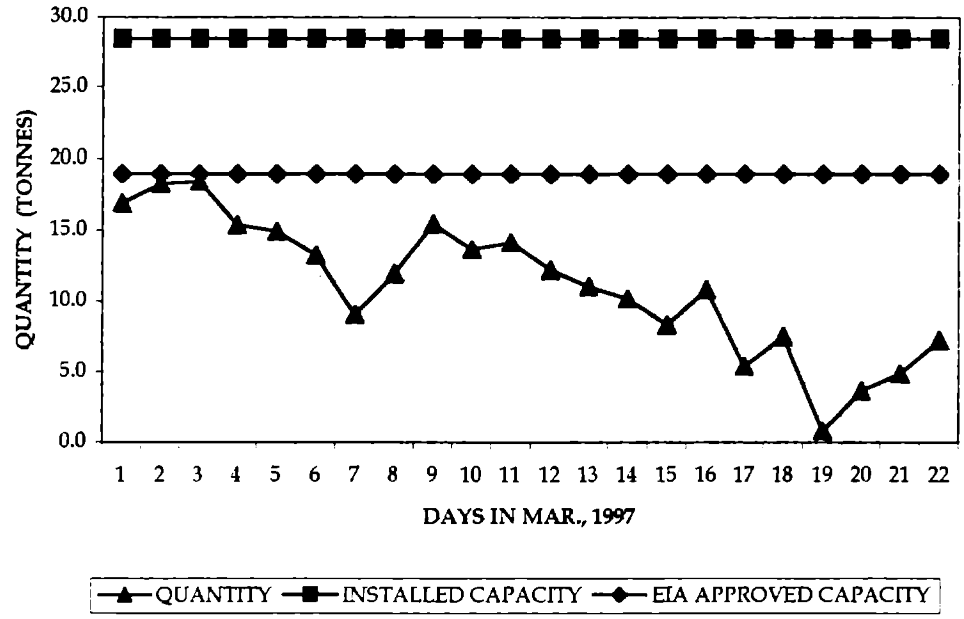


Fig 23. PATTERN OF DAILY PRODUCTION IN A SEA FOOD FACTORY APPROVED BY EUROPEAN COMMISSION FOR EXPORT TO EUROPE FACTORY 2

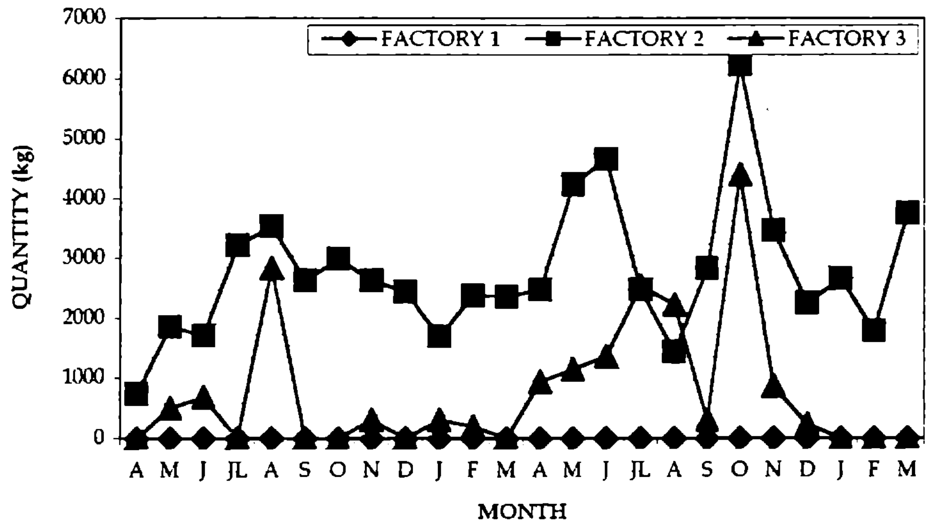


Fig 24. AVERAGE DAILY TOTAL INDIVIDUALLY QUICK FROZEN (IQF) PRODUCTION IN THREE FACTORIES (1995-97)

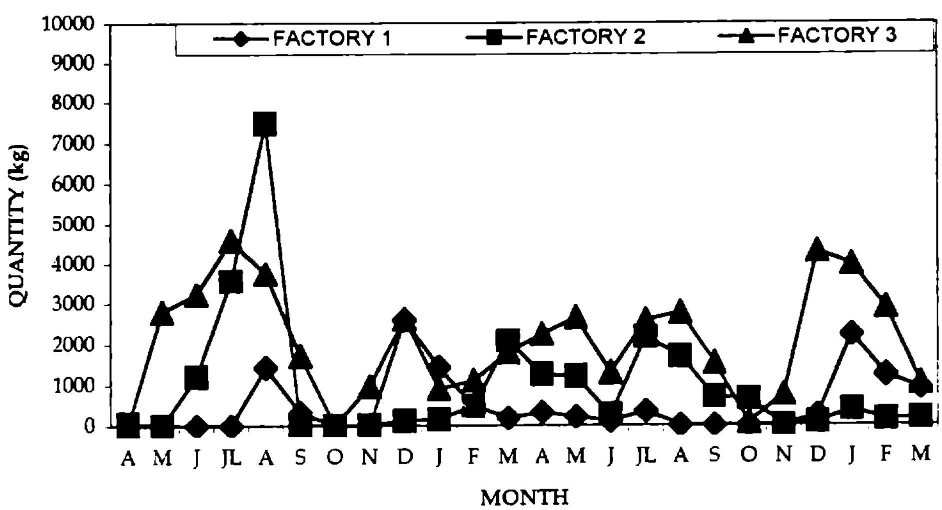


Fig 25. AVERAGE DAILY PRODUCTION OF BLOCK FROZEN PEELED AND UNDEVEINED SHRIMP IN THREE FACTORIES (1995-97)

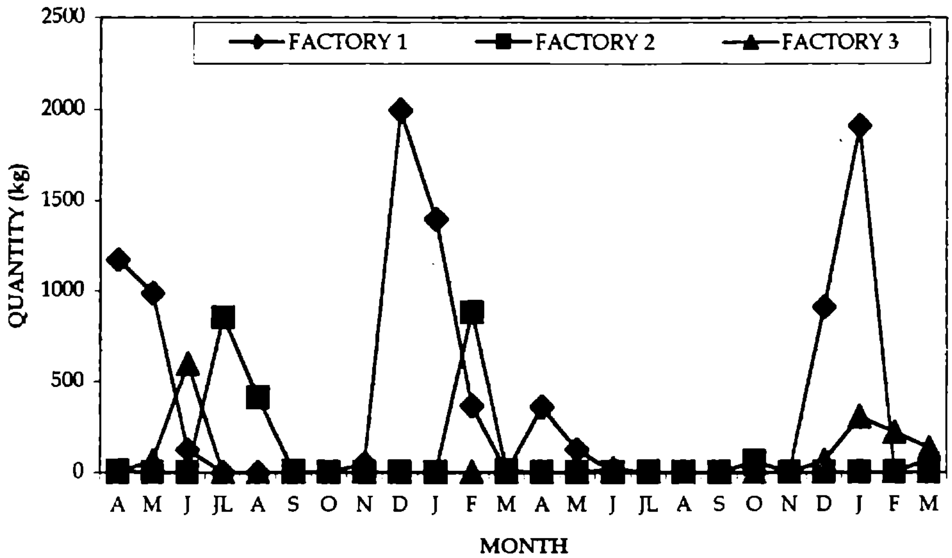


Fig 26. AVERAGE DAILY PRODUCTION OF BLOCK FROZEN PEELED AND DEVEINED SHRIMP IN THREE FACTORIES (1995-97)

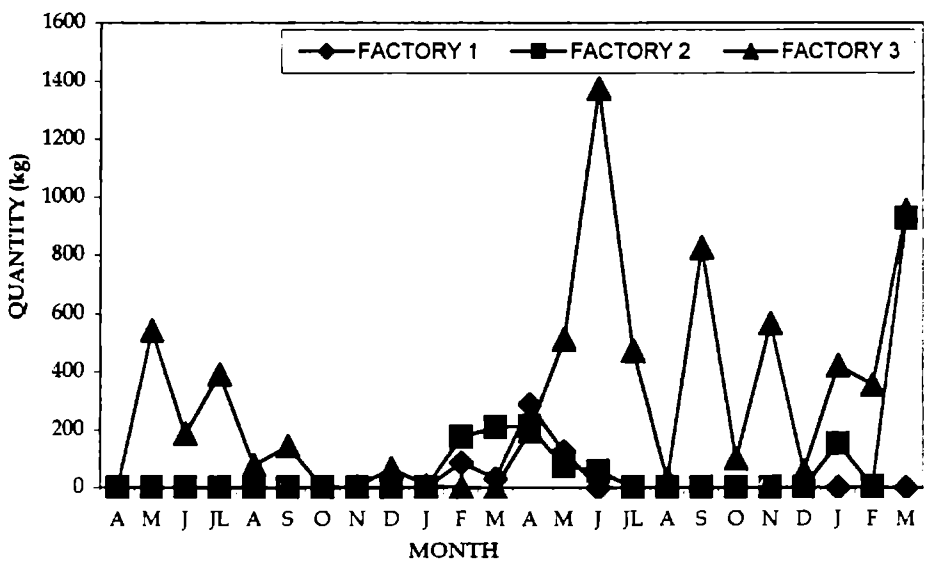


Fig 27. AVERAGE DAILY PRODUCTION OF BLOCK FROZEN HEAD LESS SHRIMP IN THREE FACTORIES (1995-97)

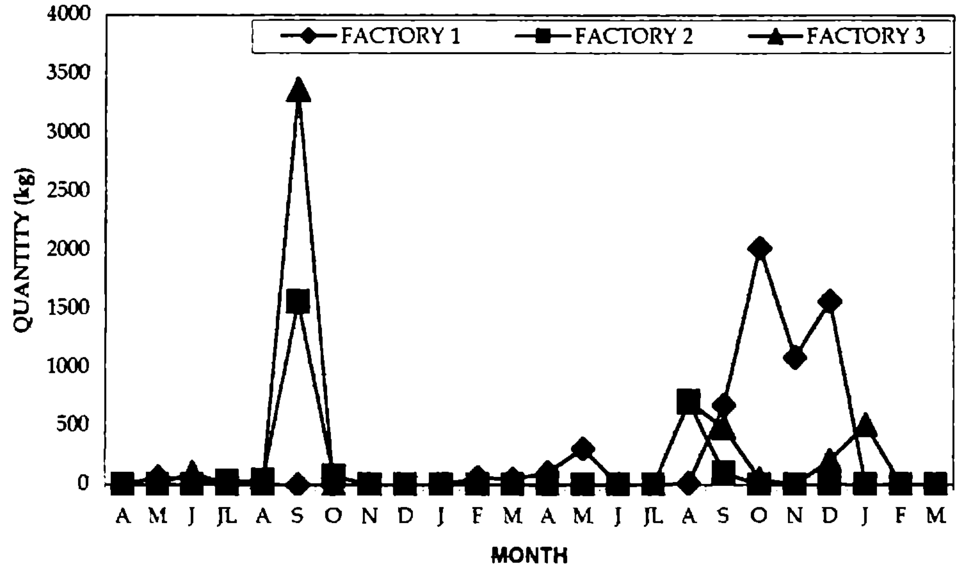


Fig 28. AVERAGE DAILY PRODUCTION OF BLOCK FROZEN CUTTLEFISH WHOLE IN THREE FACTORIES (1995-97)

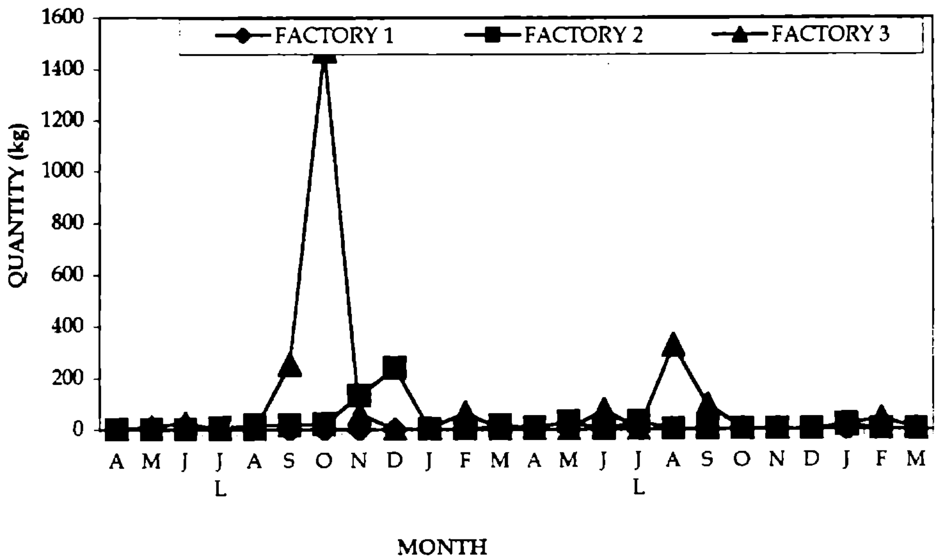


Fig 29. AVERAGE DAILY PRODUCTION OF BLOCK FROZEN CUTTLEFISH FILLET IN THREE FACTORIES (1995-97)

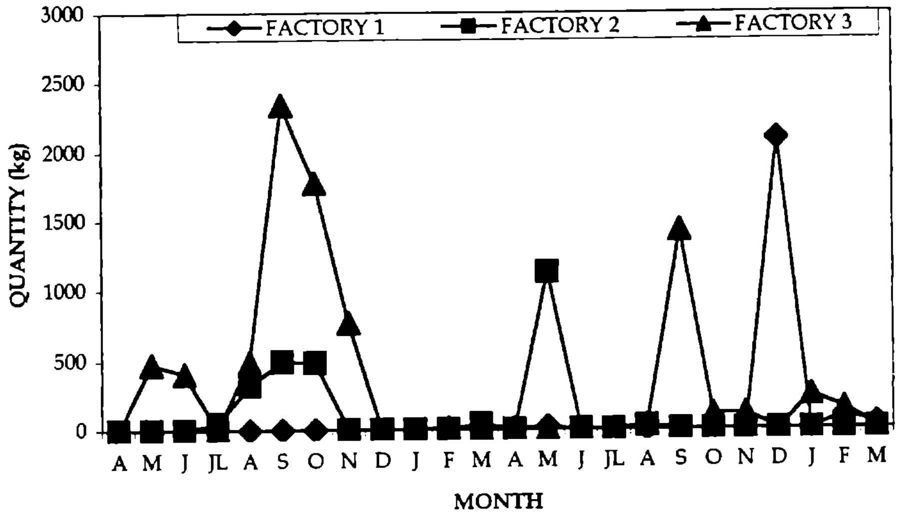


Fig 30. AVERAGE DAILY PRODUCTION OF BLOCK FROZEN CUTTLEFISH WHOLE CLEANED IN THREE FACTORIES (1995-97)

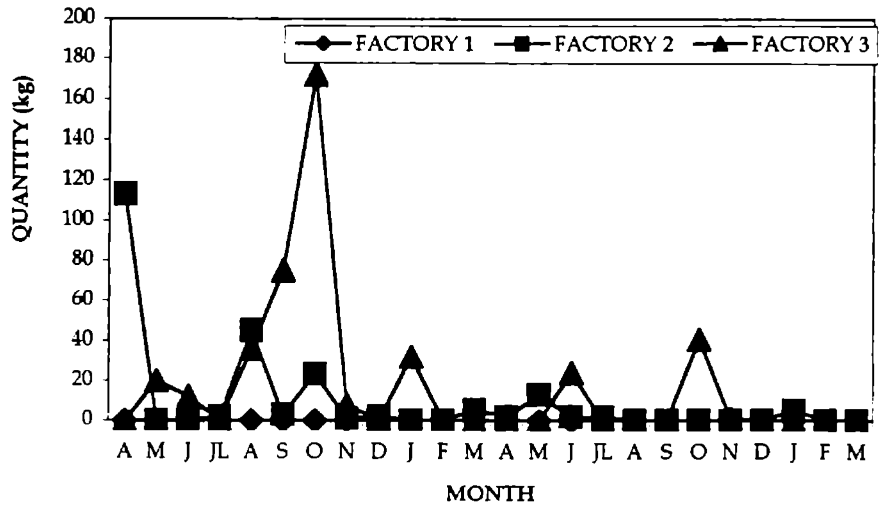


Fig 31. AVERAGE DAILY PRODUCTION OF BLOCK FROZEN CUTTLEFISH TENTACLE IN THREE FACTORIES (1995-97)

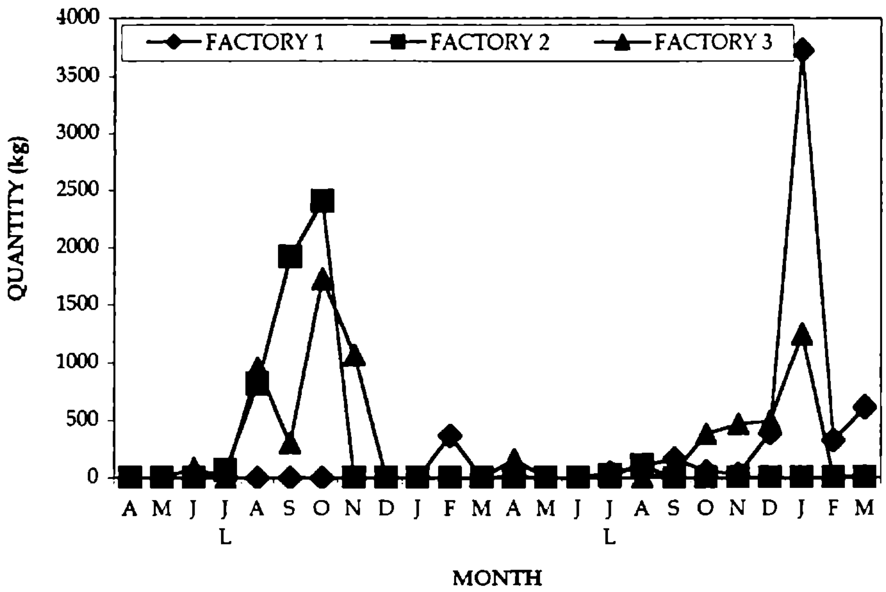


Fig 32. AVERAGE DAILY PRODUCTION OF BLOCK FROZEN SQUID WHOLE IN THREE FACTORIES (1995-97)

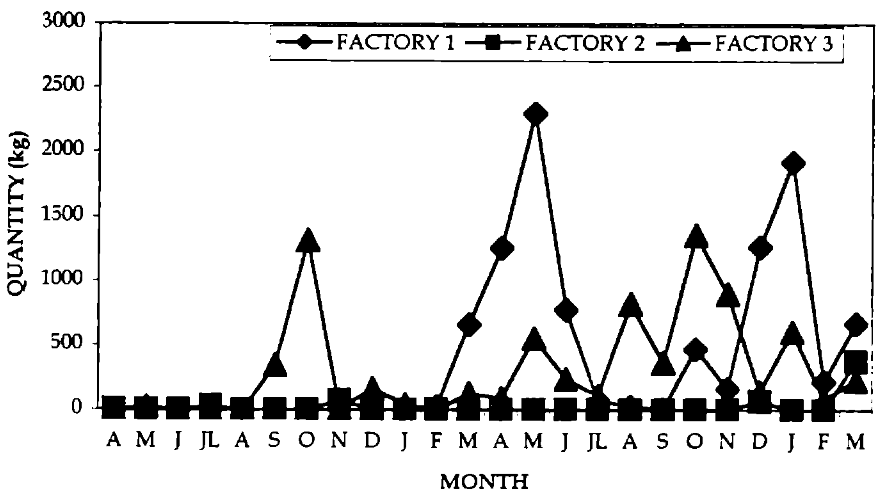


Fig 33. AVERAGE DAILY PRODUCTION OF BLOCK FROZEN SQUID WHOLE CLEANED IN THREE FACTORIES (1995-97)

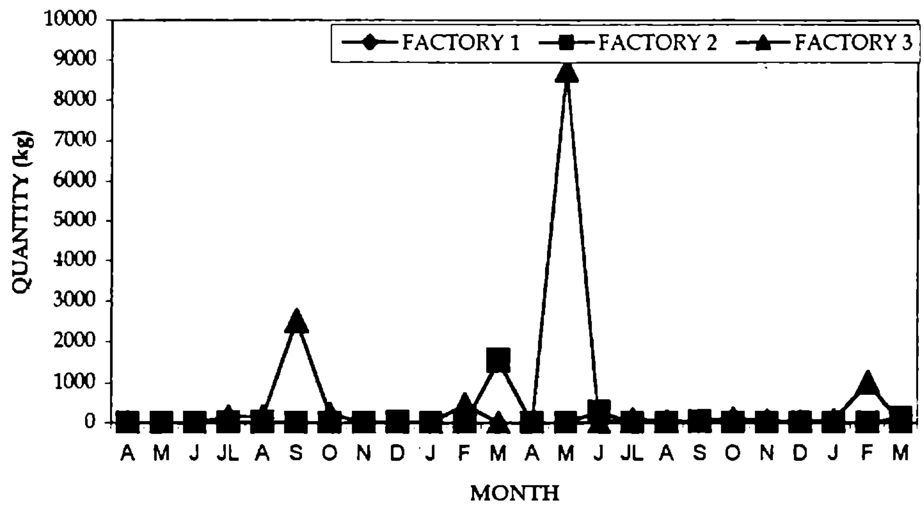


Fig 34. AVERAGE DAILY PRODUCTION OF BLOCK FROZEN SQUID TUBE IN THREE FACTORIES (1995-97)

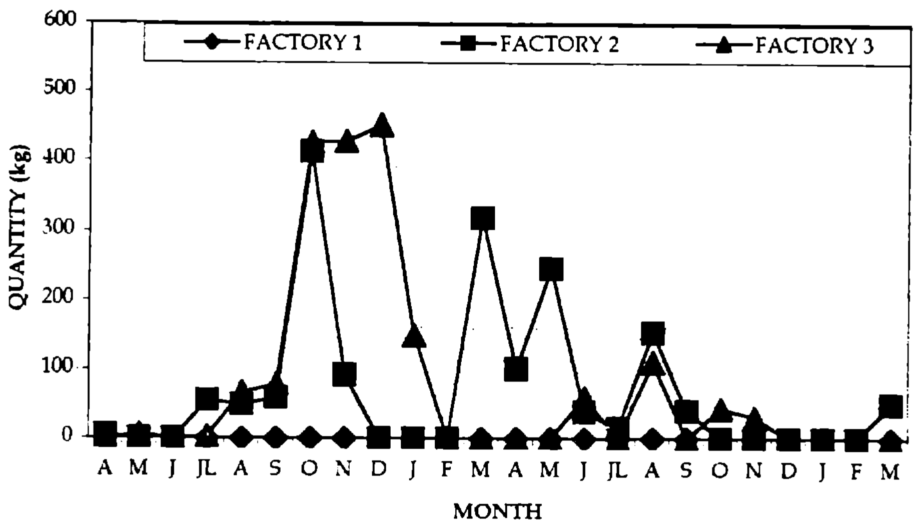


Fig 35. AVERAGE DAILY PRODUCTION OF BLOCK FROZEN SQUID TENTACLE IN THREE FACTORIES (1995-97)

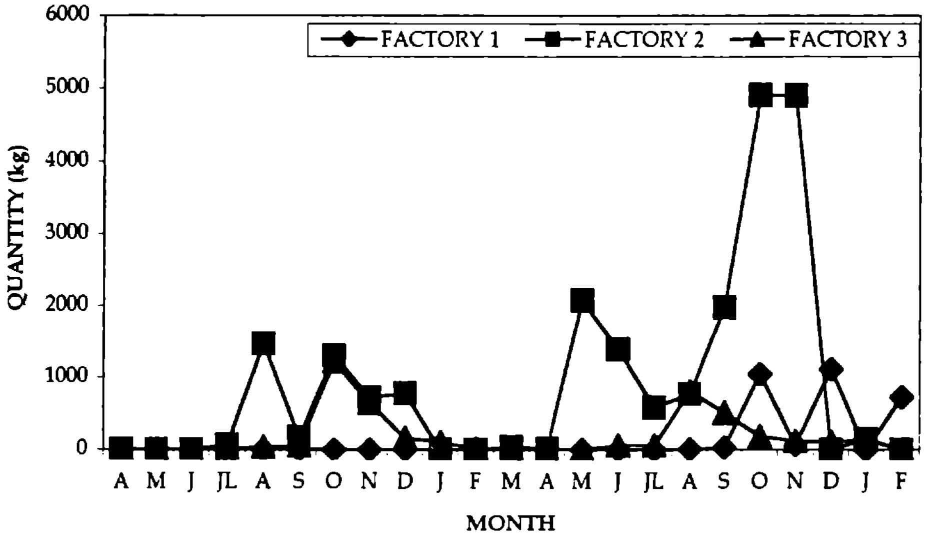


Fig 36. AVERAGE DAILY PRODUCTION OF OTHER BLOCK FROZEN PRODUCTS IN THREE FACTORIES (1995-97)

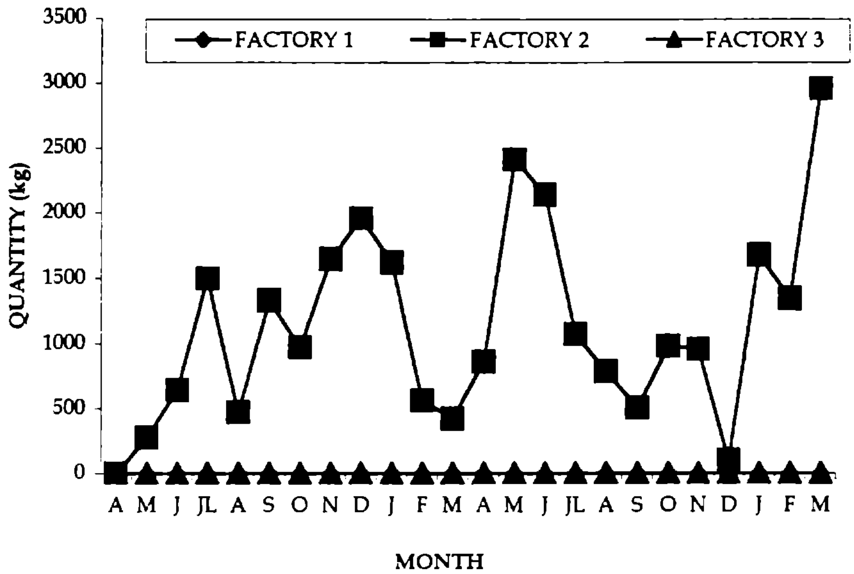


Fig 37. AVERAGE DAILY PRODUCTION OF IQF PEELED AND UNDEVEINED SHRIMP IN THREE FACTORIES (1995-97)

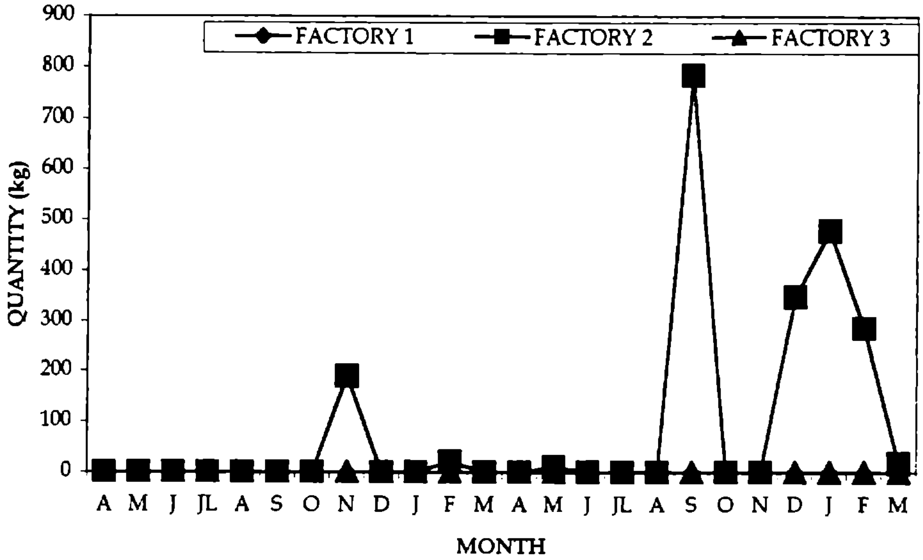


Fig 38. AVERAGE DAILY PRODUCTION OF IQF PEELED AND DEVEINED SHRIMP IN THREE FACTORIES (1995-97)

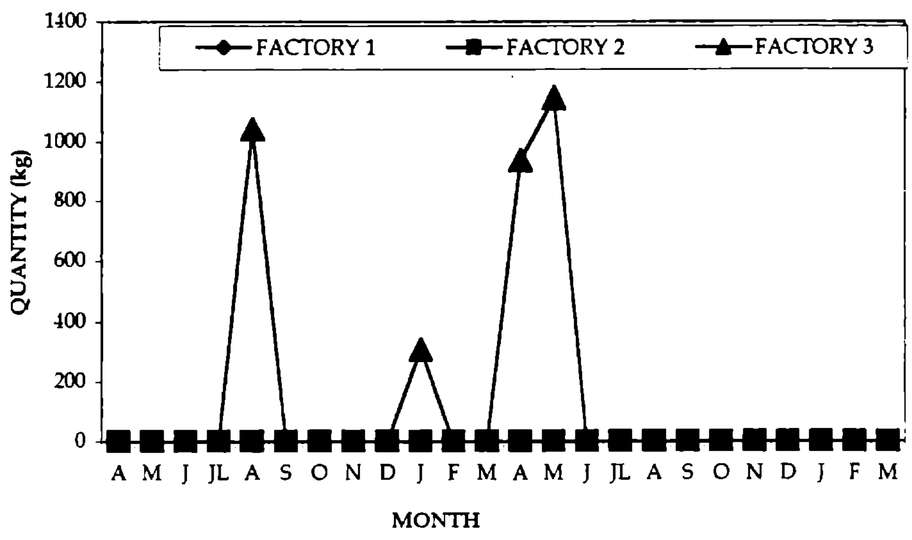


Fig 39. AVERAGE DAILY PRODUCTION OF IQF SQUID WHOLE CLEANED IN THREE FACTORIES (1995-97)

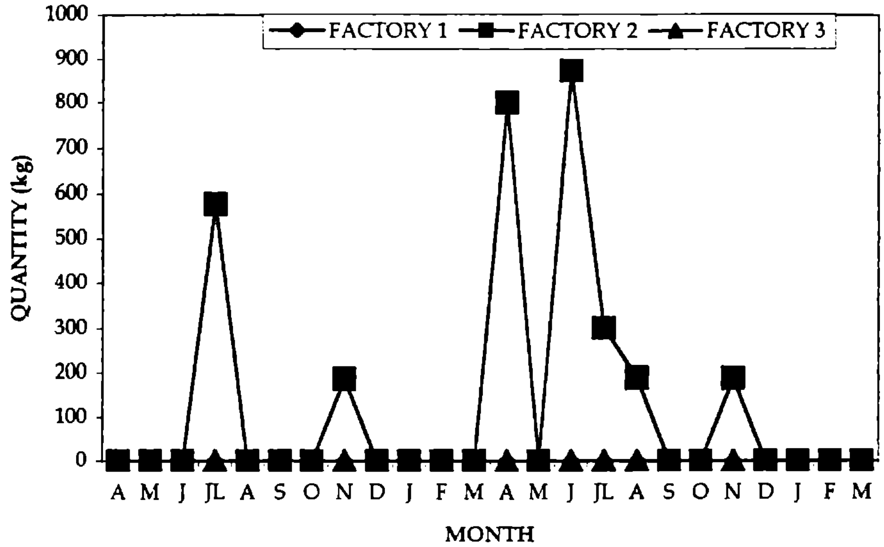


Fig 40. AVERAGE DAILY PRODUCTION OF IQF SQUID RING IN THREE FACTORIES (1995-97)

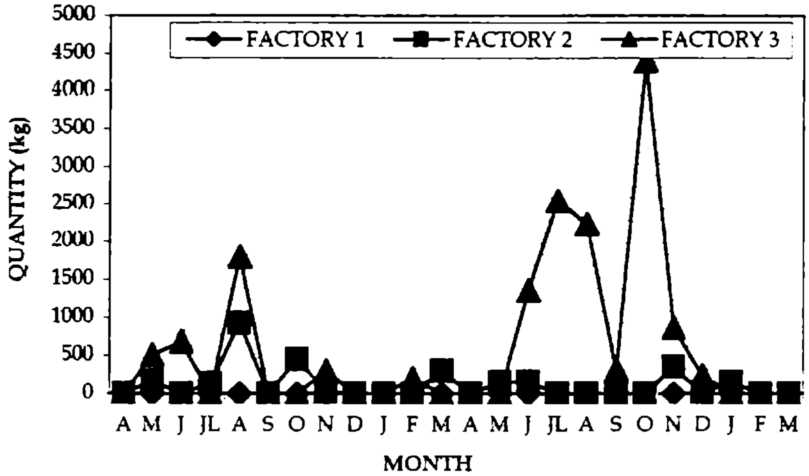


Fig 41. AVERAGE DAILY PRODUCTION OF IQF CUTTLEFISH WHOLE CLEANED IN THREE FACTORIES (1995-97)

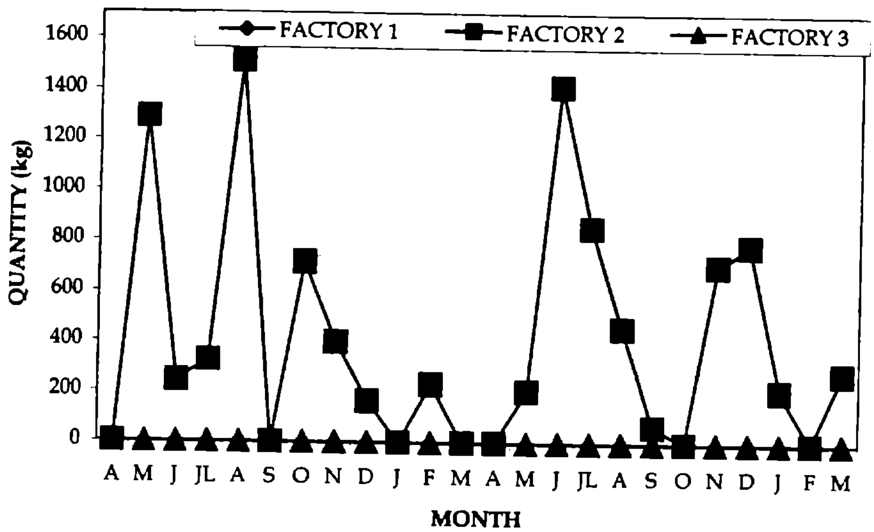


Fig 42. AVERAGE DAILY PRODUCTION OF IQF REEF COD SCALE LESS IN THREE FACTORIES (1995-97)

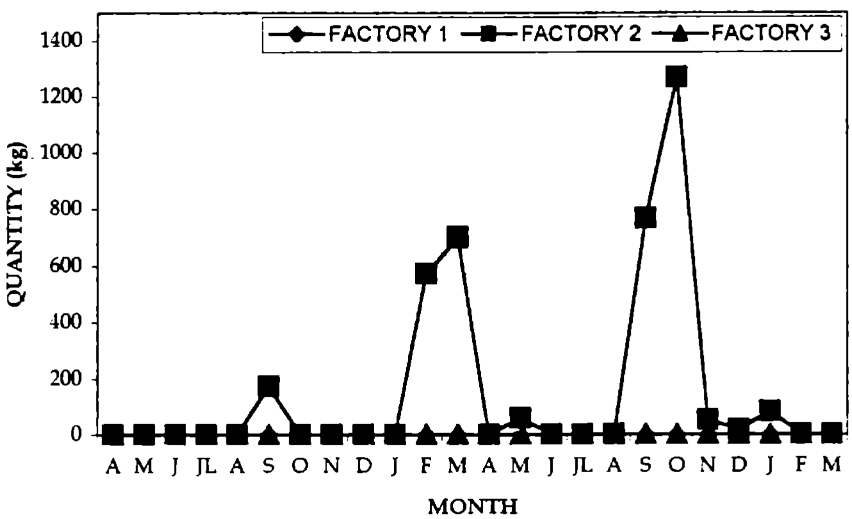


Fig 43. AVERAGE DAILY PRODUCTION OF IQF REEF COD GUTTED IN THREE FACTORIES (1995-97)

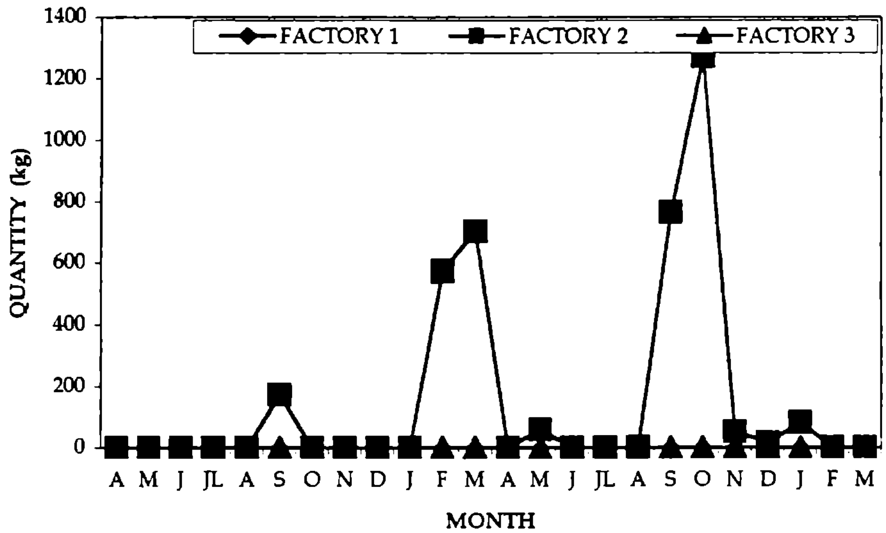


Fig 44. AVERAGE DAILY PRODUCTION OF OTHER IQF PRODUCTS IN THREE FACTORIES (1995-97)

CHAPTER 6

METHOD ANALYSIS AND WORK MEASUREMENT

1. Introduction

The main job of designing a process facility will be to take care of developing a design which will minimize production costs without affecting the function and consumer acceptability of the product adversely. The job of the method analyst is to select production methods, which will involve the most economical sequence of operations and the use of the most efficient equipment and accessories available (Mayer, 1975). He also specified how the production facilities are to be operated so as to minimize processing time, material handling especially at higher temperatures. The process engineers give the general instructions at the time of designing the process. But the process engineers will not provide any information on the work methods, which should be employed at work stations. One layout or the pattern of activity at a station may be more efficient than some other alternatives. Hence a study by method analyst is required to work out these factors.

The important factor to be noted here is that the best available method at one point of time will not necessarily be the best available method at some later point of time. Subsequent analysis may reveal that more economical materials are available; more efficient machines, tools, jigs, and fixtures have been designed; better quality assurance methods have evolved; the existing plant layout is obsolete because of the change in the production mix; and so on. This is very much true in the case of seafood industry in India, where a tremendous change in the product mix by the introduction of IQF products and value added products to the existing lines were noticed. New plants based on IQF technology are coming up in the various parts of the country. Similarly the introduction of HACCP concepts based on the EC and USFDA Directives have drastically changed the conventional system of quality control in the seafood plants in India. The conventional systems of production and production control existed in the seafood industry have now become obsolete; new equipment and fixtures had to be installed to satisfy the buyers requirements. The main task of the method analysis is to develop efficient methods for tasks, which are to be performed for the first time and to improve existing work methods. The present study aims at improving the existing methods of processing various seafood products.

Method Analysis and Work Measurement are the important methods used to improve the methods of manufacture or process of any products (Levin, 1972 ; Mayer, 1975). The method analysis helps to compare the alternate methods available for carrying out a production process. Similarly work measurement helps to estimate the standard time for carrying out each and every activity in a process.

Process chart method is the most common method used for Method Analysis. A process chart is a unique manner of describing an existing method. The process chart approach helps the analyst to get an idea for possible improvements of the existing methods of processing. Different types of process charts are available. The specific chart to be constructed in a given case will depend on the nature of the activity being studied and the amount of detail the analyst would like to include in his description. Flow process chart is found to be useful for Method Analysis of the production of various products. (Mayer, 1975).

A flow process chart is defined by the American Society of Mechanical Engineers as "a graphic presentation of the sequence of all operations, transportation, inspections, delays, and storage occurring during a process or procedure, and includes information considered desirable for analysis such as time required and distance moved".

To produce effectively and efficiently, management must establish goals for evaluating employee performance. These goals are translated into standards. A production and operations standard is a quantified criterion for measuring or judging output. The standard can be set for quantity, quality, cost, or any other attribute of output, and it is the basis for control.

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

Adam and Ebert (1995) reported the following uses for estimating time standards:

1. Evaluating individual performance and subsequent compensation.
2. Evaluating department performance and subsequent supervisor Compensation.

3. Evaluating process design, layout and work methods.
4. Comparing costs and revenues of equipment alternatives
5. Calculating standard costs.
6. Aggregate planning of work force levels and production rates.
7. Capacity planning and utilization.
8. Scheduling operations; sequencing jobs.
9. Estimating cost of products and production lots.
10. Planning types of labour skills necessary and budgeting labour expenses.

Studies on the Method Analysis and Work Measurement in seafood processing plants are scanty. Ramachandran (1988) reported that 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 fluctuation 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. Inefficient layout causing wasted movements, bad planning of work and orders, idle time of men and machine and spoilage of raw materials. 4. Shortage of raw materials due to bad planning which ultimately leads to idle time of men and machines. 5. Inefficiency of freezers and cold storages due to poor maintenance is resulting in the consumption of excess time and energy for processing. This is reported to accelerate spoilage of fish and fish products. He also reported that shortcomings due to the special nature of seafood industry such as fluctuation in raw material landings resulted in increased idle capacity of the production facilities.

Uncertain landings of a particular variety of raw material was reported to be the main reason for developing a highly flexible system for processing which in turn resulted in employing excess staff and production facilities to absorb the fluctuations in the raw material availability. Fluctuation of raw material purchase price frequently resulted in difficulty in fixing the production costs. Difficulty in procuring raw materials which are highly perishable from distant places was reported to complicate the situation. The normal time and standard time of various activities in the production of block frozen peeled and deveined shrimp, block frozen squid whole/cuttle fish whole, block frozen squid tube, canned shrimp and block frozen headless shrimp have already been studied (Ramachandran,1988; Ramachandran, 1990a).

2. Methodology

Three seafood plants in Cochin region were selected for the study. For analysing the existing methods employed in the processing of seafoods in these plants process chart approach was used as described by Mayer (1975). For the present study, flow process chart is used. The following symbols are used to describe various activities involved in the process -

⇨ = Transportation; O = Operation; □ = Inspection; ∇ = Storage; and D = Delay.

The following raw materials were used for the study on work measurement:

1. *Penaeus indicus* for the production of Individually Quick Frozen (IQF) Headless Shrimp.

2. *Parapenaeopsis stylifera* for the production of Individually Quick Frozen (IQF) Peeled and Cooked Shrimp.

Only raw materials purchased and received in raw material receiving hall in the form of headless shrimp are considered for the study. The start event considered for the study was the washing of iced material at the temporary storage site. Indigenously fabricated IQF machine was used for the study of IQF Headless Shrimp. Imported Frigoscandia freezer with flow freezing was used for IQF Peeled and Cooked Shrimp.

The work measurement was carried out as described by Levin (1972). The information regarding the methods of processing, infrastructure and various input requirements, etc., were collected by detailed observation of the processing activities of the above mentioned products from the study plants. The existing flow process charts (given in Chapter 5) were analysed and a standard flow process chart prepared to have the best sequence of production with less handling time and quality hazards. 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 process cycles. The number of observations required for a 95% confidence level and confidence limits (precision) of $\pm$ 5% were worked out using the formula:

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

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

X = Activity/ Element readings

ΣX = Sum of the observations/activity readings

N = Number of readings actually taken

Stopwatch time study was employed to measure the activity (element) in the processing plants. Keith *et al.* (1983) defines time study as the technique to establish the time required for a qualified worker to carry out a specified job at a defined level of performance.

The following types of allowances were taken into account while estimating the standard time. This is based on the special nature of seafood processing (Ramachandran,1988).

1. Personal allowance,
2. Process allowance and
3. Standing and fatigue allowance

3. Results and Discussion

3.1. Individually Quick Frozen Headless shrimp

Standardised flow chart for the production of IQF Headless Shell-on Shrimp (*Penaeus indicus*) processed manually and frozen in indigenously fabricated IQF machine is given in Figure 1.The entire production process is divided into ten activities or elements. Draining, checking of quality and grades, washing and quality checks are considered as critical. Freezing is a Critical Control Point where temperature is to be properly monitored. Usually headless items are immediately processed and packed to avoid the shell loosening and blackening. The flow chart is designed to avoid any temporary storage or delay during the production process.

Work measurement of various activities involved in the production of IQF Headless shrimp processed manually and frozen in indigenously fabricated IQF machine is shown in Table 1. Freezing was found to be the longest activity having a normal time of 19.222 min. for freezing 36/40 count materials. Washing was the shortest activity having a normal time of only 0.9 min.

The first activity in this production process is washing of raw material. Different methods were noticed in the washing process in different factories and in the same factory during different shifts. In the standard method suggested, the material is taken in stainless steel nets and it is dipped in chlorinated (5-10 ppm) tub water. In this process any ice, dirt and other foreign matter are removed.

Washed material is then recommended to be put on stainless steel porous table for draining. During this process quality checks can also be carried out as per specified norms. This is helpful to prevent any spoilt or substandard material to pass through this stage to the next activity in the production process. The main defects noticed at this stage during the study period included deteriorated pieces, discoloured pieces, loose shell, foreign matter, black spots and non-uniform pieces. The control at this stage involves the temperature regulation and removal of the above mentioned materials.

After completing the draining process ,the material is recommended to be immediately fed to the freezer conveyor for preventing any exposure of the drained material to higher temperature. Material fed on the conveyor belt shall be uniformly spread to avoid the clustering during freezing. Six female workers are suggested to be placed at this work centre to avoid any delay in feeding. Any delay in feeding will reduce the turnover of the frozen product and lead to over exposure of the drained material.

Two types of freezers (Individually Quick Frozen) are commonly used in seafood processing industry in Kerala. They are indigenously fabricated IQF units and imported ones. For this study, indigenous IQF freezers were selected. Freezing is done at -40°C in these freezers. Individually Quick Frozen Materials were later reglazed and packed in polybags manually. One female worker is recommended to be employed at each work station. One kg frozen material was glazed and packed in polybag for duplex cartoning. Along with duplex cartoning coding was also done to avoid delay in master cartoning.

Ten duplex cartons were packed in a five ply corrugated master carton.It is then sealed with large cellophane tape. These master cartons were also coded before packing. Sealed and coded master cartons were stored in the cold storage at -18 to -23°C.

The sequence of operation, preceding activities, percentage allowances given for different activities, standard time for each activity and cumulative time are given in Table 2. The standard time has been calculated based on the completion of the minimum quantity of the in-process material at the preceding workstation as shown in the Table 2. This is required to estimate the process cycle time of the whole process if the production is assumed to be continuous without any break. Turn over quantity of different activities has been taken into account to have a continuous production without any hindrance. In the case of draining and quality checking, 25 kg is considered as a unit which is required before the start of the succeeding activity i.e. feeding. But in the case of feeding, it needs only 5 kg to be fed to start the freezing activity. This is because the feeding site of the freezer takes only a maximum of 5 kg. at time to start with. For that reason at the feeding activity (preceding activity of freezing) 5kg. material is considered as essential to start the succeeding activity. There is some process delay at packaging stations due to the fact that system has to wait till 10 duplex cartons are ready before carrying out the master cartoning activity. This may affect the quality of the product. Hence it is advisable to carry out the packing activities in a chill room or anti-room of the cold store. The Process Cycle Time in this standard process was much less than the observed process times for the production of IQF HL shrimp in the study plants as reported elsewhere in this thesis. The Process Cycle Time of the Standardised process is only 29.859 min.

3.2. Individually Quick Frozen peeled,undeveined and cooked shrimp

Sodium tripolyphosphate (STPP) treated PUD shrimp was used for the study after the checking of quality and grade. Figure 2 shows the standardised flow chart for the production of peeled and undeveined IQF shrimp (300-600 count) in a fully automatic system. It is recommended that the treated material is to be taken in a stainless steel net and uniformly put into the feeding hopper. Three female workers are suggested to be employed at this workstation to carry out the activity without any hindrance. The fed material was passed through the conveyor belt to the cooking chamber.

Cooking was done by steam cooking. For this purpose steam was injected into the cooking chamber containing water. Temperature of cooking was maintained at 85°C and it depended on the size grade of the raw material used for cooking. Cooking is considered a Critical Control Point. Maintenance of proper temperature and steam-shrimp ratio is very important in the cooking chamber.

After cooking, the material was passed through the chilling chamber for chilling (crushed ice was put into the chilling chamber containing water). Temperature of the chilled water was maintained at 0 to -5°C throughout the chilling process. The chilling process is also very Critical and is considered a Critical Control Point as the quality of the water and temperature used for chilling are very critical. The chilled material was then passed through the dewatering conveyor belt for dewatering. The length of the dewatering conveyor belt was about 5 meters and the dewatered material reached into the shaker for spreading, before freezing. The spread material was directly passed into the pre-cooling chamber. Before freezing, the material should be precooled for freezing. Later the material was passed through the conveyor belt into the freezer chamber for freezing at -40°C.

The frozen material was then fed into the glazer conveyor belt and the material was glazed by means of chilled water spraying (crushed ice was put into the tank containing water and it was passed into the pump of the glazer vibrator). The quality of the ice used and the temperature maintained for the glaze water is also very critical and any contamination at this stage cannot be eliminated at subsequent stages. Glazed materials were then manually spread for glazo-freezing or glaze hardening. After glaze hardening, the material was collected in a large polythelene bag and weighed. 10 kg material was packed in master carton and sealed. Before packing, coding was done by coding machine. Then it was stored at -18 to -23°C.

Observation of the time study and results of the study are given in Table. 3. The study starts with feeding of the raw material and ends with the master cartoning of processed material for frozen storing. Most of the activities require more than two persons to be carried out. Freezing is the longest activity in the production process and its normal time is 12 minutes and average observed time is 15 minutes. Normal times and average observed times of all processing activities other than freezing are given in Table 3.

The allowances given for different activities, turn over quantity and standard time for different activities are given in Table 4. The standard time has been calculated based on the completion time of the minimum quantity of the in-process material at the preceding work station to carry out the work at a particular work station as shown in the Table 4. This is required to estimate the process cycle time of the whole process if the production is assumed to be continuous without any break. Turn over quantity of different activities has been taken into account to have a continuous production without any hindrance.

The Process Cycle Time for the production of Block frozen products was reported by Ramachandran (1988) as 5 hours 21 minutes for a batch of 220 slabs of 2 kg net weight each. This shows that, by changing the technology from block freezing to IQF, it is possible to considerably reduce the processing time. This will in turn improve the quality of the products considerably. The significant reduction in activity time is noticed in the case of freezing in IQF technology when compared to block freezing. Freezing in IQF machinery is completed in 15 to 20 min. whereas in the latest model block freezing machinery it takes 90 min. Labour requirement is also considerably reduced in IQF lines especially in automated systems when compared to block freezing lines as reported by Ramachandran (1988).

Table 1. WORK MEASUREMENT OF VARIOUS ACTIVITIES INVOLVED IN THE PRODUCTION OF IQF HEAD-LESS SHRIMP PROCESSED MANUALLY AND FROZEN IN INTEGENOUSLY FABRICATED IQF MACHINE (36/40 COUNT)

Acti vity code	Activity	Start event	End event	Average observed time (minutes)	Rati ng facto r	Normal time	Turn over quant ity (kg.)	No. of workers involved	Remarks
1	Washing	Start of washing of iced material at the temporary storage site.	Washed material kept ready for draining	0.900	1.0	0.900	25	2 F	F= Female worker
2	Draining & checking of quality & grade	Draining of the washed material started	Workers ready for rechecking of quality and grades of the next lot	2.288	0.9	2.059	25	2F	
3	Feeding	Material kept ready for feeding after draining and quality checking	Completed feeding	2.678	0.75	2.009	25	6 F	

4	Freezing	Completion of feeding	Start of appearance of frozen shrimp at the discharge end of the freezer	4.786	1.30	19.222.	33.1	-	
5	Weighing	Discharge of material after freezing at the discharge end of the freezer.	Weighed material kept ready for glazing	1.627	0.91	1.464	5 P	1 F	P =pack
6	Glazing	Frozen material after weighing kept ready for glazing	Glazed material kept ready for polybag packing	2.088	0.8	1.670	5 P	1 F	
7	Polybag packing	Glazed material kept ready for polybag packing	Sealing completed and the packed material is ready for duplex cartoning	1.623	1.05	1.704	5 P	1 F	
8	Duplex cartoning & coding	Sealed poly bags ready for duplex cartoning	After coding & packing ready for Master cartoning	1.623	1.05	1.704	5 P	1 F	

9	Master cartoning	Packed duplex carton ready for master cartoning	Sealed master cartons ready for cold storing	1.623	0.90	1.461	10 P	1 M 1 M	M= male worker
10	Storing	Sealed master cartons ready for cold storage	Cold storing completed	1.750	0.90	1.575	10 P		M.C. =Master Carton

Table 2. SEQUENCE OF OPERATION FOR THE PRODUCTION OF FROZEN IQF HEADLESS SHRIMP PROCESSED MANUALLY AND FROZEN IN INTEGENOUSLY FABRICATED MACHINE (36/40 COUNT) AND ESTIMATED STANDARD TIMES FOR VARIOUS ACTIVITIES

ACT. No.	ACTIVITY	PRECED-ING ACTIVITY	QTY (kg) TURN-OVER	NORMAL TIME (Min.)	ALLOW-ANCE (%)	STAND-ARD TIME (Min.)	CUMULATIVE TIME (Min)
1.	Washing	-	25	0.900	2	0.918	0.918
2.	Draining & Checking	1	25	2.059	1.5	2.039	2.131
3.	Feeding	2	5	0.402	4	0.418	2.549
4.	Freezing	3	25	19.220	2	19.604	22.153
5.	Weighing	4	1 P	0.293	2	0.299	22.452
6.	Glazing	5	1 P	0.334	1.5	0.339	22.791
7.	Polybag packing	6	1 P	0.341	1.0	0.344	23.135
8.	Duplex cartoning & coding	7	10 P	3.408	0.5	3.426	26.561
9.	Master cartoning	8	10 P	1.704	0.5	1.713	28.278
10.	Storing	9	10 P	1.575	0.5	1.581	29.859

P - packet

Note:

1. The standard time has been calculated based on the completion of the minimum quantity of the in-process material at the preceding workstation as shown in the table. This is required to estimate the process cycle time of the whole process if the production is assumed to be continuous without any break.

2. Freezing is the longest activity in the whole process.

3. There is some process delay at packaging stations due to the fact that system has to wait till 10 duplex cartons are ready before carrying out the master cartoning activity. This may affect the quality of the product if carried out at room temperature. Hence it is advised to carry out these activities in a chill room or anti-room of the cold store.

4. Turnover quantity for different activities has been taken into account to have a continuous production without any hindrance. For e g. In the case of draining and rechecking of quality, 25 kg is considered as a unit which is required before the start of the succeeding activity i.e. feeding. But in the case of freezing, we need not wait till all the 25 kg. to be fed to the freezer for starting the freezing activity. The feeding site of the freezer takes only a maximum of 5 kg. at a time to start with. For that reason at the feeding activity (the preceding activity of freezing) 5 kg. material is considered as essential to start the succeeding activity.

Table 3. WORK MEASUREMENT OF VARIOUS ACTIVITIES INVOLVED IN THE PRODUCTION OF IQF PEELED UNDEVEINED AND COOKED SHRIMP PROCESSED IN AUTOMATIC IQF MACHINE (IMPORTED) (*PARAPENAEOPSIS STYLIFERA* – 300/600 COUNT)

Activity code	Activity	Start event	End event	Average observed time (min.)	Rating factor	Normal time	Turn over quantity (kg.)	No. of workers involved	Remarks
1	Feeding	Material kept ready for feeding after draining and quality checking	Completed feeding	4.145	0.90	3.731	25	3 F	F= female worker
2	Cooking	Completion of feeding to cooking line	Start of appearance of frozen shrimp at the discharge end of the cooker	0.667	1.00	0.667+5.191	25	1 F	Normal time for cooking is .667′ and turnover time for 25 kg. cooked material is 5.191′

3	Chilling	Discharge of material after cooking at the discharge end of the cooker.	Chilled material kept ready for dewatering	4.585	0.90	4.127	25	2 F	
4	De- watering	Chilled material kept ready for de-watering	De-watered material kept ready for pre-cooling	4.345	0.95	4.127	25	1 F	
5	Pre-cooling	Dewatered material kept ready for pre-cooling	Pre-cooling completed and the material is ready for freezing	4.4775	0.92	4.119	25	-	
6	Freezing	Pre-cooled material ready for freezing	Frozen material ready for glazing	15.000	0.80	12.00+5 .190	10	-	Normal time for freezing is 12′ and turnover time for 10 Kg. Frozen material is 5.190′

7	Glazing & quality checking	Frozen material ready for glazing	Glazed material ready for glaze hardening	3.913	1.20	4.695	25	4 F+1 M	M=male Worker
8	Glaze hardening	Glazed material ready for glaze hardening	Glaze hardening completed	3.913	1.20	4.695	25	-	
9	Final product collection weighing & quality Checking	Glaze hardening completed and the material ready for final collection	Final product collection completed and the material ready for packing	1.600	1.20	1.920	10	3 F	
10	Master cartoning	Final product packed in poly bags ready for Master cartoning	Master cartoning completed and the Master cartons ready for storing	1.600	1.20	1.920	1 MC	2 M+2 F	

Table 4. SEQUENCE OF OPERATION FOR THE PRODUCTION OF FROZEN IQF PEELED UNDEVEINED AND COOKED SHRIMP PROCESSED IN AN AUTOMATED SYSTEM (300/600 COUNT) AND ESTIMATED STANDARD TIMES FOR VARIOUS ACTIVITIES

ACT. No.	ACTIVITY	PRECEDING ACTIVITY	QTY.(Kg) TURN-OVER	NORMAL TIME (MIN.)	ALLOWANCE (%)	STANDARD TIME (MIN.)	CUMULATIVE TIME
1.	Feeding	-	25	3.731	2	3.806	3.806
2.	Cooking	1	10	2.743	1.5	2.783	6.589
3.	Chilling	2	10	1.651	68.56	2.783	9.372
4.	De-watering	3	10	1.651	68.56	2.783	12.155
5.	Pre-cooling	4	10	1.647	68.97	2.783	14.938
6.	Freezing	5	10	17.190	1.0	18.909	33.847
7.	Glazing & Quality Checking	6	10	1.878	176.36	5.190	39.037
8.	Glaze hardening	7	10	1.878	176.36	5.190	44.227
9.	Final product collection, washing & quality checking	8	10	1.920	170.31	5.190	49.417
10.	Master Cartoning (MC)	9	1 MC	1.920	-	1.920	51.337

Note:

1. The standard time has been calculated based on the completion of the minimum quantity of the in-process material at the preceeding work station as shown in the table. This is required to estimate the process cycle time of the whole process if the production is assumed to be continuous without any break.

2. Freezing is the most longest activity in the whole process.

3. There is some process delay at packaging stations due to the fact that system has to wait till 10 duplex cartons are ready before carrying out the master cartoning activity. This may affect the quality of the product if carried out at room temperature. Hence it is advised to carry out these activities in a chill room or anti-room of the cold store.

4. Turnover quntity for differrent activities has been taken into account to have a continuous production without any hinderance. For eg. In the case of draining and rechecking of quality, 25 kg is considered as a unit which is required before the start of the succeeding activity i.e. feeding. But in the case of freezing, we need not wait till all the 25 kg. to be fed to the freezer for starting the freezing activity. The feeding site of the freezer takes only a maximum of 5 kg. at a time to start with. For that reason at the feeding activity (the preceeding activity of freezing) 5 kg. material is considered as essential to start the succeeding activity.

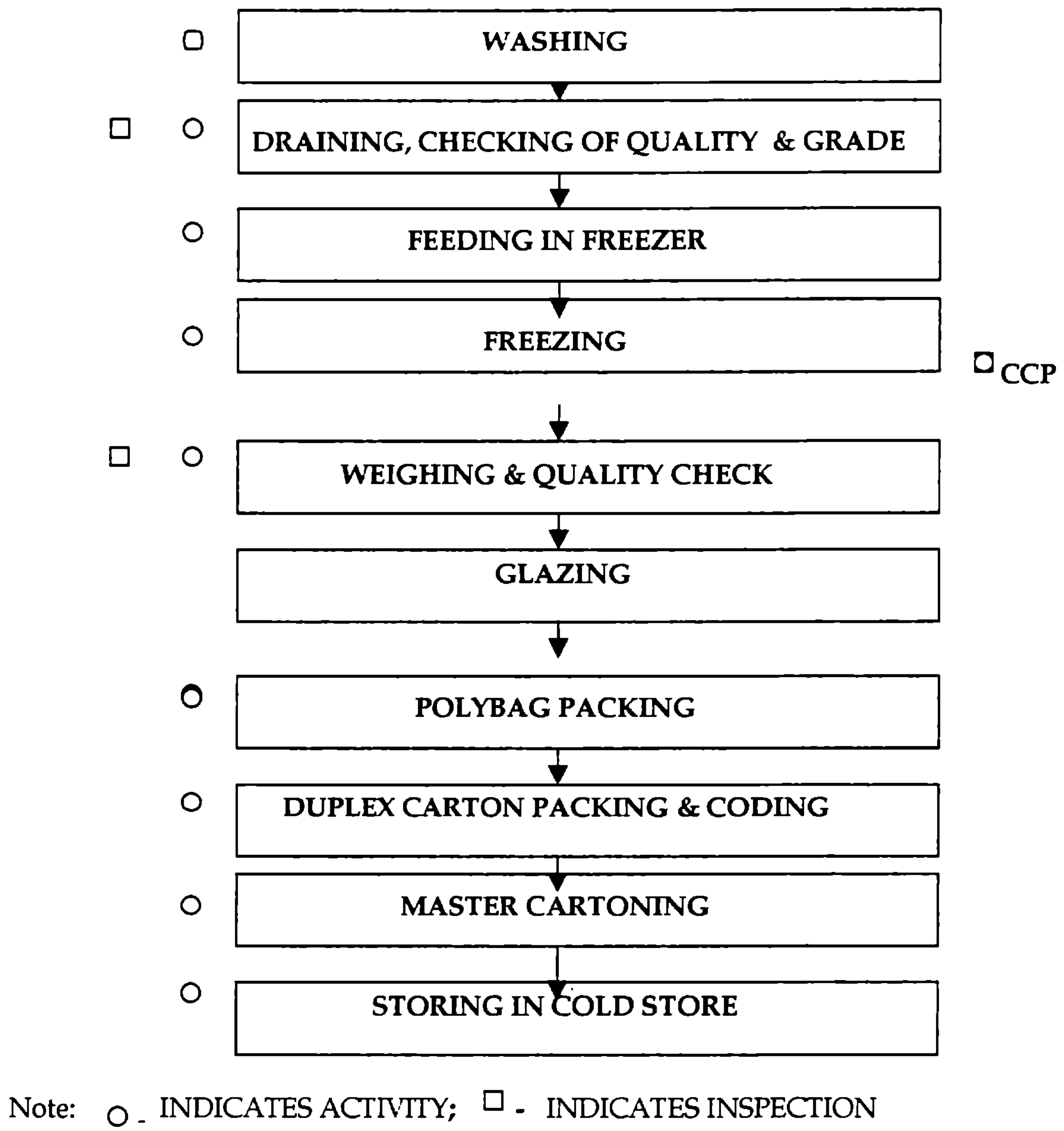


Fig 1. STANDARDISED FLOW CHART FOR THE PRODUCTION OF IQF HEADLESS SHELL-ON SHRIMP (*PENAEUS INDICUS*) PROCESSED MANUALLY AND FROZEN IN INTEGENOUSLY FABRICATED IQF MACHINE (36/40 count)

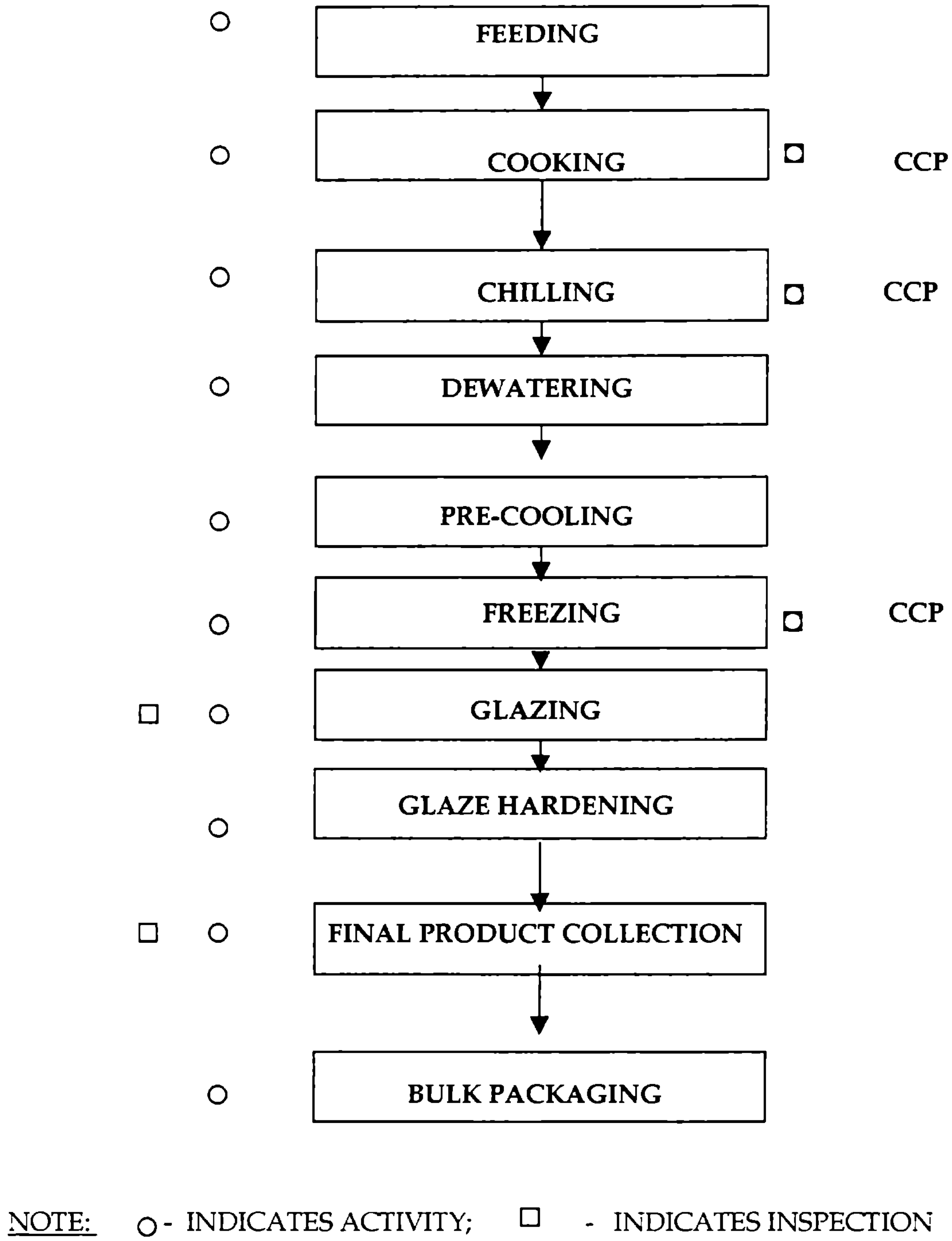


Fig.2. STANDARDIZED FLOW CHART FOR THE PRODUCTION OF PEELED AND UNDEVEINED IQF SHRIMP (300-600 COUNT) IN FULLY AUTOMATED SYSTEM

CHAPTER 7

ORGANISATIONAL DESIGN AND STRUCTURE

1. Introduction

Organizational structure is one of the most important elements of management. Organisation makes use of specialisation, by allocating specific jobs to those who are considered most suitable for the jobs. It also enables the establishment of effective communication between workers, supervisors and managers in the factories. Further more it establishes as the relationship between different departments engaged in similar jobs so that effort of all the departments can be integrated for the achievement of common objective. Organisation is defined as the process of identifying and grouping the work to be performed, defining and delegating authority and establishing relationship for the purpose of enabling people to work most effectively together in accomplishing objectives (Lal, 1990).

In very small factories comprising of only a few persons, there may be no need for any formal organisational structure. This may be so, because every one fully understands everyone else and they know their limits of responsibility and authority. In a medium, small or large factory, there is no close contact with top management . Therefore rules of the game of business have to be formally laid down so that every one knows exactly what he is required to do, and what is the limit of the authority.

Thus it makes for human relations and reduces the chances of misunderstanding and error. It provides for the optimum use of resources and it stimulates creativity by removing routine burden from those who are supposed to do creative thinking and it aids in the correct evaluation of the individual contribution (Lal, 1990).

Organisational structures vary depending upon the functions of the business and leadership style of the managers. There are so many factors affecting the designing of organisational structure for the management of quality. According to Lal (1990), these factors are company policies and objectives, business, products, company size and organisation, market and customers. The organisational structure of the company itself suggests the type of quality organisation that may be required. In a functionally organised company, most of the quality functions will be centrally directed by the quality manager, where as in a divisional type of company structure, the bulk of the quality functions may be delegated to various divisions. Only those services may be centrally retained, which are necessary for providing advice to the management. At the same time, an effective channel of communication should be established, to ensure specialised quality services at whatever point they are needed in the company organisation.

According to Lal (1990), effective quality management requires a proper organisational framework through which quality programme is implemented. However, restructuring organisation in a company is rather difficult task, because it affects the relative status, authority and responsibility of company executives. Any reorganisation without adequate groundwork is likely to cause resistance to the intended measures and may jeopardise the success of quality programme. Therefore it is advisable that in the final stage of introduction of TQM in a company, the organisational structure should not be touched. The quality programme should first be introduced in a selected area within the framework of the existing organisation. For instance, if it is found that there is heavy rejection of a particular product, the modification in the process and its control must be initiated with the active help and co-operation of process engineering and production personnel. Wherever possible, the control function should also be carried out by the operator or production supervisor. The quality manager, acting as an advisor, must remain in the background. Production and engineering personnel must be given all the credit for any improvement achieved in the process.

A practical method of developing a TQM approach is to identify the basic problems affecting the organisation's activities (Kangi and Asher, 1995) and help to moderate necessary improvements of the organisation. In the current industrial and financial environment,the implementation of the process is one of the most complex projects that a company can undertake, because of the need for all employees including top management to accept cultural change. We all know that changing an activity is much easier than changing people ; nevertheless, the management have to project a leadership style for involving everybody in the organisation in achieving good quality. It is also advisable to concentrate on the approach of effective problem solving at the early stage of a TQM process in order to understand the organisation's strength and weaknesses.

An analysis of the organizational structure and design of seafood plants is important to understand the level of adoptability of Total Quality Management system. Even though there is not even a single study on the organizational structure and design of seafood plants in India, a number of studies have been carried out elsewhere on the three main organizational design approaches: Classical, Behavioral and Contingency approaches.

1.1. Organizational design approaches

There have been a number of theoretical perspectives that have emerged over the years that can be classified as belonging to the classical approach. Two separate branches of classical school have developed. The first one gave emphasis on the management of jobs (Scientific Management). Among these, the Taylor's work on Scientific Management is important (Taylor, 1911). The second gave emphasis on management of organizations (Administrative Theory). The Bureaucratic approach to organizational design was conceptualized by Max Weber, in the early part of this century. Like Taylor, Weber also believed that the key to the survival of an organization was through mechanisms that increased the efficiency of the organisation's activities. Weberian model is based on a number of important characteristics as follows: (1) Division of labour, (2) Well defined rules and procedures, (3) Authority, (4) Impersonality and (5) Careers. These characteristics of an "ideal" bureaucracy established a major organizational movement even today (Weber, 1947). But the main issues with Bureaucratic Model are 1. Excessive red tape, 2. Inflexibility, 3. Dominance of Authority, and 4. Position Protection. The other contributors to the Classical Approach are Gilbreth, F.B., Church, A.H., Fayol, H., Davis, R.C., and Urwick.L (Szilagyi, 1981).

The ineffectiveness of the classical design approaches later led to the development of the Behavioral Approach to organizational design. The Behavioral Approach of management offered a somewhat different perspective. Whereas the Classical Approach gave attention to the efficiency of job activities, the behavioral school of management sought to understand the psychological and sociological processes - i.e. attitudes, motivation and group structure that affected employee performance.

Likert (1961) described the more effective, people-oriented organisation in terms of eight dimensions and calls it a System 4 organisation. The classical design is designated as System 1. Likert believes that System 1 organisations are ineffective because they cannot respond or cope with changes in their environment. To adapt to environmental change,the organizational design needs to be more flexible. Unlike in Classical Design Organisation, in System 4 Organisation the leadership process includes perceived confidence and trust between superiors and subordinates in all matters. Subordinates feel free to discuss job problems with their superiors, who in turn solicit their ideas and opinions. The motivational process in Classical Design Organisation taps only physical, security and economic motives through the use of fear and sanctions whereas in the case of System 4 Organisation, motivational process taps a full range of motives through participatory methods. Attitudes are favourable toward the organisation and its goals. The Communication process in Classical

Design Organisation is such that information flows downward and tends to be distorted where as in the other system information flows freely throughout the organisation – upward, downward and laterally. Here the information is accurate and undistorted. In the former system, the interaction process is closed and restricted whereas in the latter one the interaction process is open and extensive: both superiors and subordinates are able to affect departmental goals, methods and activities. The decision process, goal setting and control in the Classical Design Organization are only at the top of the organization whereas they take place at all levels in System 4 Organization and is relatively decentralized. The performance goals in Classical Design Organisation are low and passively sought by managers who make no commitment to developing the human resources of the organisation. In System 4 Organisation performance goals are high and actively sought for by superiors, who recognise the necessity for making a full commitment in developing, through training, the human resources of the organisation (Likert, 1961).

Bennis (1966) assumes that bureaucracy will wither and become less prevalent in organisations because managers will be unable to manage the tension, frustration and conflict between individual and organizational goals. In addition, bureaucracy will fade because of the scientific and technological revolution in industrialized nations.

A contingency approach strives to aid managers by suggesting organizational design strategies, which have the highest probability of succeeding in a specific situation. The success criteria revolve around the accomplishment of organizational goals.

The contingency approach is appealing to practicing managers for a number of reasons. First, the contingency approach depends not only on a particular design but also search through many variables that are important and selecting a design decision for the organisation that is appropriate for a given situation. Second, it, although empirically based, incorporates personal opinions about the situation facing an organisation. It encourages the use of different models, systems scientific management, classical organisation theory, bureaucracy and/or System 4, if they properly fit the situation. This openness and willingness to use what fits best is realistic if one considers the dynamic nature of organisations and their environments. Finally, the contingency approach clearly points out that various departments of a single organisation may require different organizational designs to accomplish goals. Thus, the same organisation may have different designs as opposed to a strictly bureaucratic or System 4 structure. The exact designs used in an organisation's departments are based on the situational mix of variables affecting their goal progress and achievement.

Burns and Stalker (1961) studied twenty industrial organisations to assess the pattern of managerial activities in planning, organising and controlling and their relations to the external environment. They discovered that management processes were different in various industries and environments. They found that each firm in their study sample could be viewed as an information-processing network. The Burns and Stalker study treated the predictability of environmental demands facing organisations. They rated environments on a 'five interval' scale, from "stable" to "least predictable." The perspective acquired from their analysis of over twenty companies resulted in the identification of two management systems: mechanistic and organic. The structure in the organic organisation is based on expertise in handling current problems. In this type of organisation, there is less rigid hierarchy, but there is a structure that is used to avoid confusion and chaos. The individual's loyalty in this type of organisation is developed around work unit membership. The group has a special value in satisfying needs of employees in the organic system. Finally,organic system is more flexible and able to cope with and adjust to changes in technology and market situations. Rigidity of structure in the mechanistic organisation hinders its ability to adapt to change. Thus, it is most appropriate to implement it in a more stable environment.

Lawrence and Lorsch (1969) conducted field studies in three different types of industries namely – plastic, food and container to determine what kind of organizational design was best suitable with various economic and market environments. The aim of the study was to find out the effectiveness of the organizational design in terms of its environmental uncertainty. They concentrated on three subsystems – marketing, economic-technical and scientific - and hypothesized that the structural arrangement of each subsystem or department would vary with the predictability of its own environment. They proposed that the greater the degree of environmental certainty, the more formalized or rigid (bureaucratic) would be the structure. The most important observation of their study is the relationship between an organisation's structure and its environment. Stable environments are best suited for a functional structure (mechanistic), with its emphasis on rules, procedures and authority. On the other hand, the more dynamic the environment, the more suited will be a product-type structure (organic), where there is a focus on authority, decentralization and coordination mechanisms. They observed the food industry to be operating in a moderately uncertain external environment with moderate degree of differentiation. Marketing research and research production are reported to be inter-dependant factors. They feel that the major problem with food industry is consumer preferences. They also reported that the organizational structure in food industry is Functional/product (mechanistic/organic)oriented.

1.2. Strategy and Structure

The study conducted by Chandler (1962) in over seventy firms in USA showed that the organisational structure follows the growth strategy of the organisation – in order to use its resources most effectively in the face of changing external environmental conditions. These new strategies create new internal structural problems to the organisation. Another important observation is that organisations do not change their structures until they are provoked or forced to by a state of inefficiency. Only changing the structure of the organisation can solve the internal problems such as ineffective departmentalization, lack of proper authority over projects, or an absence of coordination. If a structural rearrangement does not occur, then the strategy will be less than effective. His study identified four different growth strategies that were followed in the firms 1. Volume Expansion; 2. Geographic

Expansion; 3. Vertical Integration and 4. Product Diversification. He found that the entrepreneurs who started the organisations were resistant to change. On the other hand, the next generation of mangers – the professional organisers/managers – had acquired different skills and knowledge bases that were more adaptable to the later growth stages (i.e. vertical integration and product diversification).

Technology was viewed as another contingency factor in organizational design. It has, however, been viewed more as a constraining factor than a pure determinant. The task of the organizational design specialist is to find out how flexible is the technology to the needs that are imposed on the organistation by the environment. A heavily capital and equipment intensive organisation may not have the flexibility of an organisation that is more labour intensive, especially in a dynamic environment. To counteract this constraining problem of the environment, many organisations have made use of temporary task forces or permanent project managers to ensure flexibility.

Davis and Lawrence (1977) gave a detailed description about Matrix Design. Matrix Design is simply a product structure superimposed on a functional structure and is fast becoming the most popular form of organizational structure. It is certainly not the final answer, particularly with the many problems that have arisen with organisations that have adopted this design. It is quite appropriate for organisations that operate in dynamic and complex environments, that need both the costs control and flexibility offered by the functional and product structures respectively.

1.3. Organizational dimensions

Analyzing the external and internal environments, establishing goals and developing extensive organizational plans will be a futile exercise unless the manager gives a great deal of attention to the organizing function. A formal framework that permits the organisation to use its resources effectively and efficiently has to be developed. This framework is called organisation's structure. Three basic dimensions make up the organisation's structure. They are grouping, influence and coordination. The important factor for managers to identify about organizational dimensions is that they represent a sequential process. The first concern should be to group jobs followed by establishing authority and responsibility patterns within the newly formed units (influence). The final concern is to focus on integrating the various units into a unified effort to achieve the organisation's stated goals (coordination). The grouping component consists of three aspects: job specialization, departmentalization and line-staff relations. Job specialization, which involves grouping various jobs into units, can contribute significantly to effectiveness or be a big problem area. The key factor is the degree of specialization that is employed and the way workers react to this specialization. Too much specialization may lead to routine jobs boring and monotonous for the workers.

Departmentalization involves grouping departments into such arrangements as functional, product, geographical or mixed designs. The selection of these designs depends on a number of factors, the important being the cost effectiveness and adaptiveness. Functional is best for control of costs and product form is much more adaptive to changing environmental conditions. The influcence component consists of assigning or recognizing authority, power and responsibility relationships within the newly formed structure. The authority is exercised in organisations with the use of the chain of command, span of control and the principles of centralization/decentralization. The centralization/decentralization decision is one of the most important that a manager will make because it involves giving important authority to certain subordinate managers to make decisions that only higher level managers have made previously.

Coordinating the units and departments of an organization is an extremely important but massive and costly managerial activity. The need for coordination is based on three factors: the degree of interdependence and the differences in time and goal orientation between interacting units. As the degree of interdependence and the differences in time and goal orientation become more severe, the need for coordination also increases. The organising function acts as one of the major sources of development for the needed skills and roles performed by the manager. The influence component relates strongly to developing conceptual skills, and the coordination component is a determinant of diagnostic skills. Like wise, the various interpersonal, informational and decisional roles are affected by how the organisation is structured (Szyilagyi, 1981).

The traditional forms of management are based on a philosophy which divides responsibility for decisions into strategic, tactical and operational levels, i.e. the so-called management pyramid with top management (Strategic level) at the top of the pyramid, middle management (Tactical level) in between top management and employees/workers (Operational level). This management concept is totally inadequate for modern complex companies, since it does not provide effective communication between top management and bottom level employees responsible for customer satisfaction. The top management in this set up is ignorant of the real problems at the operational level and does not provide the support and backing that the operational level needs for the creation of customer satisfaction. The Japanese Management Philosophy is quite contrary to the Taylor model. According to the Japanese Management Philosophy, the business has to be carried out in an environment increasingly unpredictable, competitive and fraught with danger, that their continued existence depends on the day-to-day mobilization of every ounce of intelligence. The core of Japanese Management Philosophy is precisely this art of mobilizing and pulling together the intellectual resources of all employees in the service of the firm. They found that, only by drawing the combined brain power of all its employees, a firm can face up the turbulence and constraints of today's environment (Dahlgaard *et al.*, 1995).

A new pyramid has been developed based on the principles of TQM, and it is named as 'quality pyramid'. The quality improvement demands the total commitment of management. According to Deming (1986) it is not enough that top management commit themselves for life to quality and productivity. They must know what it is that they are committed to, i.e., what they must do. According to him these obligations cannot be delegated and support alone is not enough from the management. Action is more important. It has been estimated that 85% of all defects are caused by system errors, i.e., the errors that the management has the authority to change. Management must constantly strive to reduce system errors by setting up quality goals, drawing up quality policies and quality plans and participating actively in the follow-up auditing phase. Finally, management must concede its own lack of knowledge in the quality field and take the lead in acquiring new knowledge. If management does all this, it will have created a firm foundation on which future quality can be built. On the other hand, there is no point in building quality on a shaky foundation. Customer is the most important part of the production system. Deming introduced this idea to top Japanese managers in 1950 by means of a basic outline of an arbitrary production system. This outline, which must today be considered traditional, shows that both customer and supplier are part of the production system, and information for improving this comes from two sources: customer research and process tests. Since this outline also applies to an arbitrary sub-system, it shows that customer and supplier concepts embrace much more than just external customers and suppliers. Internal customers and suppliers i.e. employees, are at least as important as the external ones. Any person, or process, that it serves a number of internal customers, and the quality of the output delivered to these customers is crucial to the end result, i.e. the quality of the output delivered to the external customer. Deming (1986) also reported that this formidable challenge was taken up by the Japanese top managers and the result is palpable to all of us today.

A culture must be established to ensure that internal customer research functions just as well as external. Here the internal analysis should be based on entirely different principles from external analysis. Communication and team building are the key factors here. Obviously, the participation of top management is necessary in building up this culture. The focus on the customer and the employee is one of the most important innovations of TQM. The next side of the quality pyramid focuses on facts. It is obvious that one can produce quality products, if he or she knows what quality is and how he or she can achieve it. It is the customer who defines quality and not necessarily something that the production department thinks is technically challenging. This means that the production of quality goods is partly depending on the facts collected on customers' experiences and future needs. It also depends on facts about the production process. The third side of the quality pyramid is continuous performance. The success of a firm is its ability to adjust to the dynamic and changing market demands. If firms want to survive, they need to set up a system, which ensures continuous improvement in all parts of the production process. For this, Deming (1986) has introduced a simple model for process analysis and improvement, known as 'Deming Cycle' .The new model was introduced as a cycle of continuous improvements: 1. Plan improvements of products or processes (Plan). 2. Carry out the planned improvements (Do). 3. Observe the results (Check). 4. Carry out an analysis of causes and identify new improvement possibilities (Act). Repeat step 1. This method is also known as the Plan-Do-Check-Act (PDCA) cycle. Deming described this new method in the following way: 1. Design the product. 2. Make it; test it in the production line and in the laboratory. 3. Put it on the market. 4. Test it in service. Find out what the consumer thinks of it and why the non-user has not bought it (Dahlgaard *et al.*,1995). Although Deming suggested this over 40 years ago, only Japanese industries had identified its significance and adopted it in their organisations in the beginning. Now more and more organisations in the West have also understood the significance of Deming's model. This understanding is one of the most important innovations of the new TQM philosophy. The fourth and the last side of the quality pyramid is everybody's participation. The importance and meaning of everybody's participation may be illustrated by the following approach to the PDCA cycle used by the Matsushita Electric Company: 1. Identify defects and problems everywhere along the production line. 2. Find the causes. 3. Kill the causes and 4. Start all over again. This is suggested here because the employees in the sea food industry in India are totally unaware of the exact purpose of quality management programme being handled in their firms and are uncertain about the exact nature of quality management and its future for their firms. Matsushita's approach will help the management and employees of the seafood firms, to use the PDCA cycle by all employees at every level to achieve continuous improvement in their firms. This is the real essence of everybody's participation (Dahlgaard *et al.*, 1995).

It is mere commonsense that the intelligence of a handful of technocrats, however brilliant and smart they may be, is no longer enough to take them up with a real chance of success. Only by drawing on the combined brainpower of all its employees a firm can successfully survive in today's world of changing environment and markets. Team building is the only solution in this respect. Only by carrying out planning and causal analysis in work groups like quality improvement groups or quality circles, a full utilisation of the intellectual resources of the firm is possible. Quality goals and quality policies are the basis of quality plans. Most of the seafood firms in India do little in this area. Quality goals and quality policies have a definite function in TQM.

Sadgrove (1996) classified the leadership structure in an organisation into four categories – Autocratic, Feudal, Egalitarian and Anarchic. According to him egalitarian company is a much more liberated place to work. Here people communicate both up and down their own department and across their departments. Teams can be formed to solve particular problems. Since the structure is flexible, it can grow and contract in response to the market. This is the culture expected by TQM.

According to Vardaman and Halterman (1968), communication means the flow of material, information, perception, and understanding between various parts and members of an organisation. It also means all the methods, means and media of communication (communication technology), all the channels, networks, and systems of communication (organisational structure) and all the person to person interchange (interpersonal communication). It include all aspects of communication: up, down, lateral; speaking, writing, listening, reading; methods, media, modes, channels, networks, flow; interpersonal, intra-organizational and inter-organizational.

In this chapter an attempt has been made to find out the existing organizational structure, leadership style and communication system prevailing in the seafood factories in Kerala with respect to the applicability to Total Quality Management system in the seafood factories.

2. Methodology

Twenty-four seafood factories out of the total of 120 factories were randomly selected for the study using stratified random sampling technique for collecting general information of the seafood factories in Kerala. Out of this twenty four factories, ten factories were further selected at random for detailed study on the organisational structure and design, leadership style, communication and motivational aspects. To collect information on these aspects from three levels in the hierarchy (top management, middle level, floor level) pre-tested questionnaires (Appendix-II) were used. Rapid rural appraisal technique was used to get first hand information from the employees and management as described by Ward (1996). The classification of the organisational structure of the factories has been done based on the procedure described by Sadgrove (1996) to find out the leader ship style and communication prevalent in the factories.

3. Results and Discussion

Figure 1 shows the pattern of ownership of seafood factories in Kerala. The study shows that 43% of the seafood factories are partnership companies, 28% are public limited companies and remaining 29% proprietary concerns. The public limited companies are all of recent origin and came into existence in the late 1980s and early 1990s. Entrepreneurs who were already in the seafood business for a long time established 90% of the public limited companies. On critical examination of the public limited companies it could be found that most of the shareholders are belonging to a single family or their relatives. This status of the company reduces the cosmopolitan climate in the decision making process of the public limited companies. Family members or their relatives run most of the partnership companies.

Coordinating the units and departments of an organisation is an extremely important but massive and costly managerial activity. The organising function acts as one of the major sources of development for the needed skills and role performed by the manager. The influence components relate strongly to developing conceptual skills, and the coordination component is a determinant of diagnostic skills. In a similar manner, the various interpersonal, informational and decisional roles are affected by how the organisation is structured (Szilagyi,1981) The typical organisational structure of public limited companies, partnership companies and proprietary concerns in seafood processing industries in Kerala are given in Figures 2, 3 and 4 respectively. Kossen (1991) defined an organisation as a group of individuals structured by specialised activities and levels of authority. The organisational structures of the public limited companies shows that 50% are based on typical line function and the 50% have line and staff function. According to Szilagyi (1981), as organisations increase in size and complexity it is necessary to introduce personnel with specialized knowledge and skills. This creates the arrangement of line – staff functions.

The organisational structure of public limited companies consists of Board of Directors at the helm of the affairs. The Managing Director appointed by the Board of

Directors looks after the day to day affairs of the company and reports to the Board of Director from time to time. A General manager or senior manager assists the Managing Director. The line of functions are broadly classified into operations, administration and finance. Operation is the major function in the seafood factories. Senior manager (operation) who is further assisted by purchase manager in the production section, and production control manager in the production control and quality assurance section, take care of the operation division. The general administration is a small department in most of the factories. A finance manager assists the general manager in the financial aspects. Recently some companies have also introduced a personal section to look after the welfare of the employees with personal manager in charge of the section and directly reporting to the general manager. Technologist and supervisors who directly report to the respective managers further support the functional lines. The supervisors directly control the floor level workers in different sections. Line groupings are those units that are directly involved in producing the products or services but staff groupings are those units that perform in support of the line function (Szilagyi, 1981). According to Kossen (1991), staff members do not have direct authority over line members, although there are numerous exceptions. Because of their technical or professional knowledge, staff members usually provide assistance or advice to line members, which in turn help to free line managers from details that are neither directly related to daily operations nor require specialized skills and knowledge.

In case of partnership companies, the major partner acts as the managing partner and the remaining partner look after the various functions of the organisations.

In most of the partnership companies a clear-cut delegation of powers have been noticed with respect to the authority of partners. Majority of the partnership companies have three functional departments namely – production, administration and marketing. A production manager heads the production department. The production manager looks after both production and quality assurance of the company. Technologists and supervisors assist the production manager and quality assurance manager. The organizational structure of partnership companies shows typical line authority structure (Kossen, 1991).

The pattern of organisational structure in proprietary companies is more or less similar to the partnership companies except the fact that the proprietor heads the company and function as an autocratic leader.

Sadgrove (1996) discussed leadership structure in an organisation into four categories – autocratic, feudal, egalitarian and anarchic. Study shows that 71% of the seafood factories in Kerala are following autocratic style of leadership. Figure 5 shows the autocratic style of leadership in proprietorship factories in Kerala. Here the Proprietor functions as a dictator with little authority delegated to lower levels. According to Sadgrove (1996) in an autocratic setup one person is at the centre of the business, nothing happens without his approval. The present study in the seafood factories in Kerala was in perfect agreement with Sadgrove's findings. Figure 6 shows again the autocratic style of leadership in the partnership firms in the seafood industry. Remaining 29 % follow feudal leadership style (Figure 7). These factories are all public limited companies. In the companies where feudal leadership style is followed, the people at the top were far away from the bottom and the two never communicated with each other. Sadgrove (1996) also reported similar findings. So the structure is rigid. Public limited companies in Kerala show typical feudal leadership style. An egalitarian style of leadership model (Figure 8) is recommended for the seafood factories in Kerala to transform them into TQM factories. This is a basic necessity to apply any quality management measures in the seafood factories. With out this transformation all other efforts to improve quality through the modern concepts like HACCP or ISO 9000 would not be successful. According to Sadgrove (1996) "Egalitarian" company is much more liberated place to work. Here people communicate both upwards and downwards in their own departments. Teams can be formed to solve particular problems. Because the structure is flexible, it can grow and contract in response to the markets. This is the culture expected by Total Quality Management.

The type of communication prevailing in the seafood factories in Kerala is given in Figure 9. In seafood processing industry in Kerala, communication from top management to floor level employees is not satisfactory. Top managers are unable to communicate with floor level employees. According to Dahlgaard *et al.* (1995), a central element of leadership is the ability to communicate the goal to employees so perfectly that they unequivocally accept it as common goal of the group.The most important role of a leader is to help people do a better job. To achieve this, a leader must be clear about what an employee understands about his work.

Figure 10 shows the pattern of communication between superiors and lower level employees in the seafood factories. The overall communication in the factories is not satisfactory as 40% of the information is passed through oral communication. This has every chance of distorting the information in the communication channels. Only 10% of the communication are found to be participatory in nature. This shows very high degree of communication gap in the factories and autocratic style of leadership. The main media of communication are oral or through notice board. Informal channel dominates the communication net work. Meetings are also occasionally called to settle disputes. The horizontal communication is all informal. The employees have upward communication only to report their grievances. No official upward channel is provided for the lower level employees to express their ideas about products or quality assurance.

A communication system that only gives specific directives about job instructions and procedures and fails to provide information about job performance or rational-ideological information about the job has a negative organisational impact. According to Luthans (1977), this type of downward orientation promotes an authoritative atmosphere, which tends to inhibit the effectiveness of the upward and horizontal system of communication.

The following communication channels are used by the management to communicate with the floor level employees in the seafood processing industry in Kerala. In the case of permanent employees they use formal channels like issuing notice and calling meeting for direct communication. The written communication is usually routed through the hierarchical levels. In the case of contract employees, the communication is passed through the respective managers and the contractors. Usually informal oral communication is passed to the contract employees through the contractors. Kossen (1991) point out that a principal advantage of oral communication over written communication is that spoken message allow the sender to receive instant feedback. With written communication, feedback may be delayed or even non-existent. Telephone communication, although not face to face, have some of the same advantages as face to face communication.

Traditionally one of the dominant themes of communication has been the so-called down ward system. The down ward system is more accurately portrayed as superior–subordinate communication. There are personal linkage, not just information flow, in the downward systems (Luthans, 1977). Katz and Khan (1966) identified five general purpose of superior- subordinate communication in an organisation. They are, to give specific task directives about job instructions, to give information about organisational procedure and practices, to provide information about the rationale of jobs, to tell subordinates about their performance & to provide ideological type of information to facilitate the indoctrination of goals.

In seafood processing industry in Kerala, if the top management notices any quality defects or problems, that defect is usually communicated to the lower level employees either through oral communication or through a meeting. The employees feel that the exact facts are not properly communicated. Inadequacy has been noticed in all the factories regarding proper communication. Bedeian (1986) discussed the major precautions that can be taken to minimize communication breakdown. Simpson (1959) pointed out, in today's increasingly large and complex organisation, communication across the chain of command has become quite important to organisational performance. This type of communication is referred to as lateral communication. The need for lateral communication is created primarily because of problems with the organisation's structure. First, there is the issue of time. Frequently, information must be transmitted across the various levels of the organisation for decision making purposes. Under normal circumstances, this information would be transmitted along the chain of command of the marketing function, and then down the manufacturing chain of command to the responsible manager. When time is critical, as in solving a serious customer problem, this form of communication can be less than satisfactory.

The employees interviewed at different levels in seafood processing factories in Kerala feel that there is communication gap at different levels and that is the main cause for difference of opinion and conflict in the factories. Szilagyi (1981) pointed out that mutual personnel exchange (conflict resloving strategy) involves increasing the communication and understanding between groups by exchanging personnel for a time. The assumption underlying this strategy is that the exchanged personnel can learn about the other group and communicate their impression to their original group.

Employees in seafood processing industry in Kerala also feel that improving the open and efficient communication in the factories will lead to improved quality and productivity of the industry.

The study shows that the main type of communication in the factories is only informal, that is oral communication. Szilagyi and Wallace (1980) reported that the open plan design of the work place improves communication and performance between organisational members when there is a need for frequent verbal (face-to-face communication).

The top management of the seafood processing factories in Kerala considers the production turn over as the important contribution of the employees and does not provide any opportunity for the employees to participate actively for the improvement of the quality of products or overall quality of the factories. Ramachandran (1990b) reported that the fish processing industry in Kerala and elsewhere in India has totally neglected the contribution of workers in the productivity, quality and overall growth of the industry. This total neglect of workers is one of the main reasons of low productivity, low quality of the output in the industry.

90% of the seafood processing factories do not have any quality team comprising of employees from different levels. Only 10% of the factories have HACCP team, by ensuring the participation of floor level employees. These 10% of the factories have constituted HACCP team out of pressure from the EC Directive (91/493/EEC) and have obtained EC approval. Many researchers and authors have pressed the need for workers involvement in productivity and establishment of quality circle (Udapa, 1983; Smith, 1983; Rai, 1984; Chandreshekharan, 1986; Ramachandran, 1990b). This will improve the productivity and quality of the product.

The major source of communication between the middle managers and the top-level managers are through informal channel. 50% of the above are oral. Other important means of communication are written memos, letters, meetings, display of information in the notice boards, or direct discussion. The horizontal communication is mainly taking place through direct communication or through informal network. Similarly the down ward communication originated from the middle level is also taking place through direct communication or through informal channel. In fact the main communication link between the lower level employees and the middle level is found to be the supervisor. They are found to be the linking pin between the lower level employees and the middle level managers.

Open communication with participatory type of management can definitely improve the commitment of the employees and improve the quality and productivity of the seafood factories. For this there is a need of change in the existing pattern of leadership styles, organizational structures and communication systems in all the factories.

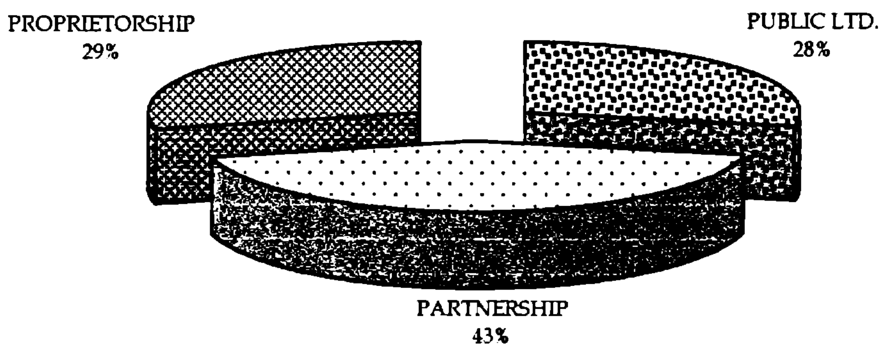


Fig 1. OWNERSHIP PATTERN OF SEA FOOD FACTORIES IN KERALA

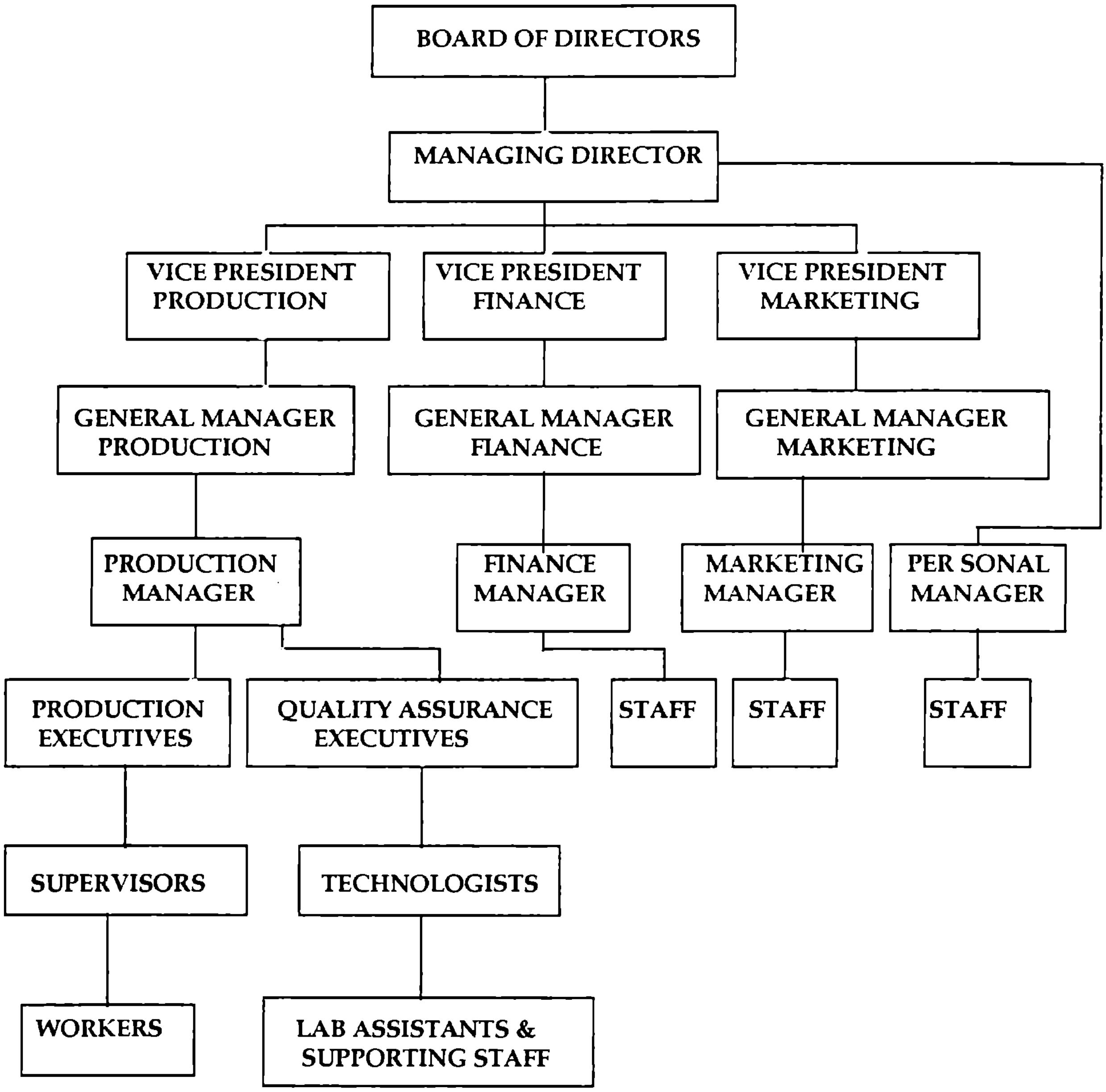


Fig.2. ORGANIZATIONAL STRUCTURE OF PUBLIC LIMITED COMPANIES IN THE SEAFOOD INDUSTRY IN KERALA

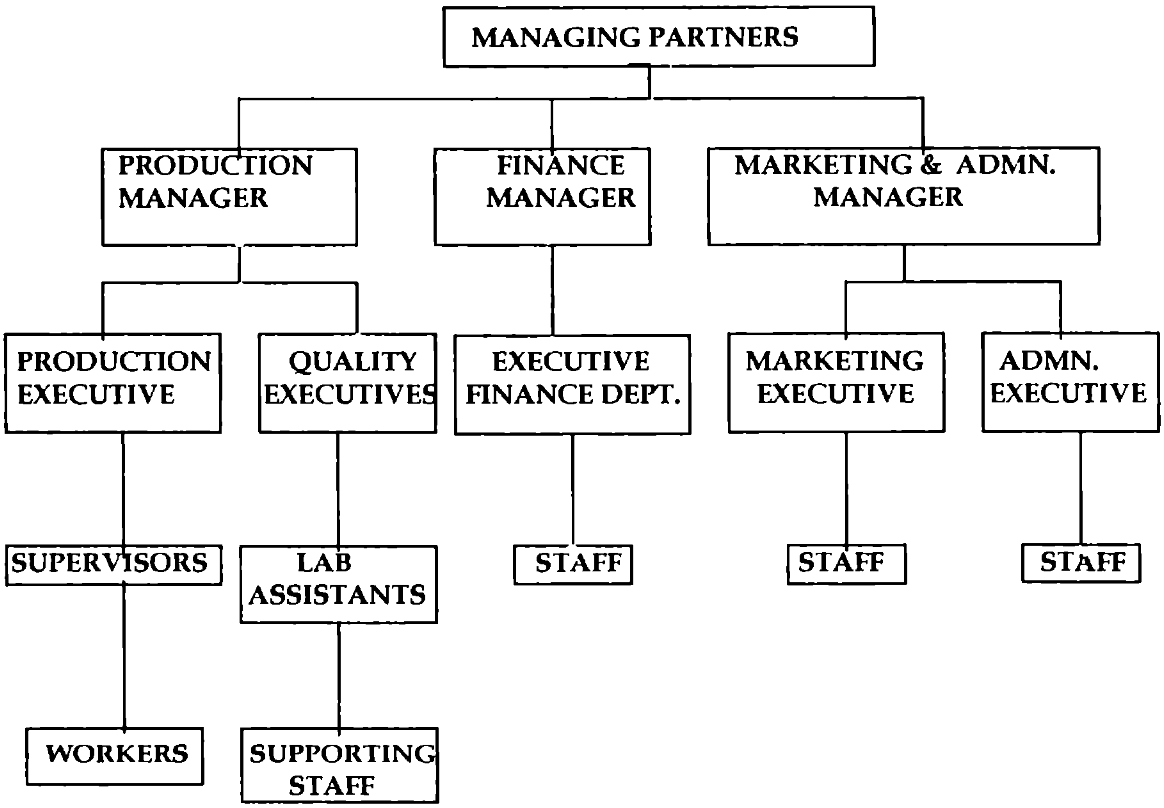


Fig. 3. ORGANIZATIONAL STRUCTURE OF PARTNERSHIP COMPANY IN SEAFOOD INDUSTRY IN KERALA

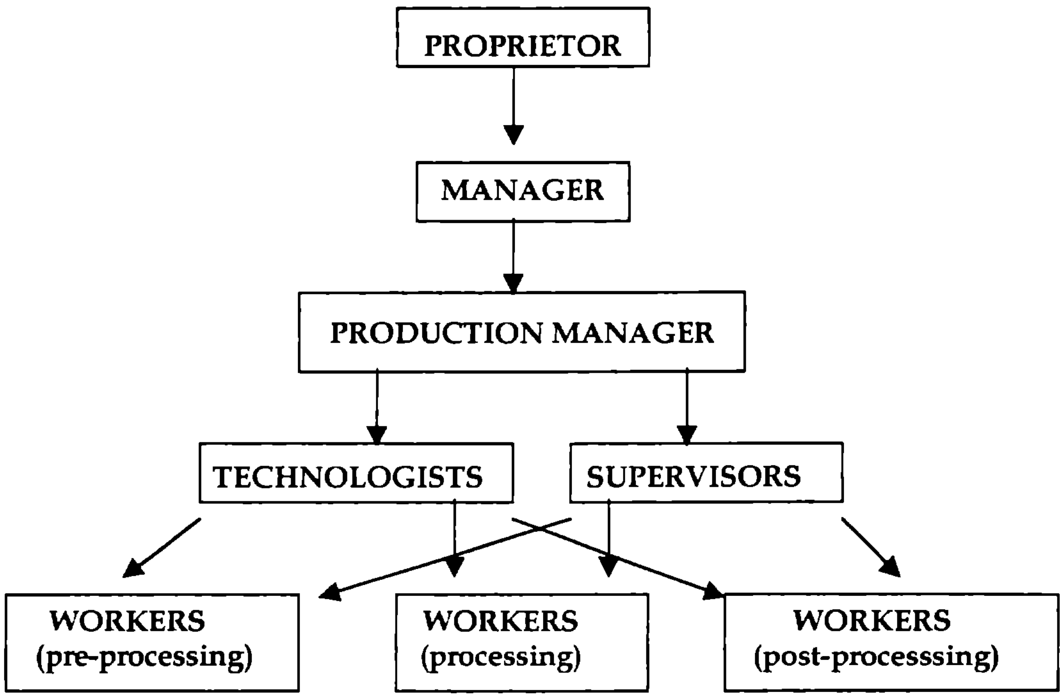


Fig.4. ORGANIZATIONAL STRUCTURE OF THE PROPRIETORSHIP COMPANY IN SEAFOOD INDUSTRY IN KERALA

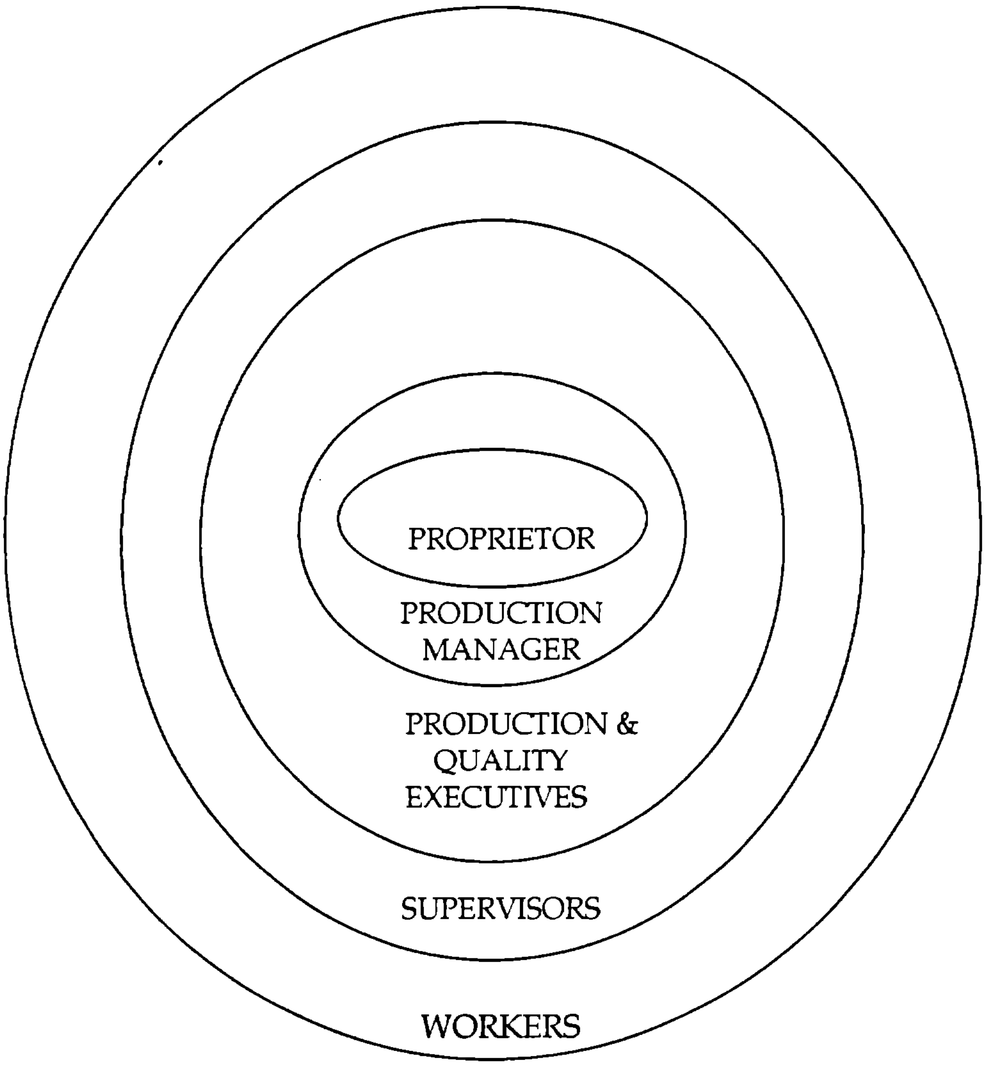


Fig.5. AUTOCRATIC STYLE OF LEADER SHIP IN SEAFOOD FACTORIES (PROPRIETORSHIP FACTORIES)

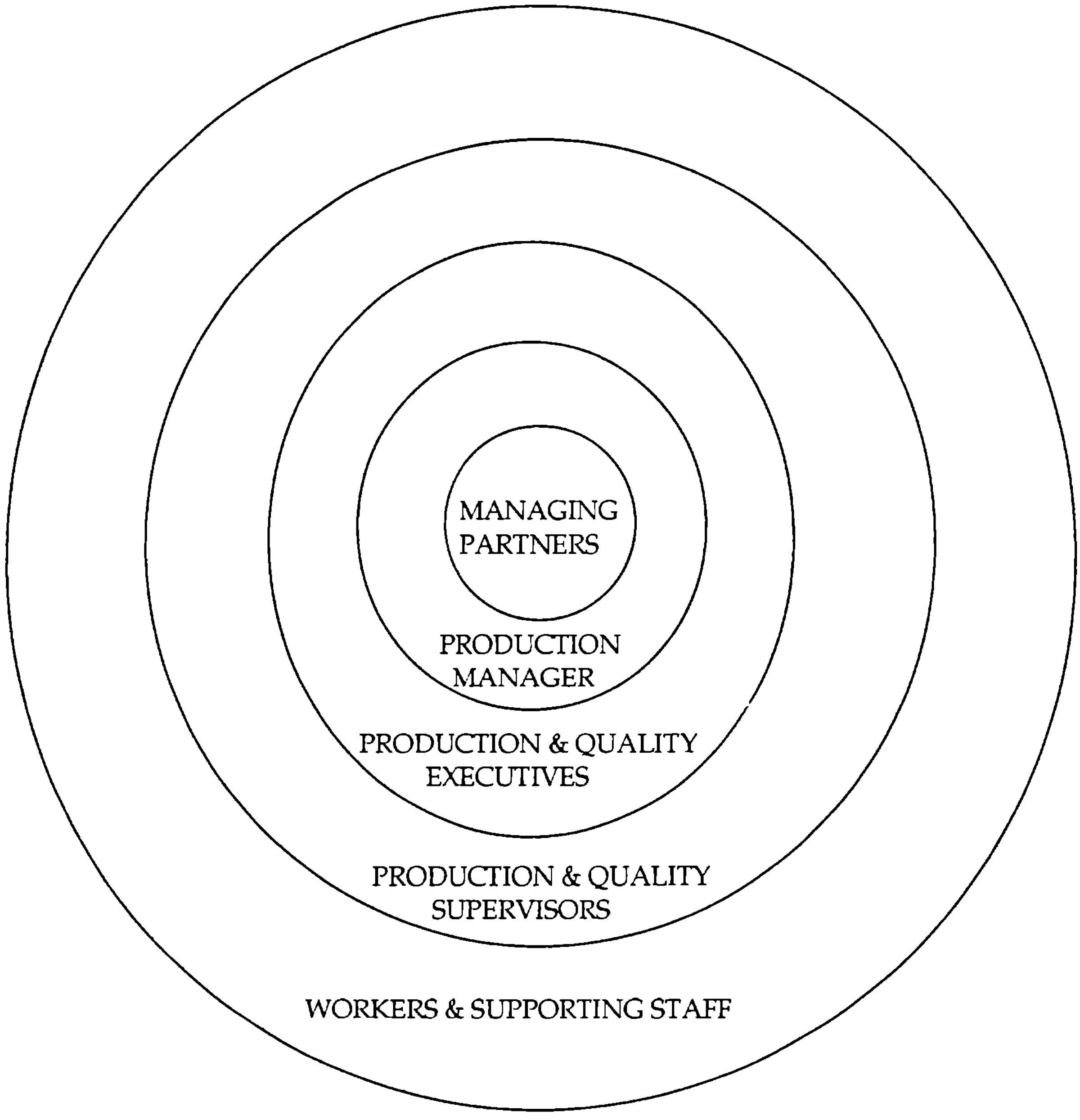


Fig.6.AUTOCTRATIC STYLE OF LEADERSHIP IN SEAFOOD FACTORIES (PARTNERSHIP FIRMS)

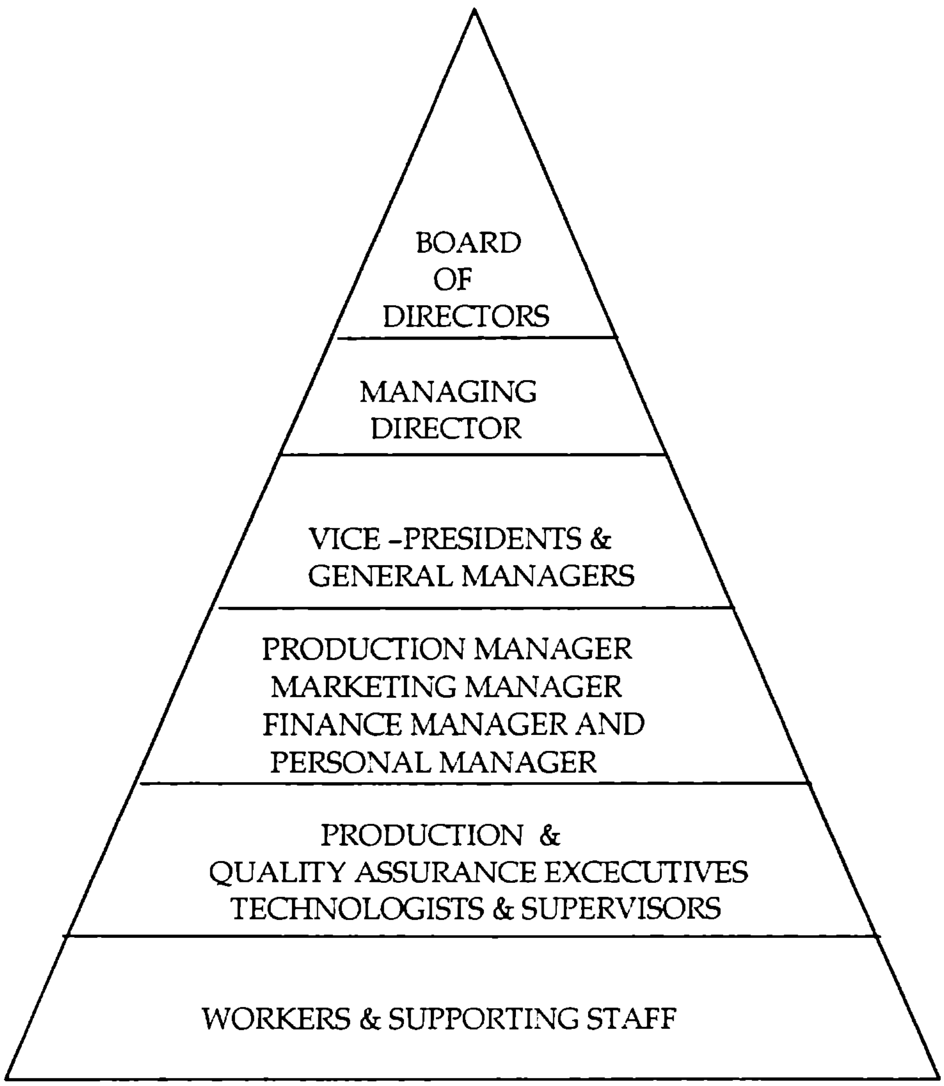


Fig.7. FEUDAL LEADERSHIP STYLE IN SEAFOOD COMPANIES IN KERALA (PUBLIC LIMITED COMPANIES)

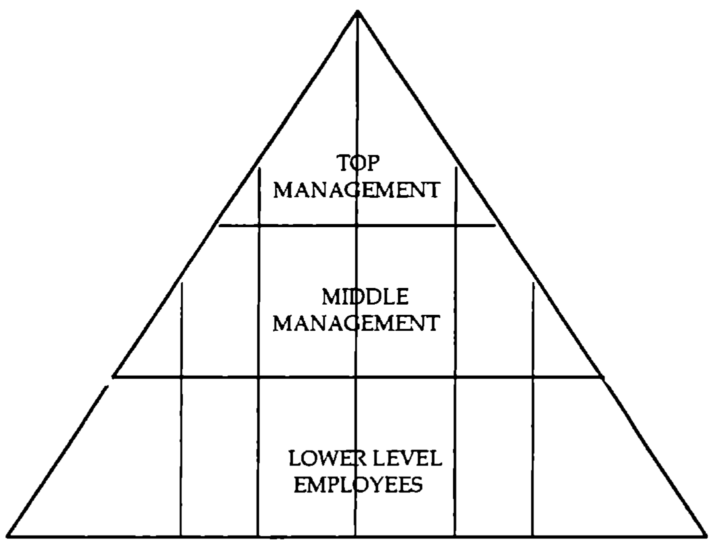


Fig.8. EGALITARIAN STYLE OF LEADERSHIP AS ENVISAGED IN TOTAL QUALITY MANAGEMENT

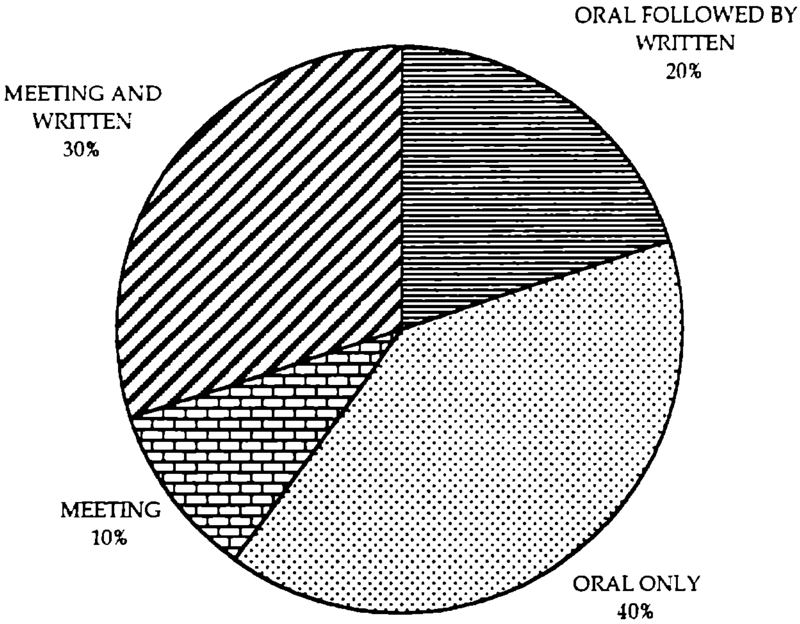


Fig.9 TYPES OF COMMUNICATION IN SEAFOOD FACTORIES IN KERALA

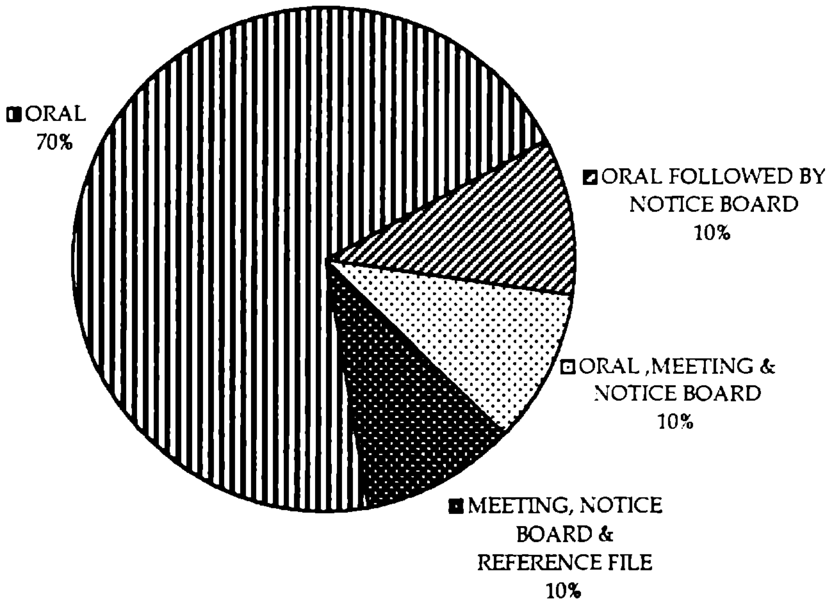


Fig 10. PATTERN OF COMMUNICATION BETWEEN SUPERIORS AND LOWER LEVEL EMPLOYEES

CHAPTER 8

HUMAN FACTOR ANALYSIS

1. Introduction

Human resource is the most significant input in any organisation and it is the most difficult one to control. The responsibility for ensuring the quality of the product is not confined to any single individual or group. All departments of the organisation share it. Thus quality assurance is not only a technical problem but also a problem of human relations. Fish processing factory in Kerala has not considered the contribution and role of workers in maintaining the quality of seafood products. Participative management where subordinates share a significant degree of decision making power with their immediate superiors, is considered to be more productive (Robbins, 1997). Genuine participation can be expected only when operatives are given full freedom to express constructive criticism and to suggest methods of improvement. Suggestions of the workers should be given serious consideration, and if found practicable, should be straightway implemented. And if the suggestion is not found useful, its drawbacks should be discussed with the workers and the difficulties in its implication should be explained to them (Lal, 1990).

The objective of improving the productivity of any organisation can be achieved only if the relationship between management and workers is cordial, and by the direct involvement of the workers. Workers can only become properly motivated when the company's objectives are consistent with their own objectives. This requires managers to obtain a belief and commitment to the idea that workers have loyalties, goals and needs similar to their own ones. For this, managers should have some special quality for whole heartedly accepting their subordinates (Hutchins, 1993).

Total quality management is a philosophy of management that is driven by the constant attainment of customer satisfaction through the continuous improvement of all organisational process. (Robbins, 1997). Employee improvement is a participative process that uses the entire capacity of employees and is designed to encourage increased commitment to the organisational success. Balakrishnan (1993) emphasises the requirement of a system's approach in quality management of seafood industry in India. He urges the need for maintaining quality of the products and recommends the use of ISO 9002 and 9004 for maintaining the same.

2. Methodology

Twenty four seafood processing factories out of the total of 120 factories were randomly selected for the study using stratified random sampling technique for collecting general information as described in the chapter on Data and Methodology. Out of this twenty four factories, ten factories were further selected at random for detailed study on the various aspects of human factors, which influence the quality, and productivity of the seafood factories in Kerala. To collect information on these aspects from three levels in the hierarchy pre-tested questionnaires were used

(Appendix-II). Rapid Rural Appraisal Techniques were used to get first hand information from the employees and management as described by Ward (1996).

3. Results and Discussion

3.1. Top management

The study on the top management regarding the quality management aspects showed that all the top managers are fully aware of the latest developments in the quality assurance in sea food industry including the reasons for the ban of imports of Indian seafoods by the European Commission. 100% of the top managers surveyed and interviewed also expressed their desire to improve the quality of their products to suit the requirement of the foreign buyers and claimed to support the innovations taking place in the quality assurance systems the world over. At present no motivational schemes are offered by the top management to improve the employees participation in the quality assurance programmes of the factories. Figure 1 shows the incentive pattern for top managers in seafood factories in Kerala. There was no quality linked incentive system or motivational measures in the seafood factories selected for the study. However, 10 % of the factories had regular production linked incentive systems at all levels. 50 % of the factories had incentive systems on certain specific jobs and the remaining 40 % factories did not have any type of incentive systems at all. The incentive systems prevailing in the factories were production linked and no weightage was given on the quality of the products being produced.

None of the seafood factories had other job enrichment or job enlargement measures or quality circles or any other participatory groups, which includes all levels of employees. 70 % of the top managers were of the opinion that the incentive systems prevailing in the factories helped only to improve the quantity turnover of the firms and did not have any impact on the quality. 30 % of them remarked that the incentive system helped in improving both the quality and quantity. The study also revealed that 40% of the top managers were not aware of the quality circles and its significance in employee's participation in production and quality management. 50 % of the top managers were aware of the benefits of quality circles and were eager in implementing the same in their factories. None of the factories studied had Zero Defect concepts to improve the quality of their outputs and participation of their employees.

80 % of the factories studied have promotional avenues for middle and top level managers. 20 % of the factories do not have any promotional opportunities for the middle or top level employees. The floor level employees do not have any promotional avenues in their factories. None of the factories studied have a system of job rotation for the employees. The study also revealed that top management in all the factories provided training facilities for their middle and top level managers. Figure 2 gives details of the types of training offered to middle level managers in seafood factories in Kerala. 40 % of factories provide both external training by the concerned institutions and internal training by the company staff. 40 % of the factories offer only external training to their middle level managers. 20 % factories offer only internal training. The top management does not provide any training for the lower level

employees except for some orientation programme by the internal staff. But certain external agencies like Marine Products Export Development Authority and State Fisheries Agencies occasionally organise training programme for the floor level employees for seafood processing and quality assurance. But this is provided to only a very few employees in the industry.

60 % of the top managers claimed that they ensured the involvement of workers of all levels in the quality improvement programme of their factories. 60 % of them also claimed that they received constructive suggestions from the employees to improve the quality and quantity of the products. Only 40 % of the top managers were found to accept the suggestions made by the employees and tried to implement them while the rest usually ignored the suggestions. Only 40 % of the top managers discussed the drawbacks of the suggestions made by the employees and tried to convince them. None of the top managers claimed to have a good employer-employee relationship in their factories. 80 % have the opinion that they had a satisfactory employer-employee relationship. 20 % informed that they have an undesirable employer-employee relationship.

Figure 3 shows the details regarding the employee strength in various seafood factories studied in Kerala. The employees are usually recruited through interviews. There is vast variation in the strength of the permanent employees in the seafood factories in Kerala. 40 % of the factories had employee strength between 150-200. 30 % of the factories had employee strength below 50. 70% of the factories employed supervisors having qualification with Pre-Degree and Degree. 30% of the factories also employed experienced persons with SSLC as basic qualification. 20 % of the factories were found to employ only graduates at supervisory level. 40 % of the factories employed only Postgraduates at their executive level. 30 % of the factories employed graduates and postgraduates as their executives. Remaining 30 % of the factories also employed persons with Pre-Degree qualification as their executives. The age pattern of lower level workers working in the seafood factories in Kerala is given in Figure 4. Another favourable factor with respect to the human input management is that majority of the employees (70 %) belong to the age group below 30 years. The wage structure of the lower level employees is given in Figure 5. There is a vast variation in the wage structure of the employees in various factories. This is mainly based on the experience and the skill of the employees and the type of the factory – public limited, partnership or proprietary factories. Since the sea food industry is a highly seasonal industry most of the factories adjust their short-term capacity to suit the production by way of layoff of the employees (mainly casual and contract) during lean season and by taking additional employees (on casual or contract basis) during peak season. Over timing of the employees is another strategy used to increase the short-term capacity during peak season. Hiring additional facility from other factories is another method employed by the management during peak season. To adjust the capacity during lean season some factories also resort to 'half duty and half pay with bus fare'. This will also help them to reduce the labour cost to some extent and to retain the employees in the pay roll.

Only 30 % of the factories had approved trade unions, and the remaining factories had a very high autocratic set up. The trade unions were formed in those factories as a result of employee unrest and most of these factories are either limited factories or partnership factories. 30 % of the sea food factories experienced human unrest which eventually led to strike. The main reasons for the strike in these factories were due to strained inter-personnel relationship between workers and the superiors; termination of employees with out proper reasons as justified by the employees or employees union; objection by the management in the formation of trade unions in their factories; and transfer of employees to other units. The management in most of the cases took an adamant stand during strike and adopted 'Win-Lose' strategy in settling the strike. Here they settled the matter by closing the factories till the employees or the union agreed to terminate the employees who are not in the good books of the employer or by cancelling the contract in the case of contract employees. On some occasion the management also used 'Lose-lose' strategy by reaching a compromise with the employees or the union. 70 % of the factories studied did not experience any workers unrest and this is probably due to the fact that most of the workers of those factories were on contract basis. Only the skeletal staff was permanent and that too at the middle and upper management levels.

90 % of the factories studied adopted two-shift system. Usual timings of the shifts are 9 a m – 5 p m and 5 p m – 1 a m. If any over flow of work was there the employees were asked to do overtime work. 90 % of the factories also provided special night duty allowances. The study revealed that there is no shortage of unskilled workers in the factories. But in 10 % of the factories, shortage of skilled employees was felt during peak seasons.

3.2. Middle level managers

50 % of the middle level managers interviewed expressed the opinion that the top management had a positive attitude towards the quality improvement programmes of the factories. The remaining 50% felt that the top management was production oriented rather than quality oriented. 80% of the middle level managers were fully aware of the quality assurance programmes in India and abroad. The middle level managers were found to be more conscious about quality than the top managers and fully supported the quality improvement programmes of their factories. 90% of the middle level managers interviewed said that there were no motivational measures in the factories to improve the quality of the products and for maintaining the sanitary conditions of the factories. The incentive systems prevailing at middle level are given in Figure 6. It is found that 60 % of the factories do not have any special incentives to boost the quality of the products or productivity of the factories. Only 40 % of the factories had regular incentives and incentives provided on certain special tasks. The incentives prevailed at middle level management were all production oriented and not quality oriented. The incentives offered by the factories were all financial incentives. The study showed that only 20 % of the middle level managers were satisfied with the present incentive systems. 80 % were not satisfied with the quantum of financial incentives provided to the middle level managers. They also expected other incentives like job enrichment, participation in decision making and other psychological incentives. Only 20 % of the middle level managers were also satisfied with the

existing salary structure offered to them. Even though the job enrichment part is neglected in the factories, 70 % of the middle level managers have job enlargement with additional responsibilities at horizontal level. All the recruitments to the middle level managers were made through interviews. 80% of them reported that there was no approved leave rules or salary structure in the factories. 80 % of the middle level managers had no participation in the decision making process. They executed the commands of the superiors and had no opportunity to discuss their ideas with the top management. The factories studied experience a very high turnover of middle level managers due to various reasons. The main reason is found to be frustration and low financial incentives. The other important reason cited is the lack of job security. Most of the female employees were found to resign after their marriage. The management was also found to terminate the staff due to irresponsibility in their work, participation in the strike, etc. The average length of service of the existing middle level managers surveyed was found to be only 4 years, which shows high rate of turnover of the middle level managers. This is very unhealthy as far as the organizational goals are concerned. 90 % of them were prepared to take additional responsibilities in improving the quality and productivity of the factories if they were offered. 80% of the factories did not have any job rotation at middle level. Introduction of job rotation and job enrichment may reduce the frustration and boost the morale of the managers. Almost all the managers felt that if job rotation and job enrichment measures are introduced in their factories it will help in reducing the quality risk and wastage of the materials. This, they feel will also reduce the rate of resignation of the managers from the present rate.

All the middle level managers studied were provided with the rest room facilities and were satisfied with those arrangements. The training facilities offered to them by the factories were also found to be satisfactory and the managers were content with them. They are mainly offered external training provided by Central Institute of Fisheries Technology, Food & Agricultural Organisation, Export Inspection Agency, Marine Products Export Development Authority, etc. A specific question has been asked to the middle level managers regarding the continuation of their service in the same factories till their retirement. 70 % of them responded that they were not interested in continuing their service in the same factories where they were then working. The main reasons cited were low salary, poor working atmosphere and lack of job security. All the middle level managers felt that their jobs were not secured in the factories where they were then working. The managers felt that they might get more satisfaction if they were given more salary, authority, responsibility and freedom to work. 90 % of the middle level mangers were frustrated with the existing setup of working conditions. Supervision of the production process is the main task carried out by the middle level managers in the factories. All the middle level managers interviewed opined that they had nothing to plan their own but directions came from the superiors and they were just instrumental in implementing these directions. The most interesting aspect of the working conditions of the managers, apart from the monetary benefit is the freedom to work and regular activities like continuous production. The least interested aspects are the attitudes of the superiors and the authoritarian style of leadership. They were also frustrated if no work was assigned to them during lean season. Here job enrichment and job enlargement may be helpful. All of them expressed the feeling that they were under the pressure from the superiors and top management to get quick results. In most of the factories the standard of performance of job of middle level managers were fixed by the factory managers under the guidance of the managing director or managing partner or proprietor as the case may be. The good work done by the middle level managers were complimented in different ways. In 70% of the cases, the good work was complimented with oral or written appreciation from the superiors and the remaining 30% of the cases, it was followed by additional increments or hike in pay scale. Firing the employees mainly had negative reinforcement. Only 10% of the factories surveyed had a HACCP team comprising of members from the middle level management. Otherwise, the middle level managers were not involved in any committee in the factories. In the factories studied, the middle level managers did not have any union or association. 70 % of the middle level managers had different expectations on the job content when they joined the service. 10% of them had a clear vision on the job contents when they join the service and the rest of them were in between these two situations. 30 % of the middle level managers felt that the top management was not fully utilising their talents and expertise for the benefit of the organisation. Majority of them was found to be frustrated and had no idea about their prospects in the factories in the next one to five years.

3.3. Floor level employees

The study showed that the majority of the floor level workers were from the surrounding villages or towns where the factories are located. Figure 7 shows the qualifications of lower level workers in the seafood industry in Kerala. They were literate and coming from economically weaker sections of the population. 70% of the employees have an educational qualification of SSLC or above. Majority of the employees were youngsters (below 30 years) and were healthy and dynamic (Figure 4). 93% of the floor level processing employees were females and 46 % of the total employees were on contract basis and 12% on casual basis.

Figure 8 shows the response of lower level employees on the attitude of top management about the quality improvement programmes. 60 % of the employees felt that the top management attitude was mainly production oriented. 60 % of the floor level employees were not aware of the recent developments in quality assurance and not even heard of such changes in the quality management area in seafood industry. 40 % of them were atleast aware of the changes in quality assurance systems in India. All the employees surveyed and interviewed supported the quality improvement programme of their factories. 100 % of the employees surveyed were also of the opinion that they did not have any motivational or incentive system in their factories to promote quality assurance programmes. Whatever incentive systems offered by the factories were all production linked and not quality linked. Financial incentives were given to the employees if they exceeded production targets. 100% employees surveyed were not satisfied with their jobs mainly because of the low salary and lack of job security. The jobs assigned to the lower level employees in the factories were mainly related to unloading of raw material, washing, grading, preprocessing, weighing, processing, packing and storing. Some workers were also entrusted with the cleaning and sanitation activities of the factories. Figure 9 shows the pattern of employment at lower levels in seafood industry in Kerala. The majority were contract workers (46 %). 12 % employees were on casual basis and only 42 % were permanent employees. The permanent employees were recruited through interviews. Most of the casual workers were engaged, through recommendations and the rest were recruited through interviews. Contract workers were not the direct employees of the factories. Here the responsibility rested with the contractor. The employees in all the factories studied stated that there were no accepted leave rules in their firms. This has resulted in the supervisors or the middle level managers misusing the system. The wage rate prevailed in the factories is given in Figure 5. Wide variation was noticed in the wage rate of the employees. This was mainly based on the experience of the workers. 40 % of the employees at the lower level earn a daily wage rate between Rs. 40-45/-. The wage rate ranged between Rs. 25-30/- (7 %) and Rs. 56-60/- (7 %). 100% employees responded that they had no role in the decision making process of their factories. There was found to be heavy turnover of employees at lower level. This was mainly due to the fact that majority of the employees were working on contract basis or on casual basis. The contract was usually agreed upon for a season or one-year. It is not necessary that the same employee returns to the same factory on the renewal of the contract in the subsequent years. The employees were found to be ready to take up additional responsibility in quality assurance programs if they are paid additional financial incentives. 60 % of the employees were expecting additional financial benefit for taking additional job. The remaining employees were even willing to take up the additional assignments under quality assurance program within the existing pay structure. All employees studied were willing to take up additional responsibilities. No job rotation system existed in the factories at lower levels. Job enrichment was also lacking. Employees welcomed job rotation and job enrichment measures in their factories. The factories also did not have any promotional avenues along the channel for these lower employees. All the factories studied provided rest rooms for the employees.

60 % factories offered internal training to their employees at the lower levels organised by the production managers, quality assurance divisions or technologists. 40% factories did not provide training to these employees. No recreational facilities were provided for the employees or their children in the factories. However 20 % of the factories have canteen facilities for the employees. No facility for education was also provided for children of the employees.

90 % of the factories did not have any committee or team comprising of the employees from this level. 10 % of the factories, out of compulsion from European Commission, formed HACCP team comprising of employees from different levels. All the employees surveyed have been doing the same job from the time of joining the service till date, which shows that there is no job enrichment or job enlargement at this level. This also indicates the stagnation of the employees at the same level without any promotional avenues. Even though the employees were ready to carry out the present work they feel the job to be tedious with poor working environment. The response of the employees with respect to the reasons for frustration is given in Figure 10. Majority of the employees felt that their jobs were tedious and tiresome which may result in prolonged illness in the long run. None of the employees who were interviewed liked to continue in the same factories till their retirement, which clearly

shows that they are not at all satisfied with the present salary and working conditions. Another major reason, which dominates this decision, is the lack of security in the factories. All the employees who have been asked the specific question on job security claimed that their jobs were not secure.

Figure 11 shows the pattern of responses of lower level employees on the factors contributing to their job satisfaction. 60 % of the employees interviewed were of the opinion that they would be satisfied if their pay were hiked. 30 % of them felt that a word of appreciation from the superiors would give them job satisfaction. 10% of them expected other monetary incentives as a stimulator of job satisfaction. With respect to the changes required for making the working environment more enjoyable and more effective there should be a regular quality/production linked incentive system along with the satisfactory hike in remuneration. Another factor is that they expect recognition for their work. A system must be introduced to recognize the good work done by them. They also expected implementation of regular shift system, full capacity utilisation and provision of training programme to update the changes in the quality and production fronts. They also wanted change in the authoritarian style of leadership. As far as their participation in the planning or production and quality assurance, they have no role to play. The decisions are taken by their superiors and passed on to them for implementation. They felt that their suggestions were not taken care of. A specific question had been asked to employees regarding the moments at their work place, which give them maximum satisfaction. Majority felt that the moment when they receive salary gave them maximum job satisfaction. They hated work after 1 am, which is common, in some of the processing factories. Another hateful work they felt was the work without proper protection in cold stores. They are subjected to maximum pressure from the supervisors and production managers to achieve the target of production. 40 % of their targets are set by the proprietor or managing directors, 40 % by the managers and the remaining 20 % by the shift supervisors. This clearly shows the line of authority in the hierarchy.

Figure 12 shows the type of responses of the superiors towards the good work done by the employees in the form of feed back. Most of the times the good work done by the lower level workers were unattended to. This lack of reinforcement from the part of the management results in the non-repetition of the good work done by the employees. None of the employees interviewed was a member of any quality team or committee of any sort in their factories. 70 % of the employees were also not associated with any union. Only 30 % of the workers had unions in the factories. Unlike the middle level managers, 90% of the lower level employees found the job content in the work place as they expected. This was probably because of the fact that the jobs at the lower levels are specific and specialised like peeling of shrimp, grading, weighing, etc.

80 % of the employees reported that no work had been failed at any stage due to the technical snag on the part of other employees. And only 10% of the employees felt that the management adequately uses their skills. All the employees were totally in the dark as far as their career prospects of their factories. Only very few of the lower level employees have obtained some sort of training by internal staff like quality managers/production managers or quality technologists. The employees had

no definite idea on which type of training they would like to have to improve the quality of the products produced by them or to improve the productivity of the firm. But they had a general idea about the significance of fish handling and maintaining the hygienic conditions of the factories.

The study clearly shows that there is no motivational measures adopted by the top management to improve the quality and productivity of factories. Different theories described by various scientists under the content approaches and process approaches of motivation, clearly specifies the role of proper motivation for effective utilisation of the employee's potentials (House and Wigdor, 1967; Ivancevich ,1969; Schmidt, 1973; Hackman, 1977; Luthans ,1977; Szilagyi and Wallace, 1980; Szilagyi,1981). Motivated employees are very important in TQM set up. Hence factories should introduce various employees motivation measures. Appropriate incentive systems have to be introduced at different levels to motivate the employees. Some form of financial incentive linked with quality of the product such as quality bonus or merit payment will provide a strong motivation for the employees to improve the quality of his work. For quality incentives to be effective, the quality of the product must be measurable in quantitative terms, so that there is no dispute about quality assessment and the employees know exactly what is required of them (Dey, 1988; Lal, 1990).

Continuous training is another important area for the management to concentrate because the training schemes provided in the seafood industry, especially at the floor level is inadequate. For employees to improve their work, it is desirable for them to know about improvements in techniques. This is very significant as far as seafood industry is concerned as the technology is fast changing. Even the concepts and practice of quality assurance itself is fast changing at the international level. The significance of training in the introduction and maintainability of TQM has been reported by a number of workers (Anon, 1986a; Kume, 1996; Dahlgaard *et al.*, 1995; Bolton,1997).

Participatory approach is another important neglected area of management in the seafood factory in Kerala as is evident from the study. This has resulted in communication gap and lack of coordination among the different levels. Robbins (1997) describes the distinct characteristic common to all participative management as the use of joint decision making. Almost every country in Western Europe has some type of legislation requiring factories to practice representative participation. That is representatives of workers are involved in decision making. Representative participation has been called "the most widely legislated form of employee involvement around the world". Hammer *et al.* (1991) reported different forms of employee's participation. Work Councils and Board Representatives are the important two types of floors available for employee's participation. The most widely discussed undertaken formal style of employee involvement is the 'Quality Circle'. The Quality Circle concept is frequently mentioned as one of the techniques, Japanese firms utilize for making high-quality products at low costs. Dey (1988), Lal (1990), Ramachandran (1990b) and Kume (1996) highlights the usefulness of Quality Circles in improving the productivity and workers involvement in achieving organizational goals. In seafood factories in Kerala, it is advisable to have Quality Circle to improve the quality and workers involvement.

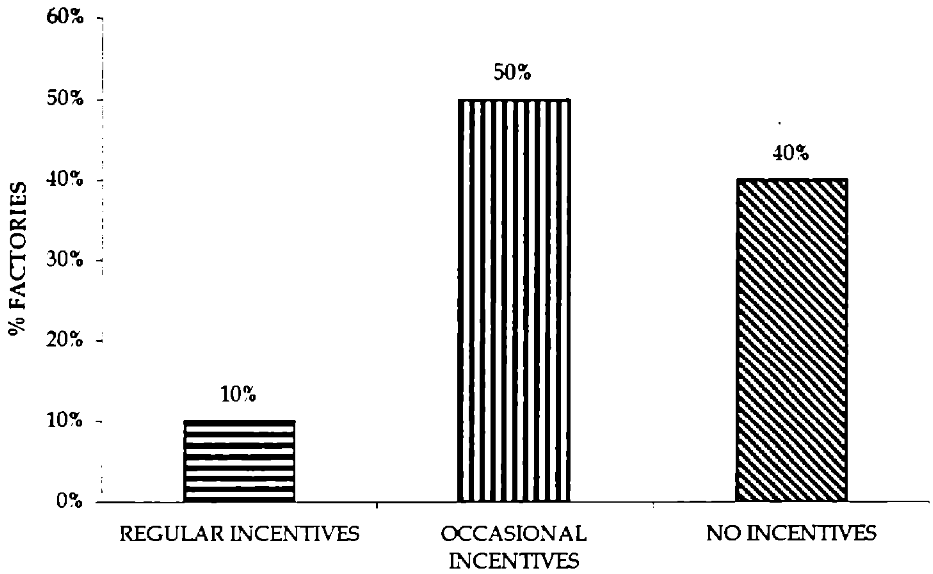


Fig 1. INCENTIVE PATTERN FOR TOP MANAGERS IN SEA FOOD FACTORIES IN KERALA

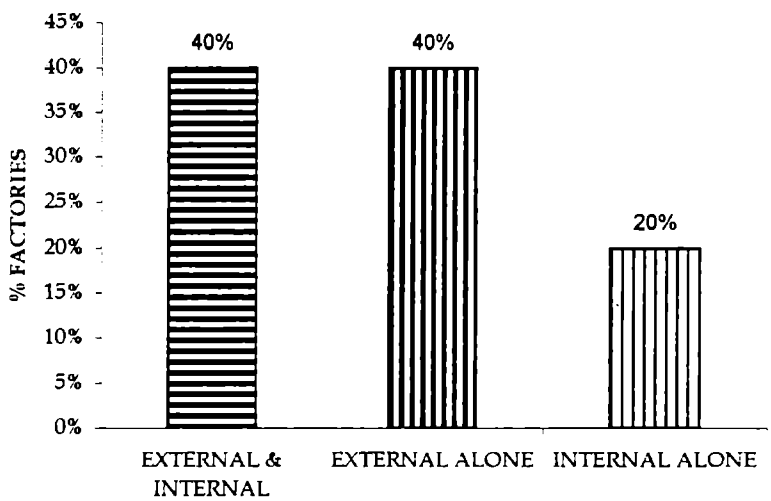


Fig 2. TYPES OF TRAINING OFFERED TO MIDDLE LEVEL MANAGERS IN SEA FOOD FACTORIES IN KERALA

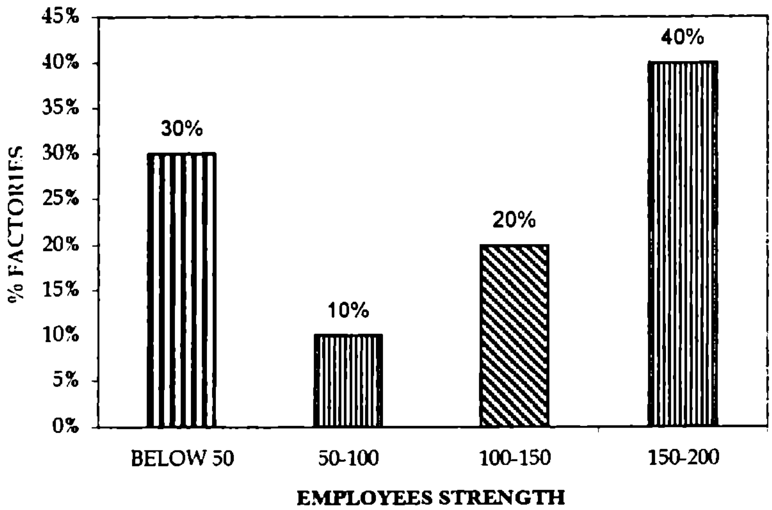


Fig 3. STRENGTH OF PERMANENT EMPLOYEES IN SEAFOOD FACTORIES IN KERALA

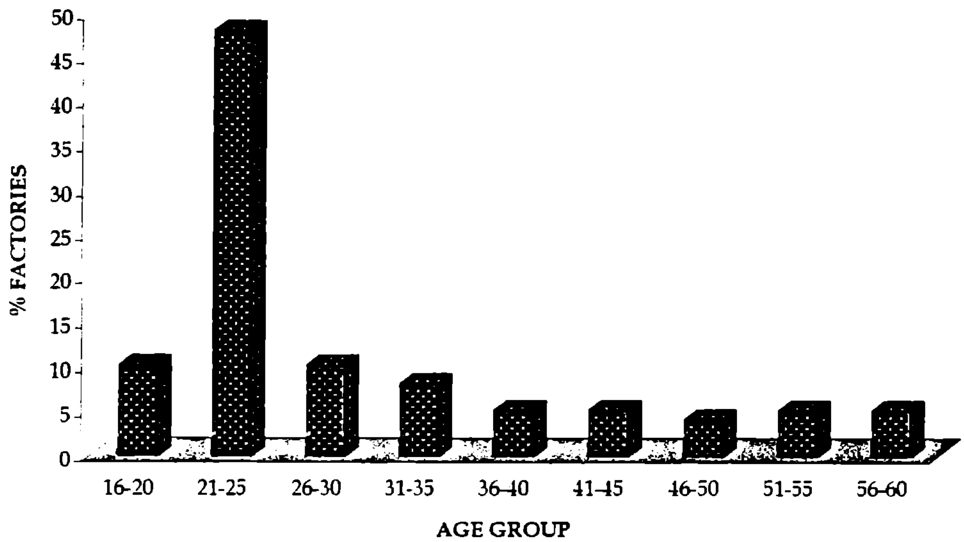


Fig 4. AGE GROUP OF LOWER LEVEL WORKERS IN SEA FOOD INDUSTRY IN KERALA

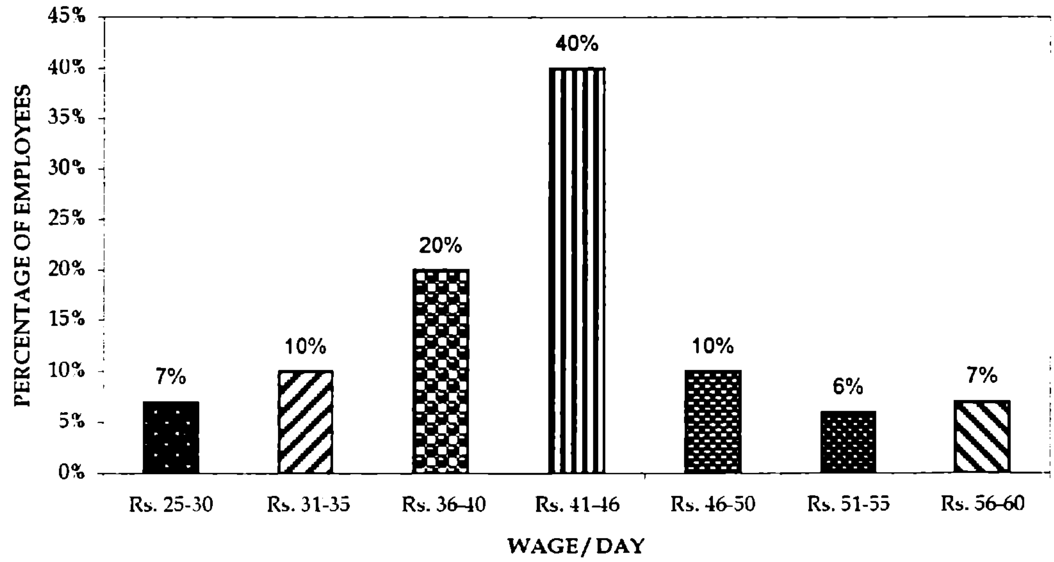


Fig 5. WAGE STRUCTURE OF LOWER LEVEL WORKERS (PER DAY) IN SEA FOOD FACTORIES IN KERALA

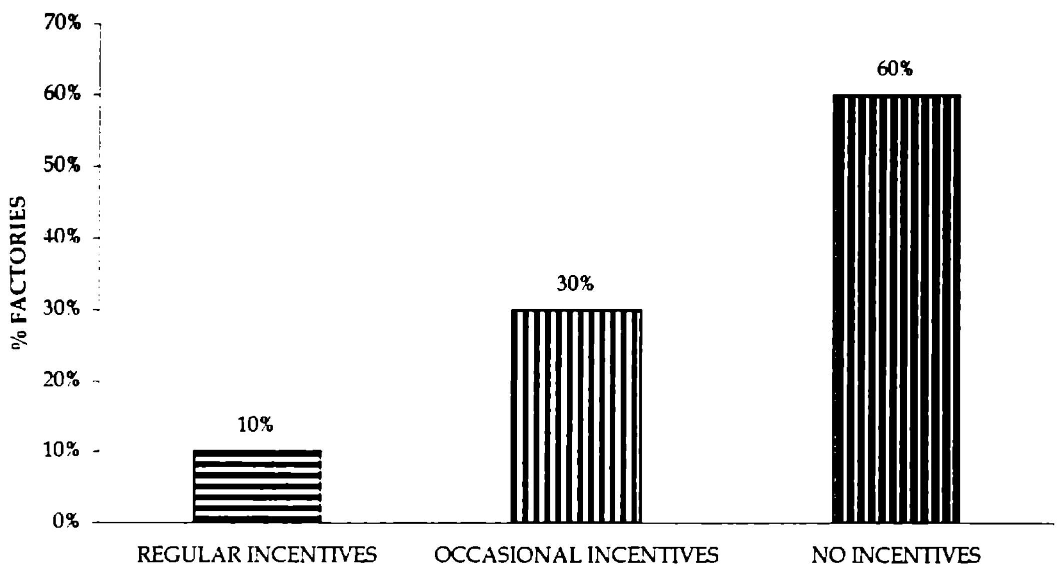


Fig 6. INCENTIVE PATTERN FOR MIDDLE LEVEL MANAGERS IN SEA FOOD FACTORIES IN KERALA

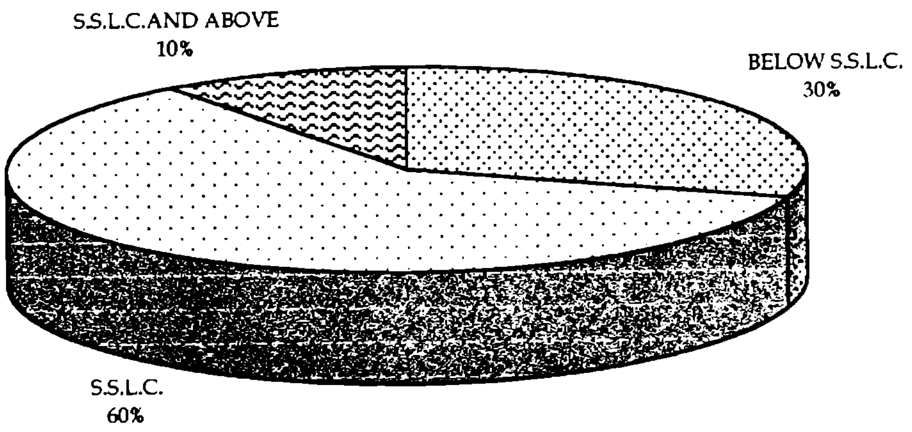


Fig 7. QUALIFICATION OF LOWER LEVEL WORKERS IN SEA FOOD INDUSTRY IN KERALA

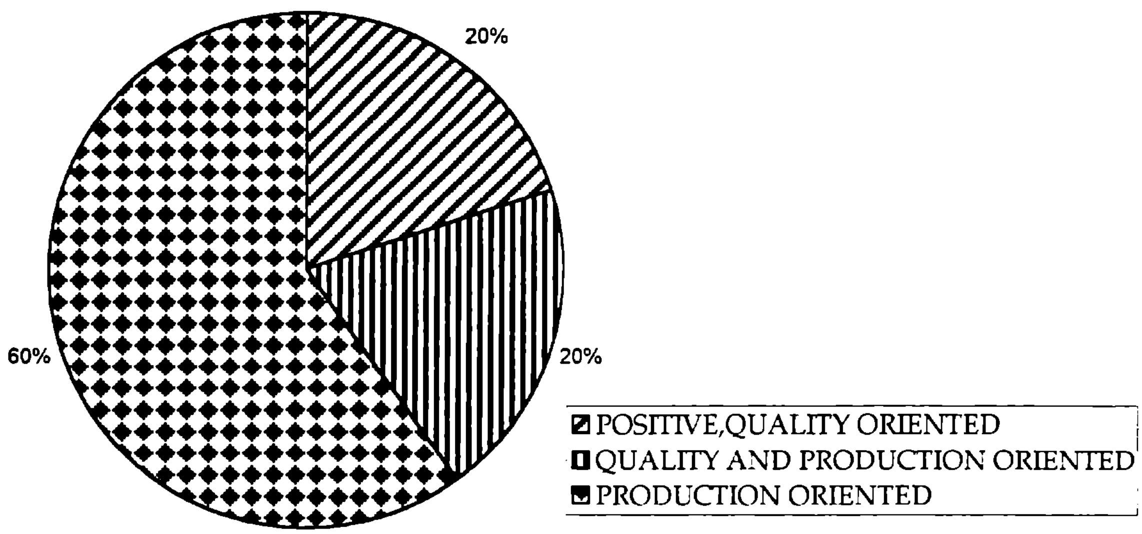


Fig 8. RESPONSE OF LOWER LEVEL WORKERS IN SEA FOOD FACTORIES IN KERALA REGARDING THE ATTITUDES OF TOP MANAGEMENT FOR QUALITY IMPROVEMENT PROGRAMME

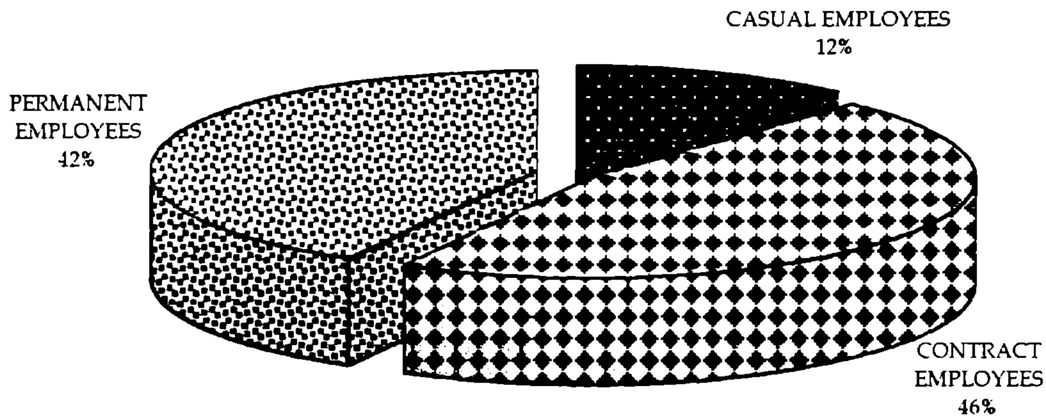


Fig 9. PATTERN OF EMPLOYMENT AT LOWER LEVELS IN SEA FOOD INDUSTRY IN KERALA

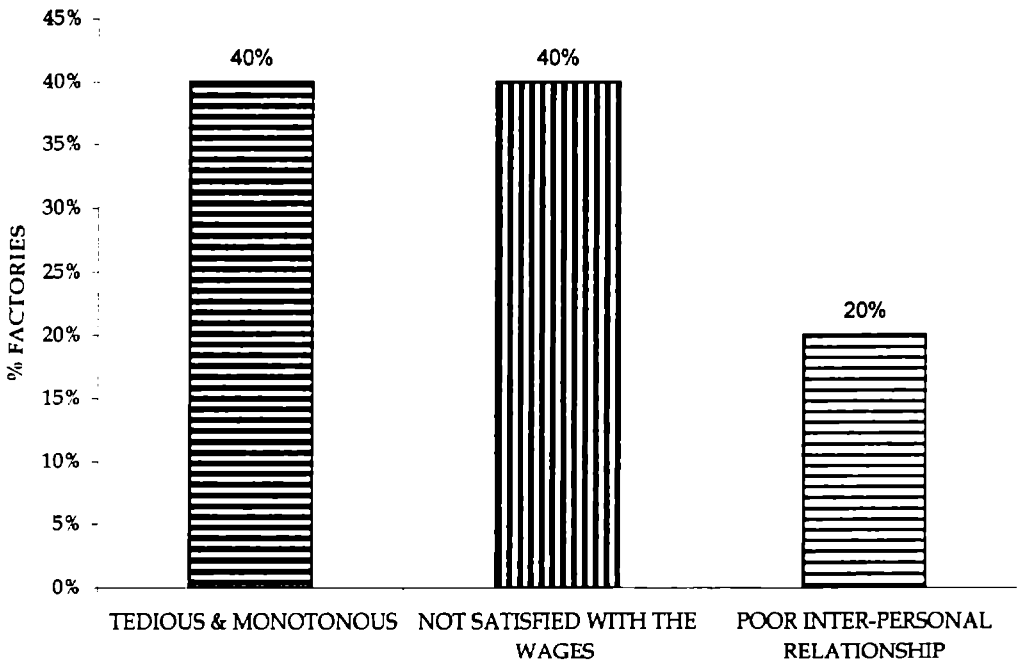


Fig 10. REASONS FOR FRUSTRATION IN LOWER LEVEL WORKERS WHO RESPONED NEGATIVELY TO JOB SATISFACTION

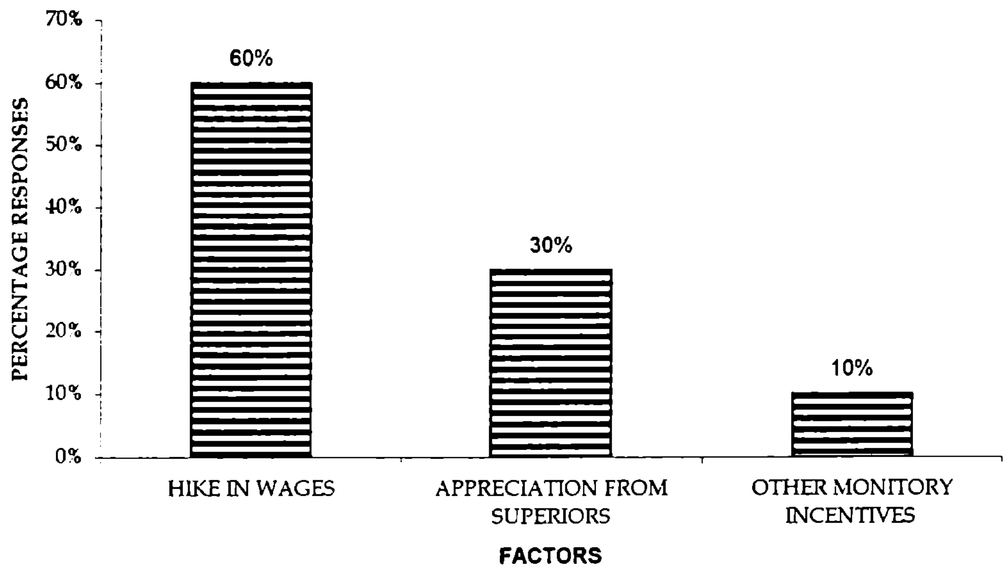


Fig 11. PATTERN OF RESPONSES OF LOWER LEVEL EMPLOYEES (%) ON THE FACTORS CONTRIBUTING TO THEIR JOB SATISFACTION

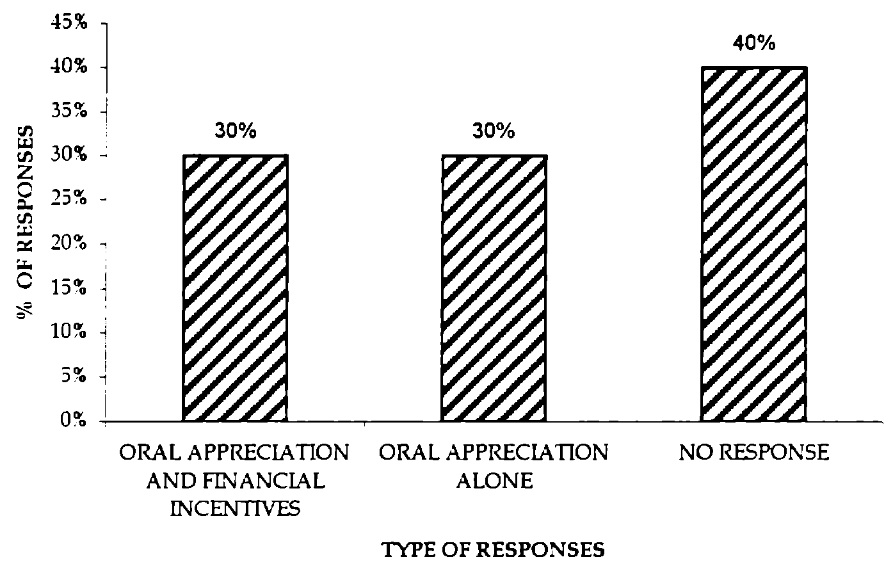


Fig 12. PERCENTAGE RESPONSES OF THE SUPERIORS FOR THE GOOD WORK DONE BY THE LOWER LEVEL EMPLOYEES

CHAPTER 9

QUALITY ASSURANCE

1.Introduction

Different authors define the word quality in different ways. Quality is uniformity, consistency and conformity to a given standard or specifications., quality is totality of features or characteristics of a product that bear on its ability to satisfy a given need also known as general acceptability. It was also stated as the composite of characteristics or attributes which differs from unit to unit, as a statement of what the user wants and what the manufacturers can and as fitness for use (Anon, 1991a).

Based on ISO 9000 concept, which came into effect during the late 1990s, a series of guidelines were evolved for assuring a total quality system. According to International Standards Organisation (ISO), quality assurance (QA) is the planned and systematic action necessary for providing adequate confidence for a product or service. Quality control on the other hand is the operational technique and activities, which carries out the programmes established by the quality assurance (Huss,1993). The seafood being an export oriented commodity, the quality aspects are very much essential (Gorga, 1994). Proper quality assurance programme in the seafood industry helps firms to meet the requirements of national and international inspection programmes in seafood quality and safety. It would help in getting higher product prices, increased sales, lower inventory costs and reduced risk liability (Sylvia *et al.*, 1994). Thus the QA programmes function as a tool for integrating marketing and production, as well as balancing costs and benefits and helps in improving production.

Seafood unlike its counterparts is highly perishable and demands special care throughout its handling till it reaches the ultimate consumer. Its quality should be controlled or maintained right from the point of harvesting itself. Proper icing procedures, protection of products against microbial spoilage through the use of fish holds in fishing vessels and cleanliness are the most important features of fish handling (Ramamurthy, 1978). Quality of fish landed in Cochin fishing harbour has already been assessed by many workers, (Lakshmanan *et al.*, 1984; Lalitha and Iyer, 1986).

Once onboard, it should be handled carefully and iced properly to delay the onset of spoilage. In fact, the contamination of seafood increases during handling, washing and freezing (Reilly *et al.*, 1984) and the quality of ice and water becomes a decisive factor in the ultimate quality. The quality and the development of spoilage depend on the type of fish - whether lean or fatty. The fatty fish requires special processing technologies (Ramamurthy, 1981). Iced storage characteristics of most of the commercially important marine fishes and squids in India have been studied (Govindan, 1971; Shenoy and James, 1972; Surendran and Iyer, 1976; Joseph *et al.*,1977; Joseph *et al.*, 1980; Perigreen *et al.*, 1987). It is also stated that product kept out of direct contact with ice keeps much long and have better acceptability than the fish kept in direct contact with ice (Basu and Khasim, 1985) and certain products like the shrimps exhibit the problems of blackening during iced storage (Chung, 1976). The proportion of the *Acinetobacter* and *Moraxella* with increase in the storage period and spoilage by *Pseudomonas* was very significant in prawn under iced storage (Surendran *et al.,* 1985). The delay in icing after harvesting, cause considerable deterioration in the quality of raw material (Dora and Hiremath, 1987; Sankar and Nair, 1988; Serrao *et al* .,1992).

At landing centre the raw materials should be immediately washed with potable water and iced in clean plastic boxes in the ratio of 1:2 (layered icing). Thomas and Mathen (1979) discussed the quality requirements of water in seafood processing with special emphasis on the physical, chemical, bacteriological and biological characteristics. It is also reported that raw seafood entering the plant carried comparatively low level bacteria of public health significance but the initial cutting operation caused ten fold increase in the bacterial count (Raj and Liston, 1963).

Another possible contamination is during the transportation of the purchased raw material from the landing centre to the pre-processing centre which must be done within the shortest possible time in insulated or refrigerated vehicles. After unloading, the vehicle must be thoroughly washed with teepol or suitable detergent before futher use.

At the pre-processing centre, the material is washed thoroughly with chlorinated potable water and processed on first in first out basis. The equipment and utensils used and movement of workers for pre-processing and processing are the other steps, which require special attention.

Waste disposal system is another important aspect, which is often neglected. The system must be scientifically designed and monitored for proper functioning. The importance of proper waste disposal has been stressed by different people (Fahri *et al.*, 1984) and there are problem of pollution due to discharge of processing wastes into water bodies (Cronin, 1982; Gates *et al.*, 1982).

In quality control practice, any cost which is incurred to ensure that the out going product is of requisite quality is termed as quality costs (Lal, 1990). Feigenbaum (1974) proposed a model to analyse quality cost that is almost universally accepted (Plunkette and Dale, 1987; Porter and Reyner, 1992). This model assumes that production costs relevant to quality changes can be divided into three broad headings - Failure costs, Appraisal costs, and Prevention costs (Lal, 1990; Juran and Gryna, 1980; Besterfeild, 1986). Prevention cost is the cost of any action taken to investigate, prevent or reduce defects and failure; appraisal cost is the cost of assessing and recording the quality achieved and the failure cost is the cost arising from failure to achieve the quality specified (British Standard Institution,1981; Anon, 1986a; Zugarramurdi *et al* .,1995).

Failure costs can be divided into internal and external (Zugarramurdi *et al.*,1995; Lal, 1990; Anon, 1991a; Anon, 1986a). The costs of failure that are incurred while the product is still with in the company's premises are called cost of internal failure. Those that arise when the product has left the company premises are called the cost of external failure. Failure is generally associated with defects (Anon, 1991a).

External failure costs are the costs of defects identified after shipment to the buyer or consumer. Internal failure costs include scrap, reprocessing, and other costs (Zugarramurdi *et al.*, 1995). Other costs include cost of additional laboratory analysis to ascertain the quality of dubious lots, extended cold storage of lots that could not be despatched due to low quality, costs produced during the analysis of faulty lots (including salary) energy losses due to improper use of ice, electricity, steam and water, faulty operation of the cold storage room, low fish yield of untrained staff and low fish yield due to improper adjustment of fish processing machines (Zugarramurdi *et al.*, *1*995). Internal failure cost is the so-called overall shrink. Shrink is loss of inventory due to spoilage, deterioration, water loss and uncontrollable acts. In the US fishery industry an average of 10% shrink is noticed for fresh fish and 1% for frozen fish (Zugarramurdi *et al.*, 1995). Venugopal (1996) pointed out that failure costs are costs of rejection, rework, re-inspection, scrap, excess inventory, over time, etc. Anon (1986a) explained failure costs as scrap, rework, re-inspection, screening, defect analysis, down grading, complaints and guarantees. External failure costs include complaints, guarantees, allowances, and recalls.

Appraisal costs include incoming inspection (to check the quality of goods from vendors), process inspection (to parts and products during manufacture), final inspection, in-plant or external (to check that finished products meet the quality requirements), product quality audit (to study the quality of outgoing products), special testing (to carry out life tests, laboratory tests) etc on products from normal production (Anon,1986a ; Zugarramurdi *et al.*,1995). The salaries of quality control and inspection people (professionals, technicians and workers). As temperature is the single most important parameter in HACCP implementation, the cost related to measurement, recording and control of temperature, including calibration of equipment, should be included as appraisal costs (Zugarramurdi *et al*., 1995).

According to the new regulations in Canada, USA, and Europe, now being implemented, fishery products manufactured outside the proposed HACCP based systems will have to pass through independent full sampling and analysis. If applied these regulation will increase the appraisal costs of the companies that do not conform to the new regulations (Zugarramurdi *et al*., 1995).

Prevention costs include, (i). the quality system (to plan and document the quality system, pre-production activities to follow new and modified designs, to identify shortcomings, to suggest improvements, to verify that the quality requirements can be met when full scale production starts), (ii).manufacturing analysis (to follow new and modified manufacturing methods and processes, to suggest improvements, to carry out process capability studies), inspection planning (to plan inspection activities), (iii). vendor evaluation (To evaluate present and potential vendors as to their ability to deliver goods of desired quality, to obtain information on the vendors from deliveries), (iv). monitoring and analysing the development of product quality (to acquire report and analyse data on quality performance to suggest any corrective measures and to follow them up), (v). system quality audit (to evaluate and review quality procedures and plans and to judge their adequacy) (vi). quality management and administration (to lead and co-ordinate quality activities), (vii). training (to plan and carry out training programme in the field of quality), (viii).

motivational programmes (to plan and carry out programmes for increased quality awareness of personnel).

Keeping in mind all the operations in seafood processing factories, this chapter deals with the present status of quality management systems followed in the seafood processing industry in Kerala and analyses the present quality control system with a view to implement TQM on seafood industry.

2. Materials and methods

The primary data required for the study of quality assurance of purchased product, quality assurance of manufacturing process and present quality control systems followed in seafood industry in Kerala were collected from the selected factories through a pre-tested questionnaire (Appendix 1). The details of sampling method and sampling size are described in Chapter 2.

For a detailed study on the Total Bacterial Counts of the raw materials, in-process and finished products of Individually Quick Freezing lines, three factories in Cochin region were selected at random. The data on the Total Bacterial Count of the raw material, in-process and finished products were taken on 5th, 10th, 15th, 20th, 25th and 30th of every month for a period of one year during 1996-97. Samples were drawn for the study from raw materials, after cooking, after chilling, after freezing, after glazing and after glaze hardening. For estimating the bacteriological quality of water used at different stages of processing in the IQF line, Total Bacterial Counts of the water samples (four samples/month) were drawn from tap, chilled water, chilled water from chilling unit and glaze water. Total Bacterial Counts of the ice samples were also estimated as in the case of water samples. Swabs were also taken from different work stations in the IQF line as per the frequency described earlier for the analysis of the products. Bacteriological (TBC) quality of the product, water, ice and swab was assessed as per Anon (1991b) and it was statistically analysed by Two Way ANOVA (Two Way Analysis of Variance) as described by Dixon and Frank (1983).

For the comparison of cost of quality for EC approved and IPQC factories, two factories – one EC approved factory and one non-EC approved factory in Cochin region were selected. The information and data were collected from their documents and by personal interviews. The data were analysed as per the PAF (Prevention-Appraisal-Failure) Model described by Feigenbaum (1974).

3. Results and Discussion

3.1.Quality control of purchased raw material

Every organisation whether a manufacturing company or a consumer organisation needs to purchase a variety of raw materials and products for further processing or consumption. In either case, quality of the raw material is an important factor, which has to be given due consideration during purchase. In the case of seafood, it is a perishable commodity. If the quality of the material is not properly maintained, ultimate result is a deteriorated or spoiled product. All manufacturing companies in any case have some form of quality control set up for assuring the quality of their own products. The same set up can be utilised to exercise control over the quality of the purchase store or depot. If the producer is non-manufacturing organisation, it has to have a special organisation for quality assurance of purchased product. Lal (1990) reported that over 70% of the quality problems in purchased products are caused by vague specification or misunderstanding of the purchaser's requirement by the producer. To avoid these problems the concept of quality management or total quality control can be applied to the purchased product also.

Table 1 shows the different methods used to procure raw materials in seafood processing industry in Kerala. 73% of the processors purchased their raw materials both directly or through supplier agents and other 22% through suppliers alone. 5% procured directly. In the factories approved by EC, it is recommended to procure raw materials directly by the companies for processing and export to European markets (Anon, 1991c). Ramachandran (1988) reported that there are five methods adopted by processors to purchase raw materials. They are, through agents, through contract, direct purchase, through own depots at the landing centres, partially from their own boats and partially from agents or contract. Study revealed that main landing centres of the seafood processing factories are Cochin fishing harbour, Neendakara Fishing Harbour, Ambalapuzha, and Thottapally. According to Ramchandran (1988) the main landing centres during 1984-85 were Ambalapuzha, Sakthikulangara-Neendakara and up to Kovalam in the south, Aroor up to Ambalapuzha, Kalikavillai and up to Kanyakumari, Cochin Fishing Harbour, Kozhikode and up to Mangalore. The only EC approved landing centre in Kerala during the period of study was Cochin Fishing

Harbour; others were not up to the EC standards. It is bound to affect the seafood export to the European markets. Lakshmanan *et al.* (1984), Lalitha and Iyer (1986) have already assessed quality of fish landed in Cochin Fishing Harbour.

Other landing centres in Kerala Coast also have to be upgraded to EC standards. From the study it was found that all seafood processors were not satisfied with the raw material availability of their factories. Iyer *et al.* (1982) reported that 70% of the idle capacity of seafood industry were due to non-availability of raw materials. 75% of the seafood processors were also purchasing raw material from other states, the quality of which was far below the prescribed standards. Not a single factory was receiving adequate quantity of raw material from a single supplier or any single purchase depot. This is one of the main factors for quality deterioration of raw materials received for processing. Processing factories in Kerala receive raw materials from a large number of landing centres viz. Ambalapuzha, Quilon, Munambam, Vadi, Thangassery, Anchuthengu, Trivandrum, Vypeen etc. apart from local suppliers.

About 50% of the seafood processors were not informing purchase specifications or customer's requirements to the suppliers. They also never informed their suppliers about their quality policy. But it was found that all EEC approved factories were regularly informing the purchase specifications and customer's requirements to the suppliers. According to Lal (1990), an efficient purchase department normally maintain a comprehensive list of suppliers and evaluation of the suppliers with respect to their ability to maintain the quality of the product at desired level as well as their production capacity. 71% of the seafood processors in Kerala were not evaluating the suppliers in terms of the quality of raw material supplied, purchase rate and availability of the raw materials. Since they were not evaluating the suppliers on the above basis, it was not possible to select the most suitable supplier from the evaluation. Quality of raw materials received from such suppliers was at variance at different point of time. A panel of approved suppliers has to be maintained by the companies based on their past experience. Quality of raw material has to be assured by the companies by purchasing raw material from approved suppliers. Approved suppliers could be verified with their approval number. This could be verified with every lot supplied.

It was found from the study that, 45% of the factories were unable to procure adequate quantity of raw materials at the right time from suppliers. The raw material procurement strategies of seafood processors vary from direct dealing with suppliers, through phone calls, employing supervising staff at purchase points, giving extra payment to suppliers, prompt and better payment and diplomatic dealings.

In the case of seafood industry, where the goods are highly perishable, storing of raw materials for long time for further processing is not recommended due to quality deterioration. Durairaj and Krishnamurthy (1986) reported that fish stored at ambient temperature was completely spoiled after 10 hours and became unacceptable. Quality changes of iced storage fishes has been reported by many workers (Govindan, 1971; Shenoy and James, 1972; Surendran and Iyer, 1976; Joseph *et al.*,1977; Joseph *et al.*, 1980; Perigreen *et al.*, 1987). But one thing is possible that in the case of an

IQF cum block freezing factory the frozen blocks can be used as the raw material for the manufacture of IQF products. 30% of the IQF cum block freezing units were maintaining adequate reserve stock in this way to insulate themselves against the interruption of short supply of raw materials during slack seasons .So IQF cum block freezing units are more suitable for the seafood processing industry in Kerala.

None among the suppliers have well staffed quality control organisation, a working quality control programme and testing facility. All factories have certain specifications for purchased raw materials and also for carrying out the organoleptic inspection. As per the EC Directive (Anon, 1991c), pre-processing centre must have well staffed quality control organisation and a working quality control programme.

None of the factories studied except EC approved ones were systematically cleaning the vehicles after unloading the raw materials in their processing premises. 25% of the factories were not washing the vehicle/containers before loading the material into the vehicle. All factories were using plastic boxes for stocking the raw materials. The study shows that 85% of the factories were using refrigerated /insulated trucks for transporting the raw materials. Others were using open truck. Ramachandran (1988) also reported that during 1984-85, 82% of the processing factories collected raw materials either by their own fleets of insulated truck or through hired insulated truck. According to Anon (1991c), fresh and thawed fishery products and cooked and chilled crustacean and molluscan shellfish products must be kept at the temperature of melting ice. It is stipulated in the EC Directive thatproducts may not be stored or transported with other products which may contaminate them or affect their hygiene, unless they are packaged in such a way as to provide satisfactory protection. Vehicles used for the transport of fishery products must be made in such a way that the temperatures laid down in the EC Directive can be maintained throughout the period of transport. If ice is used to chill the products, adequate drainage must be provided in order to ensure that water from melted ice does not stay in contact with the products. The Directive also stipulates that the inside surfaces of the means of transport must be finished in such a way that they do not adversely affect the fishery products. They must be smooth and easy to clean and disinfect. Means of transport used for fishery products may not be used for transporting other products likely to impair or contaminate fishery products, except where the fishery products can be guaranteed uncontaminated as a result of such transport being thoroughly cleaned and disinfected.

Study shows that 70% of the factories were properly washing the raw materials upon receiving at the receiving site. 70% of them also use proper quantity of ice at the right time for temporary storage of raw material for processing. But no one was doing correct temperature checking and record keeping except EC approved factories. 70% of the surveyed non- EC factories had no chill room facility for storing the raw material. All the EC approved factories had chill room facilities.

3.2. Quality control of manufacturing process

3.2.1. pre-processing division

The quality of a product is initially created during design in the form of design particulars. However this creation is only on paper in the form of manufacturing drawings and specifications. Quality is actually built into the product during its manufacture. Manufacture of a product requires a host of activities involving different departments and sections of the manufacturing organisation having the common aim of achieving the required quality and quantity targets (Lal, 1990).

It was found out that, all the seafood processing factories studied had adequate facilities of raw material receiving, processing, freezing, frozen storage and toilet/personnel hygiene facilities as per the In-Process Quality Control system prevailed at that time. Now HACCP system is mandatory for getting EC approval and there are some additional facilities required in most of the factories for getting EC approval (Anon, 1995b). Health conditions for the production and marketing of fishery products on the unified European market are to be followed for export to European countries. It is necessary that persons responsible for the establishment and implementation of EC Directives take all necessary measures to ensure food safety and quality at all stages of production and distribution. Processors shall keep a written record in regard to the identification of Critical Control Points in the establishment, implementation of methods for monitoring and checking such Critical Points, taking samples for analysis for the purpose of checking and disinfecting methods used (Anon, 1991c).

50% of the seafood processors had no facilities for peeling and pre-processing. But according to EC Directive 91/493/EEC (Anon, 1991c) it is mandatory to have a full fledged pre-processing facility attached to all the factories meant for export to European markets. 10% of the seafood processing factories in Kerala were approved under EC Directives during the study period.

About 75% of the seafood factories were not washing the raw materials before sending it to pre-processing division. 25% of them were found to wash the raw materials before sending it to the pre-processing division. As per EC Directives 91/493/EEC (Anon, 1991c), the products must be washed thoroughly with drinking water or clean seawater. There were different methods adopted for washing the raw materials at the raw material receiving sites in the factories (Figure 1). 71% of the factories used the method, dipping in chlorinated water for washing raw materials at the receiving site. 15% of them used dipping in potable water for the purpose and the remaining 14% used filth washing machines for washing the raw material. Figure 2 shows the type of washing during pre-processing in seafood industry in Kerala. The most common type of washing used was washing in water kept in tubs. Frequency distribution shows that 50% of the times the factories resorted to tub washing for washing the in-process material at the pre-processing centres. Washing in machines was also common. Thampuran (1988) reported that washing of raw material could reduce the Total Bacterial Count by 52-98% from the initial count before washing. This shows the significance of proper washing.

Figure 3 shows the percentage use of different water sources for pre-processing activities. 85% of the pre-processing centres depended on bore well for their water source for washing the raw materials as well as in-process materials. 5% of the pre-processing centres used both municipal water as well as bore well water for the purpose. Only 10% of the pre-processing centre, which is mostly located in the urban area, used municipal or corporation water supply.

As reported under chapter on Input Analysis (Chapter 3), in 70% of the factories studied, the floors of the pre-processing division were cemented and roofing was done with asbestos. In the remaining factories (including EC approved factories) the roofing was made of reinforced concrete and flooring with mosaic tiles. The wall of the pre-processing divisions of all factories studied were cement plastered and doors were all made of wood except 30% of the factories where they were made of other materials.

Thomas and Mathew (1990) studied about the filth and decomposition in prawns from peeling sheds in and around Cochin and found out that about 40% of the samples were found to have filth and 5-6% of the samples were found to be decomposed. They also reported that the smaller the size of the prawns, the higher the contamination by flies and ants in addition to decomposition.

3.2.2. Processing division

Figure 4 shows the percentage frequency of various types of washing used in the processing division of the factories studied. There were different methods of washing followed in this division, they were dipping in tub water, dipping in running water, dipping in chilled water, dipping in chlorinated water, washing in machine or shower washing. Among these methods, dipping methods were the most common with a frequency occurrence of more than 50 %. Mathen and Thomas (1988) studied about the water imbibition and thawing losses of frozen prawn meat and found out that there was no thaw loss in unwashed samples in the beginning and it increased to 6% in 6 months storage. But in washed samples thaw loss was reported to be18% after the same period of storage. This is because of water imbibing during washing process. Washing also reduces considerable amount of microflora as reported earlier in this chapter. Ramachandran (1988) reported that fish processing factories in Kerala were receiving sufficient water when compared to processing centres in other states. He also reported that the processing centres in Kerala had alternate source of water namely bore wells during summer months when municipal water was in short supply.

Study shows that about 50% used mere un-chilled and non-chlorinated water and others use machine for washing purpose with water chlorinated at 5-10 ppm level. Sobsey (1989) reported that if microbes are associated with granular material or other surfaces the effect of chlorine decreases drastically. According to EC Directive 91/493/EEC (Anon, 1991c), detergent, disinfectants and similar substances must be approved by the competent authority and have to be used in such a way that they do not have any adverse effects on the machinery, equipment and products.

All peeling/pre-processing divisions in the factories had drainage facilities. Figure 5 shows the different types of drainage systems used in this division. 40% of the factories had covered type of drainage system, which is most desirable. 33% of them had meshed drainage systems, which prevent rodents, and other insects from entering the processing premises and 27% had open drainages. As per EC Directive 91/493/EEC (Anon, 1991c), establishment must have waterproof flooring. This is easy to wash and disinfect. It should be laid in such a way as to facilitate the drainage of water and have a hygienic wastewater disposal system. The importance of proper waste disposal has been stressed by different people (Fahri *et al.*, 1984). Cronin (1982) and Gates *et al.* (1982) reported pollution problems due to the discharge of processing wastes into water bodies.

In processing factories, source of water was bore well and municipal/corporation supply. About 67% of them were using bore well water and remaining were using corporation water supply. According to Thomas and Mathen (1979) the quality requirements of water used in seafood processing industry in Kerala were not satisfactory. They discussed the quality requirements of water used in seafood industry with special emphasis on physical, chemical, bacteriological and biological characteristics. Iyer and Varma (1990) studied about the sources of contamination with *Salmonella* during processing of frozen shrimp. They found out that water from culture pond, coastal seawater, sea beach, process water, ice, shrimp contact surface, floor, rodent and lizard droppings were the major sources of contamination. Varma and Iyer (1990) studied about the viability of *Vibrio cholerae* in distilled water, municipal water and sea water at room temperature and found out that survival varied from 20 hours in distilled water at room temperature to 38-40 days in sterile sea water at room temperature. As per EC Directive 80/778/EEC (Anon, 1980) the drinking water must be used for all the operation in the seafood industry.

About 80% of the seafood processing industry had no cold room or chilled storage facility for storing the pre-processed material before further processing. Cold room or chilled storage is a must for EC approval (Anon, 1991c).

About 50% of the seafood processors were using one-kilogram ice for one kilogram raw material. Others were not aware about how much quantity of ice they were using for 1 kg material except in EC approved factories. The inspection team of EC, which visited Kerala for factory approval, suggested 1:2 ratio for raw material to ice. Iced storage characteristics of most of the commercially important marine fishes and squid in India have been studied (Govindan, 1971; Shenoy and James, 1972 ; Surendran and Iyer, 1976 ; Joseph *et al*, 1977; Joseph *et al.*, 1980 ; Perigreen *et al.*, 1987). It is also stated that product kept out of direct contact with ice keeps much long and have better acceptability than the fish kept in direct contact with ice (Basu and Khasim, 1985). Chung (1976) reported black spot formation in shrimps during iced storage. The proportion of the *Acinetobacter* and *Moraxella* increased with increasing the storage period and spoilage by *Pseudomonas* was very significant in prawns under iced storage (Surendran *et al.*, 1985). The delay in icing the fish after harvesting, causes considerable deterioration in the quality of raw material (Dora and Hiremath, 1987; Sankar and Nair, 1988; Serrao *et al.*, 1992).

63% of the processing factories had tiled walls and others had cemented walls with glaze tiles up to 3cm height. 67% of the factories had cemented floors and others had mosaic floors. Figure 6 shows the types of drainage facility in the seafood processing factories in Kerala. Most of the processing factories had satisfactory drainage facilities in the processing division. All factories had washable type of roofing or ceiling. Building shall have clean walls and ceiling. They should be adequately cleanable and kept cleaned always so that the drip or condense from the fixtures and pipes, does not contaminate the food, food contact surfaces or food packaging materials. The working place provided between the equipment and walls are to be adequately unobstructed with adequate width to permit the employees to perform their duty and to protect against contamination of food. Similarly food contact surfaces should not be contaminated with clothing or personal contact (Anon, 1995a). As per EC Directive 91/493/EEC (Anon, 1991c), water proof flooring which is easy to clean and disinfect and laid down in such a way as to facilitate the drainage of water or provided with equipment to remove water must be provided in the processing halls. According to the Directive the walls should have smooth surfaces which are easy to clean, durable and impermeable. Ceiling or roof lining should be easily cleanable.

All seafood processing factories had adequate facilities for ventilation, lighting, and protection against pests such as insects, birds, rodents etc. All the factories had a quality-related staff in processing divisions. Now, according to EC Team, which inspected processing factories in Kerala, a plant must have a minimum of three staff in quality control department.

Figure 7 shows types of freezing facilities available in different seafood factories studied. The freezing facility consisted of mainly IQF and block freezing. 12.5% of the factories had tunnel freezing, plate freezing and IQF facilities. 18.5% had tunnel and plate freezers and 12.5% had IQF facilities alone. 25% of the factories had only plate freezing facility and 25% had IQF and plate freezing facilities. Figure 8 shows the total capacity of freezing in different factories studied. 56.25% of the factories had freezing capacity of >20 to 30 tonnes/day. 37.5% had freezing capacities ranging from >10-20 tones/day. Only 6.25% had freezing capacity above 30 tonnes/day. Table 2 gives the capacity of various freezers employed in the seafood factories in Kerala. In the case of Blast freezers, 50% of the factories had a capacity of >5 to 10 tonnes/day. 33.3% had a capacity of >10-15 tonnes/day. Only 16.6% of the factories had a blast freezing capacity of upto 5 tonnes/day. In IQF, 37.5% of the factories had a freezing capacity of upto 5 tonnes/day. 25% had a freezing capacity of >10-15 tonnes/day. In the case of plate freezing facilities in the processing factories, 38.46% of them had a freezing capacity of >10 to 15 tonnes/day. 30.7% of the plate freezers had a freezing capacity of >5-10 tonnes/day. All the processing factories had more than two freezers. Ramachandran (1988) reported the variation in the capacity of the freezers in the processing factories in Kerala. He also reported that refrigerant used in the freezers and cold store are either Freon –12 or liquid ammonia. But now a days, Freon –12 is not being used in the new freezers in seafood processing industry. Liquid ammonia is used as refrigerant in all seafood processing factories in Kerala. This may be due to the high cost of Freon –12 when compared to liquid ammonia and the environmental problem associated with it. Another important aspect is that the leakage in freezers filled with liquid ammonia can be easily detectable.

Iyer and Srivastava (1989) studied on the incidence of low temperature survival of *Salmonella* in fishery products and reported that all the serotypes of *Salmonella* tested were resistant to freezing at –40°C but during subsequent storage at –20°C there was some difference between the serotypes with regard to their viability. Reily and Hackney (1982) studied on the survival of *Vibrio cholerae* in frozen and refrigerated storage.

Minimum and maximum temperature attained in the different type of freezers in the processing factories varied from –18°C to –40° C. This is mainly due to prolonged time taken for loading and unloading the material and also due to mechanical aspects inherent in the freezers. As per EC Directive (Anon, 1991c), freezing equipment should be sufficiently powerful to achieve a rapid reduction in the temperature so that the temperature laid down in the Directive 91/493/EEC can be attained.

There were different methods of defrosting techniques adopted for defrosting the freezers in the seafood processing industry in Kerala. They were pressurised water, hose washing, high power exhaust fan and cold water spraying system (Table 3). More than 60% of the processors used hose washing method.

In seafood factories, the number of cold storages and their capacity depends on the production capacity of the factories. Figure 9 shows the details regarding the number of cold storages available in the seafood processing factories in Kerala. 57 % of the factories had only one cold storage and 24% had four cold storages in their factories. Figure 10 shows the capacity of cold storages in the seafood factories in Kerala. 36% of the factories had a capacity of >100-200 tonnes and 32% of them had a cold storage capacity of upto 100 tonnes. 9% of them had a very high cold storage capacity of above 500 tonnes. Actually the capacity of the cold storages was not found to be enough for the seafood processors during peak seasons. This is because of the fact that processed and packed products could not be exported at the right time due to delay in the shipments. In such situations they were found to depend on outside cold storages for storing the products. Sanjeev *et al.* (1985) studied on the occurrence of *Staphylococci* in frozen fishery products from nine cold stores situated in and around Cochin region and reported that around 70% of the samples contain Coagulase Positive *Staphylococci*. Nair *et al.*(1987) studied the frozen storage characteristics of IQF and block frozen mackerel and found out that shelf-life of IQF samples were 17 to 20 weeks and that of blocks 23 to 24 weeks

Figure 11 shows the system adopted in stocking of products in the cold stores of seafood processing factories. About 80% of the factories had no system for the handling of final products in the cold storage. But a few factories had product wise storage and others had code wise and grade wise storage.

Fluctuation in the temperature of cold storage is a common phenomenon. Temperature ranges from –5 to –22°C in the seafood processing industry in Kerala. This affects the quality of the product. Minor fluctuation in storage temperature has only little effect on the quality but wider fluctuation will have detrimental effect (Ramachandran, 1988). Pottinger (1950) found that the fluctuations of the order of 10°C have 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 fish stored at -23 °C . No factories were doing fumigation in the cold storage in the initial period of study but the EC teams, which visited the seafood factories in Kerala recommended periodical fumigation of cold stores. Twice in a year, all factories were doing defrosting of their cold stores during the period of study.

There are different types of packing followed for seafood products. It mainly depends on the buyer's needs and requirements and also on the type of freezing. Mainly there were two types of packing of seafood products viz., IQF forms and block frozen forms. Table 4 shows the different types of packing available for IQF and block frozen products. As per EC Directive 91/493/EEC (Anon,1991c) packaging must be carried out under satisfactory condition of hygiene, to preclude contamination of the fishery products and packaging material and products liable to enter into contact with fishery products must comply with all the rules of hygiene.

There were different types of equipment used for packing in the seafood processing industry in Kerala as mentioned in detail in Chapter 3. Main equipments used were strapping machine, packing machine, vacuum packing machine, sealer, tighter, balance, multivac packing machine, individual packing machine etc. These equipments were either imported or indigenous.

All the processors had satisfactory opinion about the quality of the packing materials available in seafood processing industry in Kerala. But all of them reported the smell of plastic materials in consumer packets. 50% of the factories had specification about the packing materials and they decided the specifications depending on buyer's requirements. 80% of the factories had separate storerooms for keeping packing materials and cartons. According to Kumar (1990) packing material used for frozen material had low temperature withstanding capacity. Physico-chemical properties and other characteristics of packing materials are dealt with in detail by Wheaton and Lawson (1988).

3.3. Quality control and Inspection system followed in seafood processing industry in Kerala

Quality related problems have become dominant in seafood processing industry in Kerala. This has resulted in the rejection of seafood sent from India to many destinations. The latest being the total block listing of seafood companies from India exporting seafood to Europe and partial block listing by the United States. The quality systems prevailed in the seafood industry in India were outdated and no longer in use in the developed world. Table 5 shows the various types of quality control systems adopted by seafood processing factories in Cochin and Quilon regions. From the study it was found that, during 1995-1997, 87% of the seafood processing factories in Cochin were following In-Process Quality Control System and 13% were following ISO 9002 and In-Process Quality Control System. During 1997 there was a total block listing of seafood products from being exported to Europe. Later, during 1997-98, 10% of the factories in Kerala were approved by the EC for exporting their products to Europe. At present, Hazard Analysis Critical Control Point (HACCP) quality system is mandatory in seafood processing industry in India. Kaul *et al.* (1989) conducted studies on the adoption of recommended quality control practices by fish processing factories.

50% of the factories surveyed had full-fledged quality concept but it was not implemented fully in the manufacturing sector. Quality concepts of the different processing factories included customer satisfaction by making good quality products; degree of fitness for use; packing only first quality product; and supplying best product with consumer appeal.

About 60 % of the processors had no quality policy or objective. The quality policy of the remaining processors included training workers to achieve quality, maintaining average quality, total customer satisfaction on a continuous basis, to be a market leader in seafood export, getting good price for product and to keep quality, making good products without loss and customer satisfaction in producing ready to eat/health conscious material. A good quality policy will define the objectives and responsibilities of the business regarding quality management. The quality policy is the responsibility of the chief executive and should be communicated and published throughout the business in its own right (Bolton, 1997).

There were different opinion among the management about the effect of quality on company's sales and profitability. They were

1.Maintaining a steady quality has helped the company to have long lasting customers

2.Easy marketing at better rate

3.Good quality products

4.Fetch better price and more sales

5. Good quality gives good sales and profit

6.High returns from best quality products

7.Quality improvement has increased sales and customer confidence.

About 50% of the factories had the same opinion that increasing quality grade would help them to get additional value for their products. Brown and Sylvia (1994) reported that consumers want more than safe and wholesome food - they want consistent and high quality food. Fishers and processors must meet these changing demands and realise that harvesting and processing using traditional practices or simple "rules of thumb" are inadequate to meet evolving international standards for seafood quality. Every country incorporates minimum safety standards for import regulations, which processors routinely meet and generally exceed. The problem lies in knowing the level of quality beyond simple safety that must be met to improve profits and create new market opportunities. Contemporary consumers demand a level of quality that is costly to produce. However depending on the market, excess quality will increase costs and decrease profits. Both exceeding and not meeting optimal quality will lead to lower profits. Ronsivalli and Baker (1981) gives the impact of assurance of high quality of seafoods at point of sales.

All processing factories had qualified quality control technologists. Their minimum qualification was graduation. But most of them were post graduates in fisheries. They had 2 to 12 years experience. The human resource aspects of the seafood industry have been dealt in detail in Chapter 7 and 8. After the EC ban on the export of Indian seafoods, the seafood processors have started giving more importance to quality assurance. Record keeping in all the factories studied during 1995-97 was done as per In-Process Quality Control system. But now, HACCP is mandatory for exporting seafood to USA and European markets (Anon, 1995b), and registers are maintained as per HACCP system.

3.4. Microbiological quality

Figure 12 shows the average month wise total bacterial count (per gram) of peeled and deveined raw material used for Individually Quick Frozen production of factory 1 during 1996-97. A wide fluctuation was noticed in the Total Bacterial Counts during this period. A sudden fall in the bacterial count was noticed in the month of July, August, September and October. Increase in the bacterial count was noticed during the month of November, and February. Fluctuation in the bacterial count is due to the seasonality. That is after monsoon, temperature and humidity of the atmosphere was not favourable for the growth of bacteria. The temperature at which growth of bacteria occurs best is known as optimum temperature and is 37°C (Ananthanarayanan and Panicker, 1982). Moreover water availability in somewhat sufficient quantity during rainy season also might have helped in proper washing of the raw materials at the pre-processing centres and receiving sites. These can be the main reasons for comparatively reduced bacterial counts during rainy seasons. There was a general increase in the bacterial counts of raw materials during summer months. This could be attributed to the higher temperature prevailing during summer. Similarly there was a decline in the bacterial counts during winter months. Surendran and Gopakumar (1982) reported seasonal variation in the bacterial count of skin, gills and intestine of newly caught oil sardine from Cochin water. They found higher bacterial counts in the warmer months of March, April, May and June. Similarly lower counts were noticed in the winter months of December and January. Georgala (1957) and Karthiayini and Iyer (1971) have made similar observations. Shewan (1961) also reported seasonal variation in the bacterial count in seafood with respect to changing environmental conditions.

Figure 13 shows the average month wise Total Bacterial Count (per gram) of in-process peeled and deveined material during the production of Individually Quick Frozen peeled, deveined and cooked shrimp in factory 1 during 1996-97. Bacterial count after cooking process was very low compared to the raw material count. Next step of Individually Quick Freezing process was chilling. After chilling process, the bacterial count showed a marginal increase, probably due to the inferior quality of water and ice used. This may also be due to improper quality management like improper cleaning and sanitation of the equipments. The next step of the processing was freezing. In this stage, a slight decrease in the bacterial count was noticed from the preceding stage. Thampuran (1988) reported that freezing of fish and prawn at -40°C caused 70-80 % reduction in the Total Bacterial Count of the muscle. Again bacterial count increased slightly after glazing stage due to the reasons stated earlier about the quality of water and ice used. The sanitary condition of the equipments like glazer belt also might have contributed to this increase in bacterial counts. The next step of the processing was glaze hardening. In this stage a slight decrease in the bacterial count was noticed. Raj and Liston (1963) reported that raw seafoods entering the plant carried comparatively low levels of bacteria of public health significance but it increased during the processing operation. However, all the samples analysed from different stages of processing in factory 1 was within the prescribed standards (Anon, 1991b).

Figure 14 shows average month wise total bacterial count (per gram) of peeled and deveined raw material used for IQF production in Factory 2. Here, as in the case of factory 1, a low bacterial count was noticed during the rainy months of August, September and October and higher counts during the summer months. The reasons for this pattern of bacterial counts have already been discussed earlier.

Figure 15 shows average month wise bacterial count (per gram) of in-process peeled and deveined material for the IQF production of peeled,deveined and cooked shrimp in factory 2. After cooking, the bacterial count of the cooked material was very low compared to the bacterial count of the raw material. No significant fluctuation in the bacterial count of this processing activity was noticed during the entire period of study. After the cooking process, as in Factory 1, the bacterial count was again increased slightly especially after chilling and glazing activities.

Figure 16 shows average month wise total bacterial count (per gram) of the peeled and deveined raw material for IQF production in Factory 3 during 1996-97. In this case also lower bacterial counts were noticed during rainy and winter seasons and higher counts during summer months.

Figure 17 shows average month wise bacterial count (per gram) of in-process peeled and deveined material used for the production of IQF peeled, deveined and cooked shrimp in Factory 3. Bacterial count of the cooked material was comparatively lower as in other two factories. The significant variation in the bacterial count was noticed after chilling, glazing and glaze hardening. Maximum bacterial counts were noticed in these stages in May, June and December. Greater fluctuation in the total bacterial counts in the various stages after chilling shows ineffective quality management practices in this factory compared to the other two factories. This is evident during hot months when room temperature and humidity were high. An effective temperature monitoring is very significant especially during summer months.

Figure 18 shows average month wise total bacterial count (per gram) of peeled and undeveined raw material used for IQF production in Factory 1 during 1996-97. Wide fluctuation was noticed in the total bacterial counts of raw materials used for the production of this product. In this case also the trend was similar to the trend shown by the raw materials used for the production of IQF peeled and deveined shrimp as reported and discussed above. Maximum bacterial count was noticed in the summer months and lower count during rainy seasons.

Figure 19 shows average month wise total bacterial count (per gram) of in process (peeled and undeveined) material during the production of peeled and cooked shrimp in Factory 1 during 1996-97. Here also the bacterial count was very low after cooking when compared to the bacterial counts of raw material. The results of other stages show that there were not many fluctuations in the bacterial counts during different months. This shows effective process control in this factory.

Figure 20 shows average month wise total bacterial count (per gram) of peeled and undeveined raw material used for IQF production in Factory 2 during 1996-97. As in the previous case fluctuation was noticed in the total bacterial counts during different months but variations was lesser compared to Factory 1. Other trends are similar as reported in Factory 1.

Figure 21 shows average month wise total bacterial count (per gram) of in-process (PUD) material during the production of IQF peeled and cooked shrimp in Factory 2 during 1996-97. Total bacterial count after cooking stage was comparatively higher when compared to Factory 1 and Factory 3. It was mainly due to improper quality control practices followed in this particular factory for the production of this product. The Total bacterial count after the cooking process shows fluctuation higher than in other factories. This could be due to non-uniform time-temperature control in the cooking process during the study period.

Figure 22 shows average month wise total bacterial count (per gram) of peeled and undeveined raw material used for IQF production in Factory 3 during 1996-97. This factory shows the least fluctuation in the total bacterial population during the entire study period. It can be inferred that the washing and quality management practices followed in this factory at the receiving site are comparatively satisfactory when compared to other factories. The study also shows that this factory was approved by EC for export to European markets.

Figure 23 shows average month wise total bacterial count (per gram) of the in-process peeled and undeveined material during the production of IQF peeled and cooked shrimp in factory 3 during 1996-97. Total bacterial count of the cooked material was very low and showed very little fluctuation during the entire period of study. This shows effective time-temperature management in this factory for cooking of shrimp. The total bacterial counts of other activities also show lesser variations during the different months when compared to the other two factories. This could be due to the changed quality management practices adopted in this factory for obtaining EC approval.

Table 6 shows the results of the two way ANOVA of the bacteriological tests of the samples taken from each step in the production of IQF peeled and cooked shrimp in Factory 1. Treatment 1(Raw material) showed significantly higher count and treatment 2(after cooking) showed significantly lower count. There was no significant difference among treatment 3, (after chilling) 4, (after freezing) 5 (after glazing) and 6 (after glaze hardening).

Among months, August and November registered lower bacterial count and April showed significantly higher count. There was no significant difference among counts in the months of September, January, February and March and also May, June, July, October and December.

Table 7 shows the results of the two way ANOVA of the bacteriological tests of the samples taken from each step in the production of IQF peeled and cooked shrimp in Factory 2. Treatment 1(Raw material) showed significantly higher bacterial count and treatment 2(after cooking) significantly lower bacterial count. There was no significant difference among treatment 3 (after chilling), 4 (after freezing), 5 (after glazing) and 6 (after glaze hardening).

Months of August and September were having significantly lower count and month May significantly higher count. There was no significant difference among bacterial counts in June, July, October, November, December, April, January, February, and March.

Table 8 shows the results of the two way ANOVA of the bacteriological tests of the samples taken from each step in the production of IQF peeled and cooked shrimp in Factory 3. Treatment 1(raw material) gave a significantly higher count and treatment 2(after cooking) showed significantly lower count. There was no significant difference in count among 3(after chilling), 6 (after glaze hardening), 4 (after freezing) and 5 (after glazing).

Among months September, February, and March registered lower count and May, June, and November significantly higher count. There was no significant difference among months of July, August, October and January.

Table 9 shows the results of the two way ANOVA of the bacteriological tests of the samples taken from each step in the production of IQF peeled,deveined and cooked shrimp in Factory 1. Treatment 2(after cooking) showed significantly lower count and treatment 1 (raw material) showed significantly higher count. There was no significant difference among 3(after chilling), 4(after freezing), and 6(after glaze hardening).

Regarding months, July, August and January showed significantly lower count followed by October, November, December, March, May, June, and September. Month April was having significantly higher count compared to all other months.

Table 10 shows the results of the two way ANOVA of the bacteriological tests of the samples taken from each step in the production of IQF peeled,deveined and cooked shrimp in Factory 2. Treatment 2 (after cooking) was having significantly lower count compared to all other processes. Treatment 1 (raw material) was having significantly higher bacterial count compared to the rest. There was no significant difference among treatment 4 (after freezing), 5 (after glazing), and 6(after glaze hardening).

Significantly higher counts were observed during March, April, September and November and significantly lower bacterial counts during May, June and August. There was no significant difference in bacterial count during October, April, and May, and bacterial counts were not significantly different during October and December.

Table 11 shows the results of the two way ANOVA of the bacteriological tests of the samples taken from each step in the production of IQF peeled, deveined and cooked shrimp in Factory 3. Treatment 1 (raw material) showed significantly higher count and treatment 2 (after cooking) significantly lower count. The difference in bacterial count in treatment 3 (after chilling), 4 (after freezing) 5 (after glazing), and 6 (after glaze hardening) were having no significant difference.

Months April, August, September, November, January, February and March showed significantly lower counts followed by months July and October. Months May, June, and December registered significantly higher Bacterial Count.

3.4.1. Water quality

The standard for the total bacterial count of water used in seafood factories is 100/ml as per EC Directive 80/778/EEC (Anon, 1980). The Indian standard also stipulates the same standard (Thomas and Mathen, 1979). Pattern of average month wise total bacterial count per ml of water from different workstations in an IQF factory during 1996-97 is given in Figure 24. The tap water showed higher bacterial counts than the stipulated standards during the months except November, December, January and February. This may be due to the dip in water temperature during winter months. Ice showed slightly higher bacterial counts than the standard during the months of April, May, June, September and October. The total bacterial count of ice was within the prescribed standard during other months. The chilled water used for chilling the in-process material also showed a similar trend of higher count during summer and rainy seasons. From October to March the bacterial counts of chilled water were within the prescribed standard. In the case of Chilled water samples drawn from the chilling unit of the IQF system, it was found to be within the standard in all months except April, May and June. The glaze water used in the IQF system was found to be within the standard in all months as far as the total bacterial count was concerned. The glaze water was found to be properly treated with chlorine with sufficient contact times. This could be the reason of lower bacterial counts in glaze water. This shows that if adequate process control measures are taken the microbial quality of the water and ice could be brought to the stipulated standards.

3.4.2. Swab test

Figure 25 shows the pattern of average month wise total bacterial count per sq. cm of swab from different workstations in an IQF factory in Kerala during 1996-97. Bulk feeder is the starting workstation in an IQF system. The total bacterial count at this station during the study period showed wide fluctuation. This could be due to the improper cleaning and sanitation of this workstation. The raw materials in a factory are being received from different pre-processing and landing centres and there is every chance of variation in the contamination rate, bacterial population and its load. Since the bulk feeder is the receiving site of raw material for the IQF unit, it is advisable to properly clean and disinfect the site after the discharge of material from a particular source. The cooker belt showed the lowest Bacterial Count among all other workstations during the entire period of study. This may be due to the automatic sterilisation taking place at this site by the steam injection. The total bacterial count of the chiller showed slight fluctuations indicating ineffective process control at this site. The total bacterial counts at the freezer showed less fluctuation except in December. Similarly the counts in the glaze vibrator also showed less variation. Fluctuation in counts was noticed at the last work site in the machine namely glaze hardening. This could be attributed to the human handling of the products at this stage.

3.5. Quality costs

Table 12 shows comparison of quality costs in a seafood factory approved by EC and a factory approved only by the EIA under IPQC system. The turnover in the

EC approved factory is much higher than the turnover in the other factory. This shows better utilisation of the available capacity and better market opportunities for EC approved factory. The total quality cost in IPQC approved factory is higher by more than two folds than that of EC approved factory. This is mainly because of the higher failure cost. In the EC approved factory the prevention cost is slightly higher than in the other factory. The appraisal cost is very high in EC approved factory. However, the saving in the failure cost helps this factory to bring down the total quality cost to a considerable extent.

Figure 26 shows the comparison of the percentage of total cost in a seafood factory approved by EC and a factory approved only under IPQC scheme of EIA. In EC approved factory the prevention cost was 8.25% of the total quality cost where as it was 2.28% in other factory. Appraisal cost was 75.69% in the EC approved factory and 12.38% in the other one. Failure cost was only negligible in EC approved factory, i.e.16.07%, whereas it was very high in the other factory with 85.34% of the total quality cost.

From this study,it is clear that the factories which adopt strict process control as per the new HACCP concept will be able to reduce the total cost of production by reducing the total quality cost. According to Lal (1990) and Anon (1991a) if the cost of prevention is increased to control the total quality costs, that is, quality of conformance improves mainly due to preventive activities, the failure costs drop steeply at first and there after at decreasing rate. With increasing quality of conformance, the appraisal costs tend to increase to a small extend, this is because of the fact that although final inspection costs may be markedly reduced, in process inspection and testing increases to some extent to enable the satisfactory working of process control (Lal, 1990).

Many quality problems were reported from foreign buyers during 1995-96. Table 13 shows rejection / detention of seafood products in the factories studied during 1995-96. From this table found out that, during this period quality complaints of the seafoods in Kerala,was mainly reported from USA markets. The reason is due to *Salmonella* contamination, decomposition and filth. Japanese market also rejected the seafood products exported from Kerala due to the yellow discolouration of frozen squid and sea urchin spine in the frozen peeled and undeveined shrimp. George (1979) discussed the crisis in the seafood industry faced by the rejection of Indian seafood by USFDA due to the presence of salmonella in the consignments exported to the US. This has led to more stringent inspection by USFDA and he pointed out that salmonella are assumed to become contaminated during transportation, handling or processing due to the poor sanitation and hygiene or the use of contaminated water or ice. Shassi and Ramachandran (1998) while studying the changing market demand for Indian seafood found out that the main reasons for rejection of Indian seafood in the overseas markets are due to salmonella contamination, decomposition and the presence of filth. They reported an estimated detention of 228 consignments of Indian seafood by USFDA during 1994-95. Their study also revealed the details of detention by European countries. The main reasons for detention of Indian products in European markets were short weight, over count, and poor quality. Rejection and block listing became a common phenomenon and this has ultimately resulted in imposing stringent regulation for exports to Europe and USA.

Table 1. Methods used for raw material procurement in seafood industry in Kerala

Mode of purchase	Percentage
Direct	5
Direct and supplier	73
Suppliers	22

Table.2. Capacity of various freezers employed in sea food factories in Kerala.

	Up To 5 T	>5 - 10 T	>10 - 15 T	>15 - 20 T	>20 - 25 T	> 25
	(in Percentage)					
Blast	16.6	50.0	33.3	0.0	0.0	0.0
IQF	37.5	12.5	25.0	0.0	12.5	12.5
Plate	0.0	30.7	38.5	15.4	7.7	

Table 3. Different methods used in defrosting of sea food processing factories in Kerala.

Method of defrosting	Percentage
Pressuresed water	9
Hose washing	68
High power exhaust fan	9
Cold water spray	14

Table. 4. Packing available for Individually Quick Frozen and block frozen products

	Type of packing			
BLOCK	10 x 2 kg	5 x 4 kg	10 x 1.8 kg	10 x 1.6 kg
IQF	1 x10 kg	1x15 kg	1x 20 kg	- -

Table 5. Quality control system followed in seafood industry in Kerala

	COCHIN (%)	QUILON (%)
IPQC	87	100
IPQC & ISO 9002	13	0

Table 6. Two-way Anova of bacterial count of in-process& raw material of IQF peeled & cooked shrimp in Factory No.1

Source	Sum of squares	Degree of freedom	Mean square	F-ratio	Probabilty
Treatment	24.172	5	4.834	177.281	0.000E+00
Block	2.377	11	0.216	7.924	4.885E-08
Error	1.500	55	0.027	--	--
Total	28.049	71	--	--	--

Table 7. Two-way Anova of bacterial count of in-process& raw material of IQF peeled & cooked shrimp in Factory No.2.

Source	Sum of squares	Degree of freedom	Mean square	F-ratio	Probabilty
Treatment	21.196	5	4.239	314.152	0.000E+00
Block	0.408	11	0.037	2.749	6.576E-03
Error	0.742	55	0.013	--	--
Total	22.346	71	--	--	--

Table 8. Two-way Anova of bacterial count of in-process& raw material of IQF peeled & cooked shrimp in Factory No.3.

Source	Sum of squares	Degree of freedom	Mean square	F-ratio	Probabilty
Treatment	30.790	5	6.158	223.601	0.000E+00
Block	1.392	11	0.127	4.594	6.285E-05
Error	1.515	55	0.028	--	--
Total	33.696	71	--	--	--

Table 9. Two-way Anova of bacterial count of in-process& raw material of IQF peeled, deveined & cooked shrimp in Factory No.1.

Source	Sum of squares	Degree of freedom	Mean square	F-ratio	Probabilty
Treatment	29.562	5	5.912	154.107	0.000E+00
Block	2.543	11	0.231	6.026	2.375E-06
Error	2.110	55	0.038	--	--
Total	34.214	71	--	--	--

Table 10. Two-way Anova of bacterial count of in-process& raw material of IQF peeled, deveined & cooked shrimp in Factory No.2.

Source	Sum of squares	Degree of freedom	Mean square	F-ratio	Probabilty
Treatment	24.469	5	4.894	481.163	0.000E+00
Block	0.665	11	0.060	5.945	2.835E-06
Error	0.559	55	0.010	--	--
Total	25.694	71	--	--	--

Table 11. Two-way Anova of bacterial count of in-process& raw material of IQF peeled, deveined & cooked shrimp in Factory No.3.

Source	Sum of squares	Degree of freedom	Mean square	F-ratio	Probabilty
Treatment	33.612	5	6.722	230.361	0.000E+00
Block	2.905	11	0.264	9.050	6.058E-09
Error	1.605	55	0.029	--	--
Total	38.122	71	--	--	--

Table 12. COMPARISON OF QUALITY COSTS (Rs.) IN IPQC APPROVED FACTORY AND EUROPEAN COMMISSION APPROVED FACTORY

Components Of Costs	IPQC Approved	EC Approved
Turn Over	46,00,00,000	62,00,00,000
Prevention Cost	1,23,000	1,54,000
Appraisal Cost	6,67,400	14,13,200
Failure Cost	46,00,000	3,00,000
Total Quality Cost	53,90400	18,67,200

Table. 13. Rejection / Detention of sea food products in the factories studied during 1995-96

Products	**Reasons**	**Name of the country**	**Quantity (Kg)**
Frozen PUD shrimp	Sea Urchin spine	USA	21000
Frozen PUD shrimp	Decomposition, Salmonella	USA	21000
Frozen PUD shrimp	Sea Urchin spine	Japan	63000
Frozen PUD shrimp	Salmonella	USA	600
Frozen PD shrimp	Decomposition, filth, excess vein	USA	21000
Frozen PD shrimp	Salmonella	USA	21000
Frozen squid	Yellow discolouration	Japan	42000
Frozen squid	Yellow discolouration, Pink discolouration, Cadmium	Italy	63000

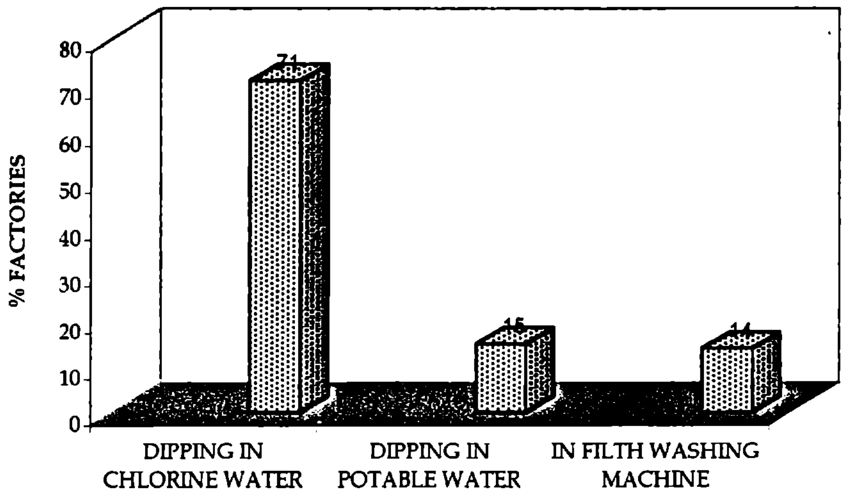


Fig.1. TYPE OF WASHING AT RAW MATERIAL RECEIVING SITE IN THE FACTORIES

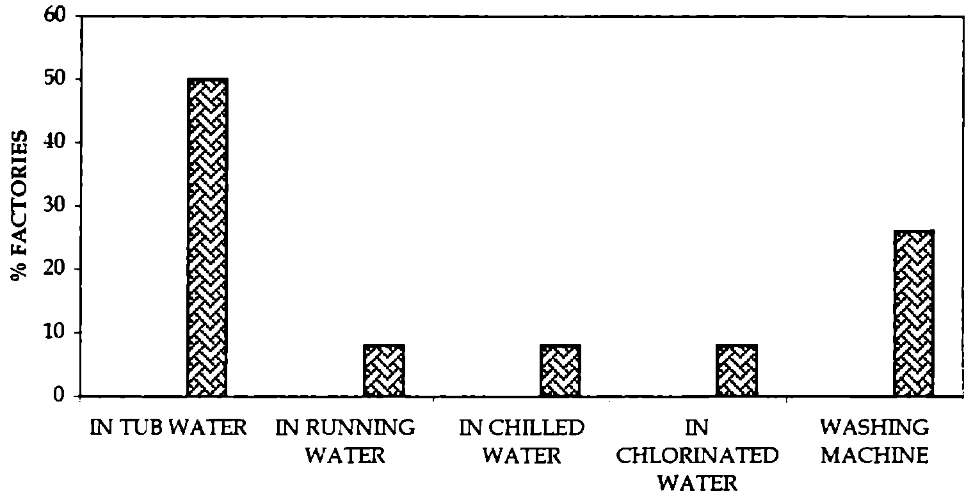


Fig 2. TYPE OF WASHING DURING PRE-PROCESSINGIN SEA FOOD INDUSTRY IN KERALA

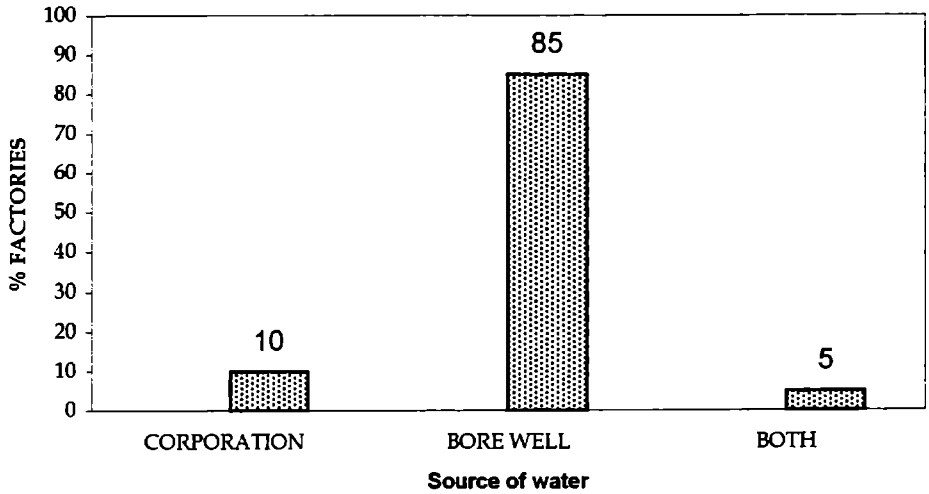


Fig 3. PERCENTAGE USE OF DIFFERENT WATER SOURCES FOR PRE PROCESSING

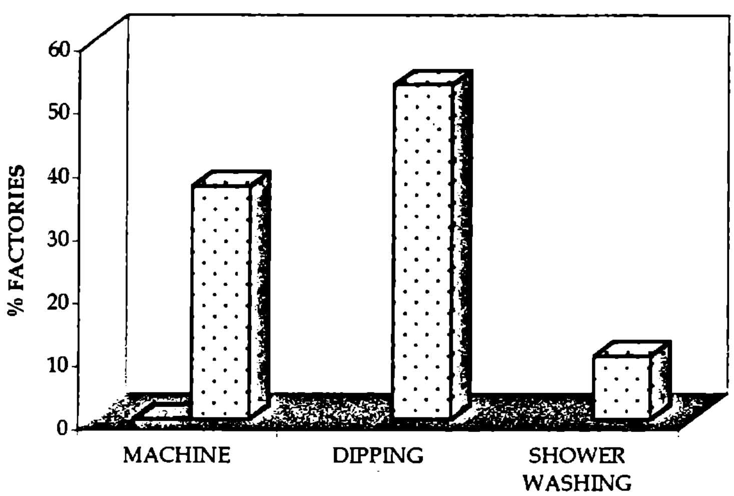


Fig 4. TYPE OF WASHING THE RAW MATERIAL IN THE PROCESSING SECTION

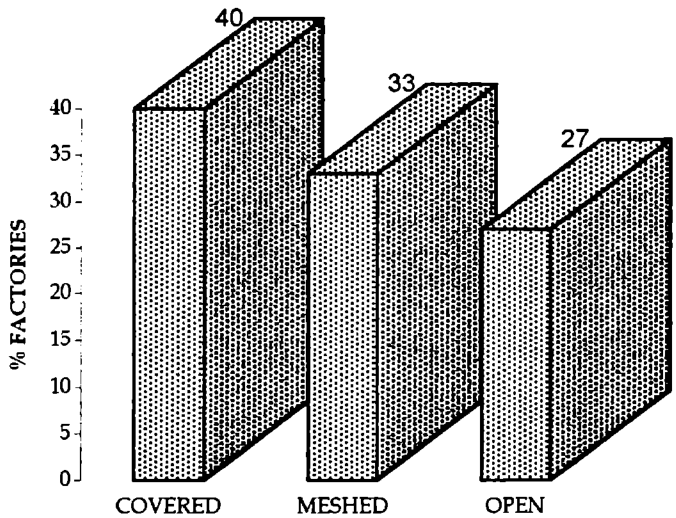


Fig.5. PERCENTAGE OF DIFFERENT TYPES OF DRAINAGE IN THE PRE PROCESSING DIVISION IN FACTORIES

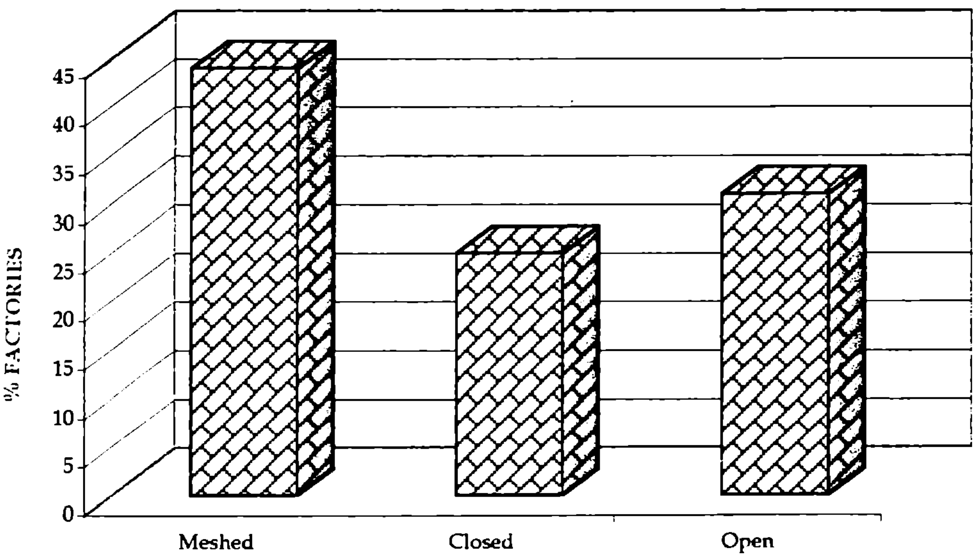


Fig.6. TYPE OF DRAINAGE FACILITY IN PROCESSING DIVISION

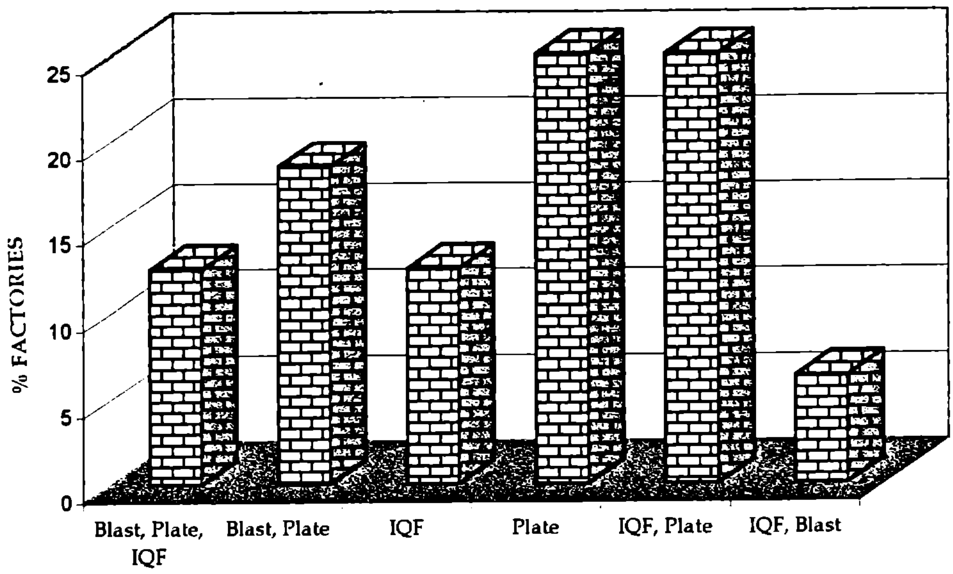


Fig.7. TYPE OF FREEZING FACILITY AVAILABLE IN DIFFERENT SEAFOOD FACTORIES IN KERALA

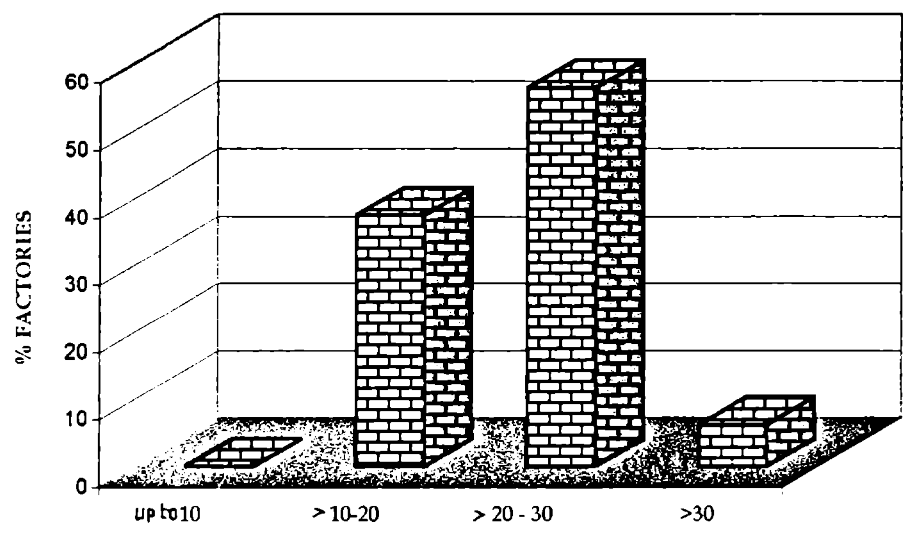


Fig.8. TOTAL FREEZING CAPACITY OF DIFFERENT SEAFOOD PROCESSING FACTORIES IN KERALA

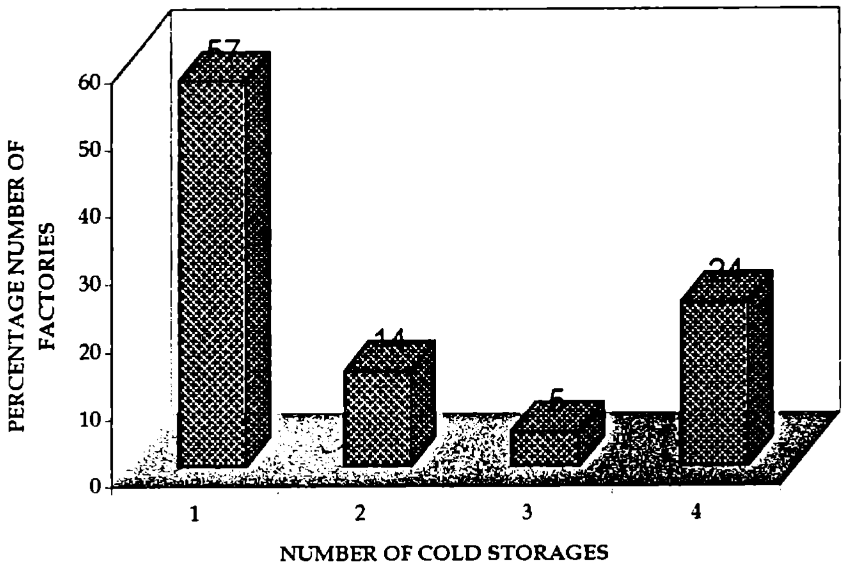


Fig 9. NUMBER OF COLD STORAGES IN SEA FOOD FACTORIES IN KERALA

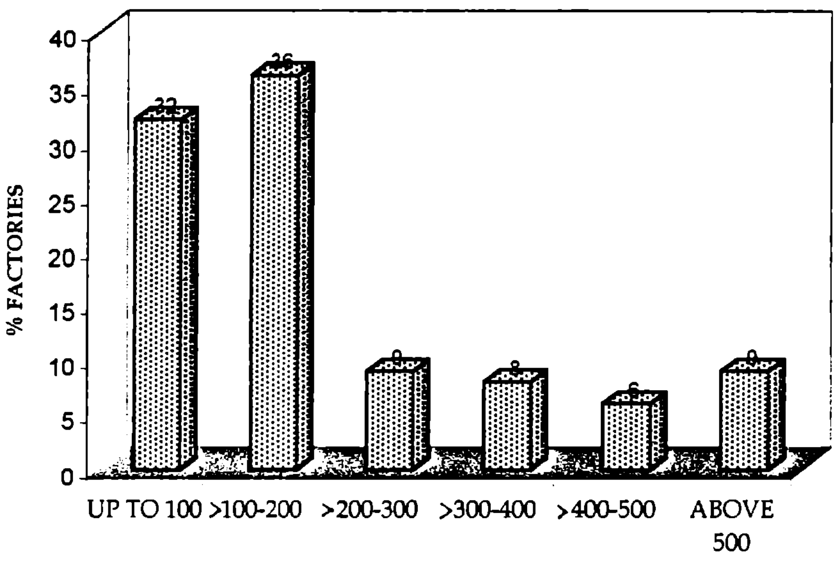


Fig 10. COLD STORAGE CAPACITY OF SEA FOOD FACTORIES IN KERALA

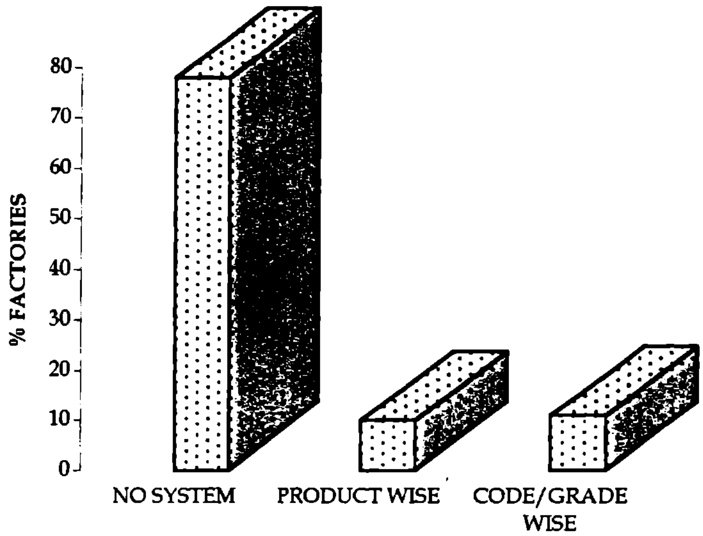


Fig 11. SYSTEM ADOPTED IN STOCKING OF PRODUCTS IN COLD STORAGE

Fig 12. AVERAGE MONTH-WISE TOTAL BACTERIAL COUNT (per g) OF RAW MATERIAL (PEELED AND DEVEINED SHRIMP) USED FOR IQF PRODUCTION IN FACTORY 1 (1996-97)

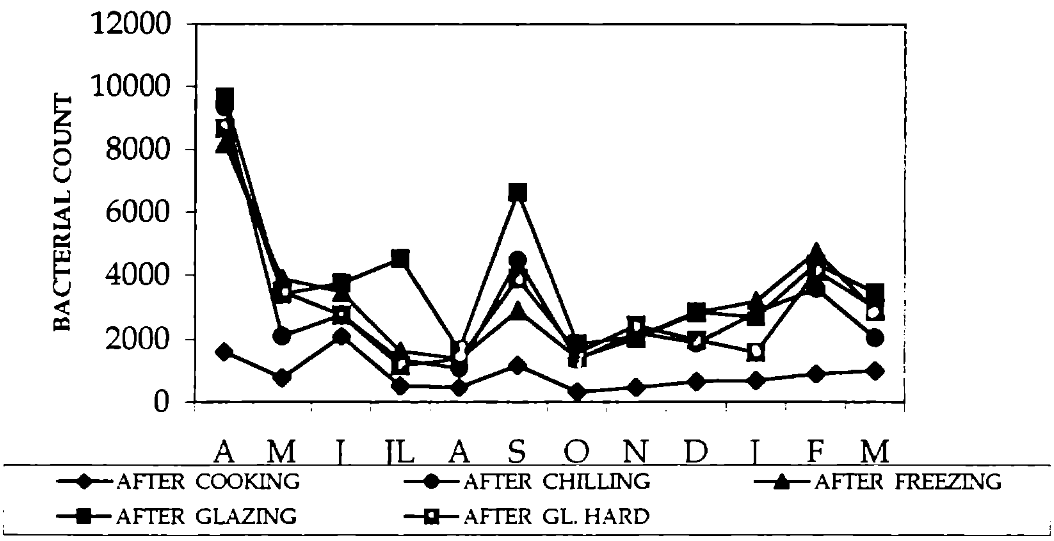


Fig 13. AVERAGE MONTH-WISE TOTAL BACTERIAL COUNT (per g) IN-PROCESS MATERIAL (PD) DURING THE PRODUCTION OF IQF PEELED,DEVEINED & COOKED SHRIMP IN FACTORY 1 (1996-97)

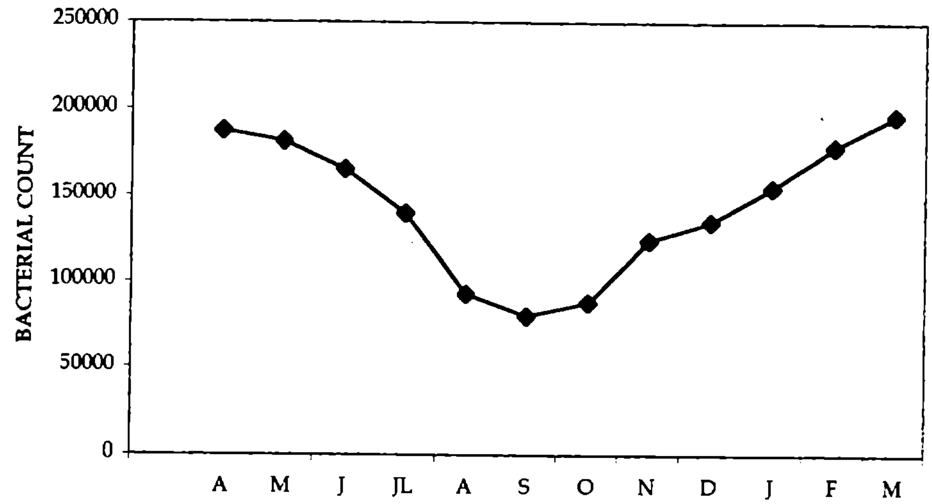


Fig 14. AVERAGE MONTH-WISE TOTAL BACTERIAL COUNT (per g) OF RAW MATERIAL (PEELED AND DEVEINED SHRIMP) USED FOR IQF PRODUCTION IN FACTORY 2 (1996-97)

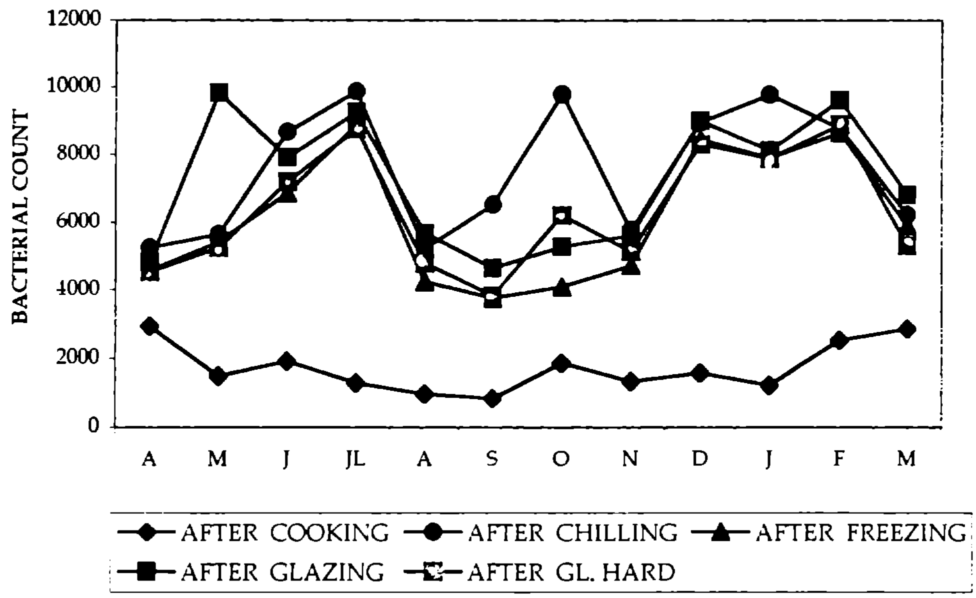


Fig 15. AVERAGE MONTH-WISE TOTAL BACTERIAL COUNT (per g) OF THE IN-PROCESS MATERIAL (PD) DURING THE PRODUCTION OF IQF PEELED & DEVEINED,COOKED SHRIMP IN FACTORY 2 (1996-97)

Fig 16. AVERAGE MONTH-WISE TOTAL BACTERIAL COUNT (per g) OF RAW MATERIAL (PEELED AND DEVEINED SHRIMP) FOR IQF PRODUCTION IN FACTORY 3 (1996-97)

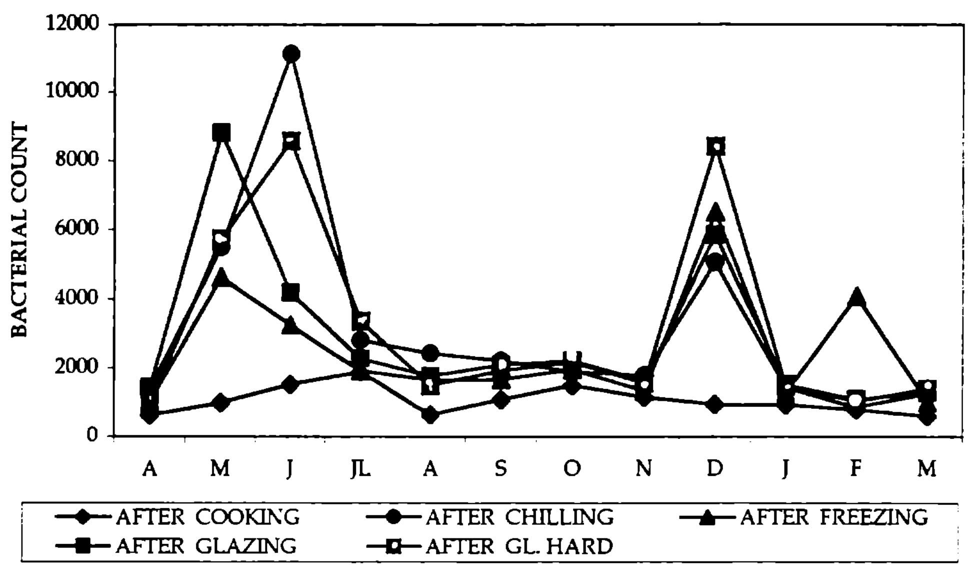


Fig 17. AVERAGE MONTH-WISE TOTAL BACTERIAL COUNT (per g) OF IN-PROCESS MATERIAL (PD) DURING THE PRODUCTION OF IQF PEELED,DEVEINED & COOKED SHRIMP IN FACTORY 3 (1996-97)

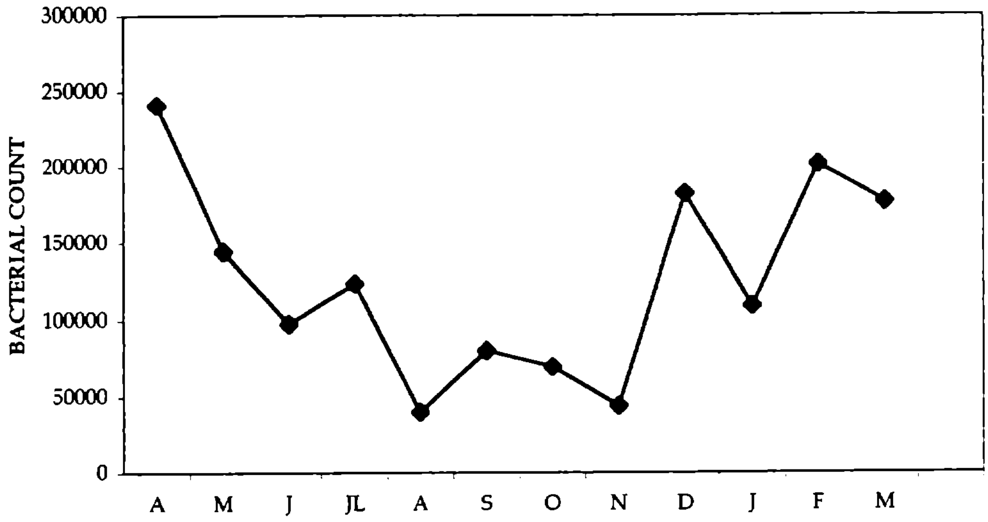


Fig 18. AVERAGE MONTH-WISE TOTAL BACTERIAL COUNT (per g) OF RAW MATERIAL (PEELED AND UN DEVEINED SHRIMP) USED FOR IQF PRODUCTION FACTORY 1(1996-97)

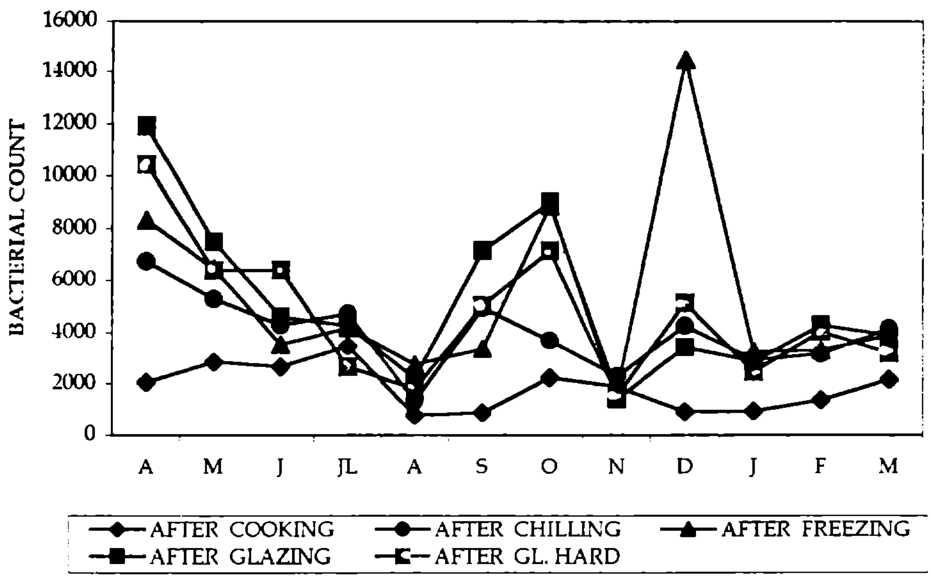


Fig 19. AVERAGE MONTH-WISE TOTAL BACTERIAL COUNT (per g) OF IN-PROCESSMATERIAL(PUD) DURING THE PRODUCTION OF PEELED & COOKED SHRIMP FACTORY 1 (1996-97)

Fig 20. AVERAGE MONTH-WISE TOTAL BACTERIAL COUNT (per g.) OF RAW MATERIAL (PEELED AND UN DEVEINED SHRIMP) USED FOR IQF PRODUCTION IN FACTORY 2 (1996-97)

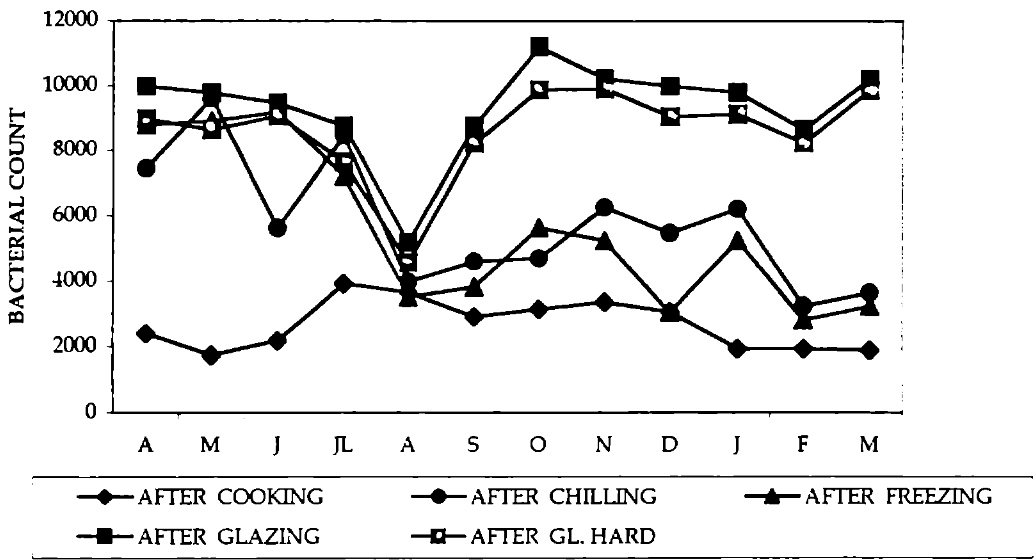


Fig 21. AVERAGE MONTH-WISE TOTAL BACTERIAL COUNT (per g) OF THE IN PROCESS MATERIAL (PUD) DURING THE PRODUCTION OF IQFPEELED AND COOKED SHRIMP IN FACTORY 2 (1996-97)

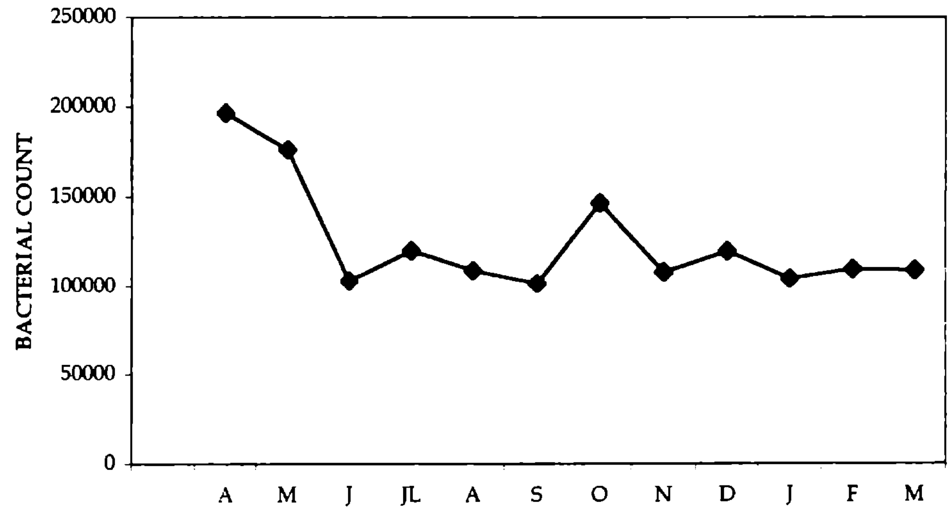


Fig 22. AVERAGE MONTH-WISE TOTAL BACTERIAL COUNT (per g) OF RAW MATERIAL (PEELED AND UN DEVEINED SHRIMP) USED FOR IQF PRODUCTION IN FACTORY 3 (1996-97)

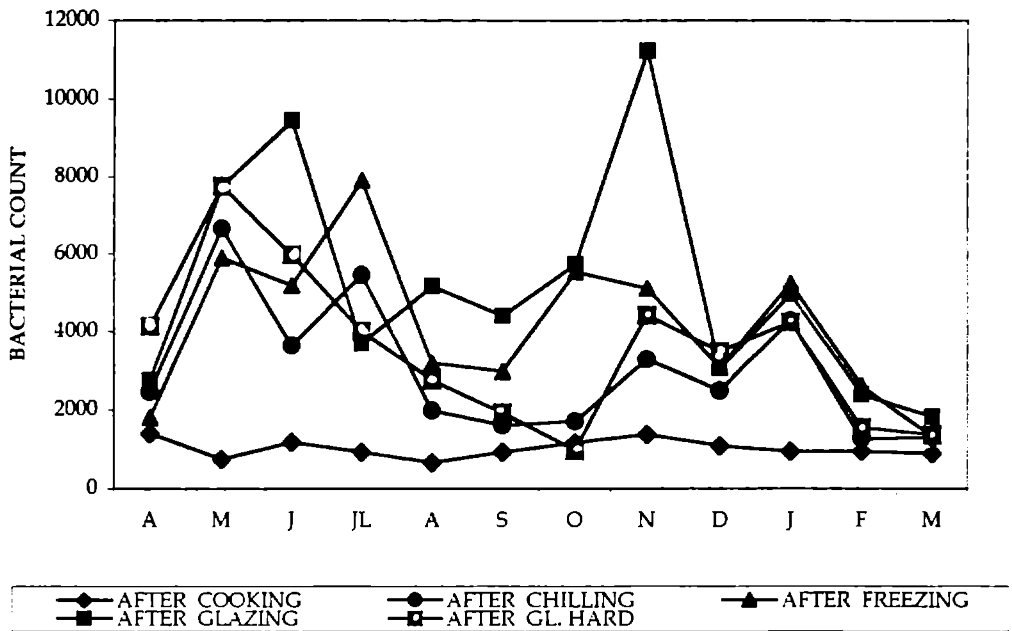


Fig 23. AVERAGE MONTH-WISE TOTAL BACTERIAL COUNT (per g) OF THE IN PROCESS MATERIAL (PUD) DURING THE PRODUCTION OF IQF PEELED & COOKED SHRIMP IN FACTORY 3 (1996-97)

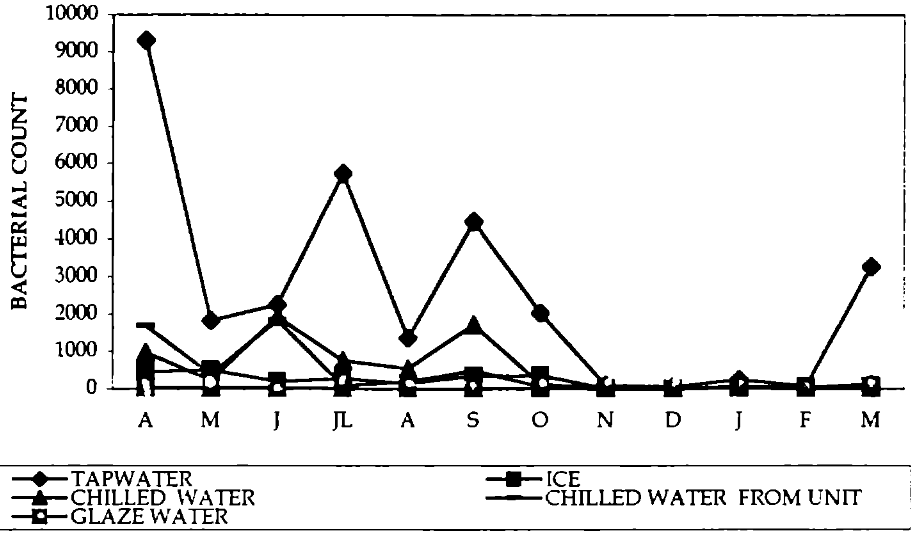


Fig 24. PATTERN OF AVERAGE MONTH-WISE TOTAL BACTERIAL COUNT PER ML OF WATER FROM DIFFERENT WORK STATIONS IN IQF FACTORY (1996-97)

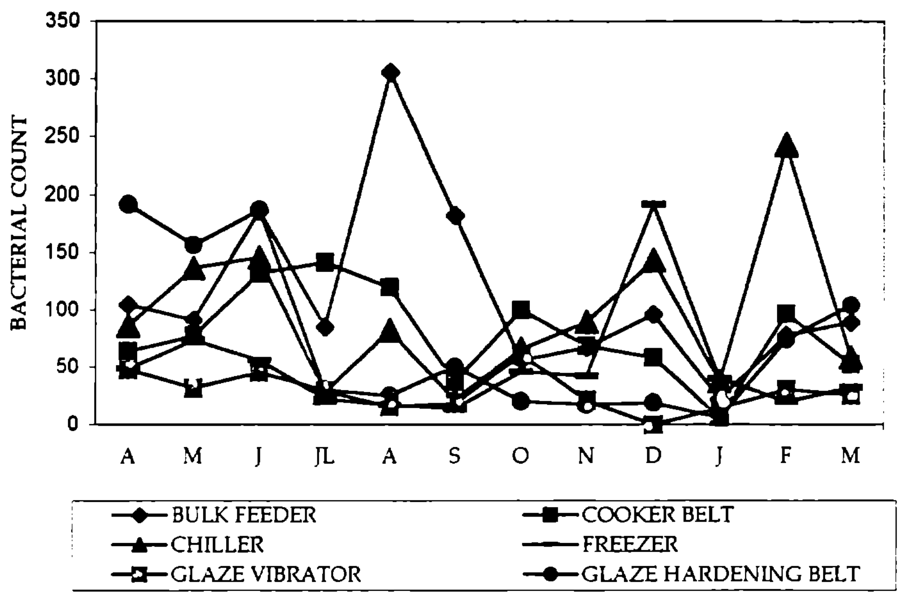


Fig 25. PATTERN OF AVERAGE MONTH-WISE TOTAL BACTERIAL COUNT PER SQURE CM OF SWAB FROM DIFFERENT WORK STATIONS IN IQF FACTORY (1996-97)

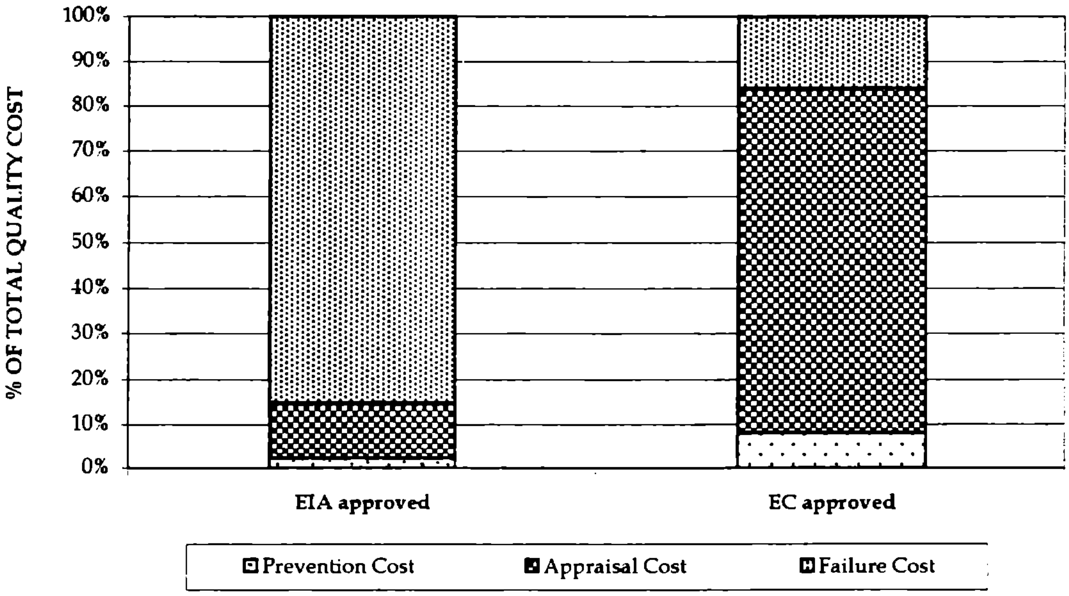


Fig 26. COPMPARISON OF QUALITY COST IN A SEAFOOD FACTORY APPROVED BY EXPORT INSPECTION AGENCY (IPQC) ALONG WITH EC APPROVED FACTORY

CHAPTER 10

SUMMARY, RECOMMENDATIONS AND CONCLUSION

1. Summary

Quality related problems have become dominant in the seafood processing industry in India. This has resulted in the rejection of seafood sent from India to other destinations. The latest being the total block listing of seafood companies from India from exporting to Europe and partial block listing by the U.S. Traditional quality systems prevailing in the seafood industry in India have been inadequate in meeting international quality requirements, until recently. According to EC Directive, all the seafood factories exporting to European countries have to adopt Hazard Analysis Critical Control Point (HACCP) with the required modifications in the factories. Based on this, Export Inspection Agency (EIA) has now made HACCP system mandatory in all the seafood processing factories in India. This transformation from a traditional end product based inspection system to a process based quality control system requires thorough changes in the various stages of production and quality management. Hence the present study was carried out on the following aspects:

1. Analysis of various **inputs** used for the production of seafood in the seafood factories in Kerala with reference to their applicability to the newly suggested quality concept (HACCP).

2. **Layout** analysis of the existing seafood factories and the development of a suitable layout, based on the new quality management concept.
3. Analysis of the **process control** parameters like production flow, sequencing and CCPs for the production of various seafood products. Based on the study, standard flow charts were prepared and CCPs established. Production pattern in the factories selected for the study was also analysed.
4. **Method analysis** and **work measurement** of the processing of important IQF products were carried out and based on this, the normal time and standard time for each and every activity involved in the production of these products were calculated. Process Cycle Time for the production of these products was also worked out.
5. **Oraganisational design** and **structures** of the seafood factories were analysed and a suitable organisational structure recommended for the effective functioning of the **Total Quality Management (TQM)** system in seafood factories.
6. **Human factor analysis** were carried out in the seafood factories to study the present leadership styles, motivational measures and communication systems prevailing in the factories and to suggest required changes and recommendations to introduce TQM principle.

7. **Quality assurance** systems followed in the seafood factories were studied in detail and its suitability assessed for the implementation of the newly recommended quality management system.

In the light of the main objective of introducing TQM in seafood factories in Kerala for effectively implementing the HACCP concepts, various management measures have been suggested.

1.1. Infrastructure Facilities of Seafood Processing Plants

22% of the factories studied in Kerala were established either in the early period of the introductory stage of seafood freezing industry in India or in the late1970s. 52 % of the seafood factories were established between the late1970s and late 1980s. 26% of the factories were established after 1980s. As far as the sizes of the factories were concerned 42% of the factories were small-scale factories, 38% were medium-scale and 19% large-scale. The small-scale factories were mainly proprietary concerns and medium scale factories partnership concerns. The large-scale companies were mainly public limited companies and were of recent origin. 38% of the seafood factories had only one sister unit, 4% of the factories had two sister units, 13% had three sister units and 22% had four sister units, and the remaining had no sister units at all. 90% of the seafood processing factories had space for the future expansion of the buildings. 30% of the factories had collaboration with international markets like USA, Japan and Saudi Arabia.

All seafood processing factories studied in Kerala had adequate facilities of raw material receiving, processing, freezing, frozen storage, and personnel hygiene. 50% of the seafood processing factories had the facilities for peeling or pre-processing. All seafood processing factories had a separate raw material receiving division. As far as the processing capacity is concerned, 77% of the factories had a capacity of less than 5 tonnes/day in the peeling/ pre-processing division and 23% had 5-10 tonnes/ day.

95% of the processing factories had adequate facilities for fly proofing, vermin and rodent control. All seafood processing factories had self-closing doors and hand washing and leg dipping facilities. 60 % of the factories had leg-operable type taps. 82% of the factories studied had facilities for washable type ceiling. Wall to wall and wall to floor joints in the factories were rounded off and free from projections to prevent accumulation of dirt and dust. All factories had adequate facilities for proper lights, adequate ventilation and are fitted with exhaust fans.

The equipment and machinery used in the processing division of factories in Kerala were shower washing machine, filth washing machine, drum washing machine, agitator machine for squid and cuttlefish treatment, weighing machine, ice crusher, grading machine, squid ring cutting machine and insectocutor. Different types of freezers were used in the seafood factories; they were blast freezers, plate freezers and indigenous and imported Individually Quick Freezing Freezers. 57% of the factories had only one cold storage and 24% had four cold storages. The cold storages have a capacity of 100 tonnes and above.

The main direct inputs used in the factories were different types of fish and shellfish as raw material, labour force, utilities, and packaging. The abundance and the regularity of supply of raw material are the most important consideration in the selection of plant location. Potable water is an indispensable input in all production activities and its availability can influence plant location. This influence is minimal if there is water in required quantity and quality in the vicinity of possible sites. The main sources of water were bore well and municipal/corporation supply. Water was also brought in tanker lorries during summer seasons and whenever the factories experience water shortage.

Fluctuation in the voltage and power failure was the main problem facing the seafood processors as far as the electrical power supply is concerned. It adversely affects the quality of the product and productivity of the factories.

1.2. Layout

1.2.1.Existing Layout

The layouts of the existing factories showed that none of the factories had a balanced layout. This had resulted in under-utilisation of some facilities in these factories. Most of the factories developed their plant facilities at their will and pleasures, without taking into account of the scientific principles of a proper layout. This has resulted in, excess handling and cross movement of materials and men, which in turn resulted in contamination and bottleneck in work stations.

According to the study, 62.51% of the seafood factories in Kerala during 1995-96 had process layout. 33.33% of the factories had a combination of process and product layouts. Only 4.16 % of the factories had product layout. 37.5% of the seafood factories had modern IQF lines. This was all established after the middle of 1980s with the change in the export-import policy of the Govt. of India. Some of the latest additions to the IQF lines are imported product lines with full automation. Most of the indigenously fabricated IQF lines had combination layouts with some of the activities carried out manually and some automatically. .

Taking into account all the above mentioned factors and the shift in the market demand from block frozen products to IQF products, an improved layout has been designed to suit the conditions now prevailed in Kerala. The proposed layout has a total work area of 1900 sq. m. All the requirements mentioned in the EC Directive are taken into account in this layout.

The study showed that the present level of capacity utilisation of most (50%) of the seafood processing factories in Kerala was only 5-10 tonnes per day as against the existing installed capacity of 20-30 tonnes per day in majority (56%) of the factories. This has been taken into account while deciding the capacity of the proposed layout. In the improved layout a 10 tonne IQF facility and 10 tonne Block freezing facility are proposed and a combination layout is designed.

Movement and material flow in the proposed layout is also suggested. This arrangement considerably reduces human handling and human movements for transporting the material.

1.3. Process control

Arrangements of facilities and sequencing of processing were having wide variation in different seafood processing factories. Wide variation is also noticed in the Critical Control Points (CCPs) established in different factories for the same products. There was no standardisation of the production methods and in the establishment of CCPs in the factories. A comparison of the flowcharts and Critical Control Points of the products commonly produced in seafood factories in Kerala were carried out. Based on this study the flow charts were standardised and new Critical Control Points established.

There was regular production in 86% of the factories studied even though the capacity utilisation was very low. 56.25% of the factories had freezing capacities of >20-30 tonnes/day, 37.5% of the factories had >10-20 tonnes and 6.25% above 30 tonnes/day. None of the factories had full capacity utilisation. The factories having an installed freezing capacity of >5-10 tonnes/day were found to have the best capacity utilisation among all the factories studied. The average capacity utilisation of these factories was 50%. The capacity utilisation of the factories having an installed freezing capacity of up to 5 tonnes/day is 20%. The capacity utilisation of the factories having installed capacity above 15 tones/day was very poor.

Study on the production pattern of the selected factories showed very high fluctuation in block as well as IQF products. A comparison has also been made with the production in two EC approved factories.

1.4. Method analysis and work measurement

The important factor to be noted here is that the best available method at one point of time will not necessarily be the best available method at some later point of time. Subsequent analysis may reveal that more economical materials are available; more efficient machines, tools, jigs, and fixtures have been designed; better quality assurance methods have been evolved; the existing plant layout is obsolete because of the change in the production mix; and so on. This is very much true in the case of seafood industry in India, where a tremendous change in the product mix by the introduction of IQF products and value added products to the existing lines were noticed. New plants based on IQF technology are coming up in the various parts of the country. Similarly the introduction of HACCP concepts based on the EC directives and USFDA directives have drastically changed the conventional system of quality control in the seafood plants in India. The conventional systems of production and production control which existed in the seafood industry have now become obsolete; new equipment and fixtures had to be installed to satisfy the buyer's requirements. The main task of the method analysis is to develop efficient methods for tasks, which are to be performed for the first time and to improve existing work methods. The present study aims at improving the existing methods of processing various seafood products. The work measurement of the following IQF products was carried out.

1. Production of Individually Quick Frozen (IQF) Headless Shrimp.
2. Production of Individually Quick Frozen (IQF) Peeled and Cooked Shrimp.

The normal time and standard time of all the activities involved in the production of these products were worked out and the process cycle time calculated.

1.5. Organisational structure

The study shows that 43% of the seafood factories are partnership companies, 28% are public limited companies and remaining 29% proprietary concerns. The organisational structures of the public limited companies shows that 50% are based on typical line function and the 50% have line and staff function.

In case of partnership companies, the major partner acts as the managing partner and the remaining partners look after the various functions of the organisations. In most of the partnership companies a clear-cut delegation of powers have been noticed with respect to the authority of partners. The pattern of organisational structure in proprietary companies is more or less similar to that of the partnership companies except that in the proprietary company, the proprietor heads the company and functions as an autocratic leader.

71% of the seafood factories in Kerala are following autocratic style of leadership and the remaining 29 % feudal leadership style. In the feudal company, the people at the top were far away from the bottom and the two never communicated with each other. An egalitarian style of leadership model is recommended for the seafood factories in Kerala to transform them into TQM factories. This is a basic necessity to apply any quality management measures in the seafood factories. With out this transformation all other efforts to improve quality through the modern concepts like HACCP or ISO 9000 may not be successful.

In seafood processing industry in Kerala, communication from top management to floor level employees is not satisfactory. Top managers are unable to communicate with floor level employees. The following communication channels are used by the management to communicate with the floor level employees. In the case of permanent employees they use formal channels like issuing notice and calling meeting for direct communication. The written communication is usually routed through the hierarchical levels. In the case of contract employees, the communication is passed through the respective managers and the contractors. Usually informal oral communication is passed to the contract employees through the contractors.

The top management of the seafood processing industries in Kerala considers the production turn over as the important contribution of the employees and does not provide any opportunity for the employees to participate actively for the improvement of the quality of the products or quality of the factories. 90% of the seafood processing factories did not have any quality team comprising of employees from different levels. Only 10% of the factories had HACCP team, which includes floor level employees. These 10% of the factories constituted HACCP team out of pressure from the EC Directive (91/493/EEC) and have obtained EC approval.

The major source of communication between the middle managers and the top level managers are through informal channel. 50% of them are oral. Other important means of communication are written memos, letters, meetings, display of information in the notice boards, or direct discussion. The horizontal communication is mainly taking place through direct communication or through informal network. Similarly the down ward communication originated from the middle level is also taking place through direct communication or through informal channel. In fact the main communication link between the lower employees and the middle level managers are found to be the supervisors. They are found to be the linking pin between the lower level employees and the middle level managers.

Open communication with participatory type of management can definitely improve the commitment of the employees and improve the quality and productivity of the seafood factories. For this, there is a need of change in the existing pattern of leadership styles, organizational structures and communication systems in all the factories.

1.6. Human factor analysis

Top level managers are fully aware of the latest developments in quality assurance in seafood industry and they desire to improve the quality of their products to suit the requirement of the foreign buyers and claimed to support the innovations taking place in the quality assurance systems world over. At present no motivational schemes are offered by the top management to improve the employees participation in the quality assurance programmes of the companies. There was no quality linked incentive system or motivational measures in the seafood companies selected for the study. However, 10% of the companies had regular production linked incentive systems at all levels. 50% of the companies had incentive systems on certain specific jobs and the remaining 40% companies did not have any type of incentive systems at all.

None of the seafood companies had job enrichment or job enlargement measures or quality circles or any other participatory groups, which includes all levels of employees. 70% of the top managers were of the opinion that the incentive systems prevailing in the companies helped only to improve the quantity turnover of the firms and did not have any impact on the quality.

80 % of the companies studied have promotional avenues for middle and top level managers. The floor level employees do not have any promotional avenues in their companies. None of the companies studied have a system of job rotation for the employees. The top management in all the companies provide training facilities for their middle and top level managers.

None of the top level managers claimed to have a good employer-employee relationship in their companies. 80% of them had the opinion that they had a satisfactory employer-employee relationship while 20% informed about an undesirable employer-employee relationship.

The employees are usually recruited through interviews. There is vast variation in the strength of the permanent employees in the seafood companies in Kerala. 70% of the factories employed supervisors having qualifications of Pre-Degree to Bachelor's Degree. Another favourable factor with respect to the human input management is that majority of the employees (70 %) belong to the age group below 30 years. There is a vast variation in the wage structure of the employees in various factories. This is mainly based on the experience and the skill of the employees and the type of the factories.

Only 30 % of the factories had approved trade unions. And the remaining factories had a very high autocratic setup and the management resists forming trade unions in these factories. 30% of the seafood factories experienced human unrest, which eventually led to strike. 70% of the factories never experienced any strike and this is probably due to the fact that those factories employ majority of the workers mainly on contract basis. In these factories only a skeletal staff were permanent, that too at the middle and upper management levels.

90 % of the factories studied adopted two-shift system. The study revealed that there is no shortage of unskilled workers in the factories. With regard to the skilled employees, 10 % of the factories had shortage especially during peak seasons.

The middle level managers were found to be more conscious about quality than the top managers and fully supported the quality improvement programmes of their factories. The incentives prevailed at middle level management were all production oriented and not quality oriented. The incentives offered by the factories were all financial incentives. The study showed that only 20% of the middle level managers were satisfied with the present incentive systems and the remaining 80% were not satisfied with the quantum of financial incentives. 70% of the middle level managers have job enlargement with additional responsibilities at horizontal level. All the recruitment to the middle level was through interviews. There was no approved leave rules or salary structure in 80% of the factories. 80% of the middle level managers had no participation in the decision making process. They executed the commands of the superiors and had no opportunity to discuss their ideas with the top management. The factories studied experience a very high turnover of middle level managers due to various reasons. Frustration and low financial incentives were found to be the major reasons. The other important reason cited was the lack of job security. The average length of service of the existing middle level managers surveyed was found to be only 4 years. This is very unhealthy as far as the organizational goals are concerned. 80% of the factories did not have any job rotation at middle level. 90 % of the middle level mangers were frustrated with the existing set up of working conditions.

Majority of the floor level workers were from the surrounding villages or towns where the factories are located. They were literate and originated from economically weaker sections of the population. 70% of the employees had an educational qualification of SSLC or above. Majority of the employees belonged to young age (below 30 years) and was healthy and dynamic. 93% of the floor level processing employees were females. 46 % of the total employees were on contract basis and 12% on casual basis.

60% of the floor level employees were not aware of the recent developments in quality assurance and not even heard of such changes in the quality management area in seafood industry. There were no motivational or incentive systems at lower level to promote quality assurance programmes. Whatever incentive systems offered by the factories were all production linked and not quality linked. Wide variation was noticed in the wage rate of the employees. This was mainly based on the experience of the workers. 40 % of the employees at the lower level get a daily wage rate between Rs.40/- and 45/-. The wage rate ranged between Rs.25/-and 30/- (7 %) and Rs.56/- and 60/- (7 %). All the employees surveyed responded that they had no role in the decision making process of their factories. There was found to be heavy turnover of employees at lower level.

The employees were found to be ready to take up additional responsibility of participating in quality assurance programmes if they were paid additional financial incentives. 60 % of the employees were expecting additional financial benefit for taking additional job. No job rotation system existed in the factories at lower levels. Job enrichment was also lacking. The factories also did not have any promotional avenues along the channel for these employees.

60 % factories offered internal training to their lower level workers. 90 % of the factories did not have any committee or team comprising of the employees from this level. 10 % of the factories, out of pressure from European Commission, formed HACCP team that included employees from different levels. Poor working environment is found to reduce the productivity of the factories. Pay hike was found to be the main incentive to improve the productivity of these workers. A word of appreciation from the superiors was also found to satisfy 30% of the employees. 10% of them expected other monitory incentives as a stimulator of job satisfaction. 70 % of the employees were not associated with any union. Only 30 % of the workers had unions in the factories.

1.7. Quality assurance

73% of the processors purchased their raw materials both directly or through supplier agents and other 22% through suppliers alone. 5% procured the raw material directly from Cochin fishing harbour, Neendakara fishing harbour, Ambalapuzha and Thottapally landing Centres.

Seafood processors were not satisfied with the availability of raw material to their factories. 75% of the seafood processors were also purchasing raw material from other states, the quality of which was far below the prescribed standards. Not a single factory was receiving adequate quantity of raw material from a single supplier or any one purchase depot. This is one of the main factors for quality deterioration of raw materials received for processing. Processing plants in Kerala receive raw materials from a large number of landing centres viz., Ambalapuzha, Quilon, Munambam, Vadi, Thangassery, Anchuthengu, Trivandrum, Vypeen, etc. apart from local suppliers. About 50% of the seafood processors were not informing purchase specifications or customers requirements to the suppliers. They also never informed their suppliers about their quality policy.

71% of the seafood processors in Kerala were not evaluating the suppliers in terms of the quality of raw material supplied, purchase rate and availability of the raw materials. None of the plants studied except EC approved ones were systematically cleaning the vehicles after unloading the raw materials in their processing premises. 25% of the plants were not washing the vehicle/containers before loading the material into the vehicle. Study shows that 70% of the factories were properly washing the raw materials upon arrival at the receiving site. 70% of them also use proper quantity of ice at the right time for temporary storage of raw material for processing.

85% of the pre-processing centres depended on bore well for their water source for washing the raw materials as well as in-process materials while others used municipal or corporation water supply. About 80% of the seafood processing factories had no cold room or chilled storage facility for storing the pre-processed material.

The freezing facility consisted of mainly IQF and block freezing. 12.5% of the factories had tunnel, plate and IQF facilities. 18.5% had tunnel and plate freezers and 12.5% had IQF facilities alone. 25% of the factories had only plate freezing facility and 25% had IQF and plate freezing facilities. 56.25% of the factories had freezing capacity of >20-30 tonnes/day. 37.5% had freezing capacities of >10-20 tonnes/day. Only 6.25% had freezing capacity above 30 tonnes/day. In the case of Blast freezers, 50% of the factories had a capacity of > 5 to 10 tonnes/day. 33.3% had a capacity of >10-15 tonnes/day. Only 16.6% of the factories had a blast freezing capacity of upto 5 tonnes/day. In IQF, 37.5% of the factories had a freezing capacity of upto 5 tonnes/day. 25% had a freezing capacity of >10-15 tonnes/day. In the case of plate freezing facilities in the processing plants, 38.46% of them had a freezing capacity of >10 to 15 tonnes/day. 30.7% of the plate freezers had a freezing capacity of >5-10 tonnes/day.

In seafood factories, the number of cold storages and their capacity depends on the production capacity of the factories. 57 % of the factories had only one cold storage and 24% had four cold storages in their factories. 36% of the factories had a cold storage capacity of >100-200 tonnes. 30% of them had a cold storage capacity of up to 100 tonnes. 9% of them had a very high cold storage availability of above 500 tonnes. Actually the capacity of the cold storages was not found to be enough for the seafood processors during peak seasons. This is because of the fact that processed and packed products could not be exported at the right time due to delay in the shipments. In such situations they were found to depend on outside cold storages for storing the products.

During 1995-1997, 87% of the seafood processing factories in Cochin were following In-Process Quality Control System and 13% were following ISO 9002 and In-Process Quality Control System.

The total quality cost in IPQC approved factories are higher by more than two folds than that of EC approved factories. This is mainly because of the higher failure cost. In the EC approved factory the prevention cost is slightly higher than in the other factory. The appraisal cost is very high in EC approved factory. However, the saving in the failure cost helps this factory to bring down the total quality cost to a considerable extent.

The microbiological quality of raw material and in-process material of the important IQF products were carried out for a period of one year. Fluctuation in microbial counts at different stages was noticed and was found to correlate with the poor sanitary conditions in the factories.

Pattern of average month-wise Total Bacterial Count per ml of water from different work stations in an IQF factory was carried out. The tap water showed higher Bacterial Counts than the stipulated standards during all months except November, December, January and February. This may be due to the dip in water temperature during winter months. Ice showed slightly higher Bacterial Counts than the standard during the months of April, May, June, September and October.

Average month-wise Total Bacterial Count per sq. cm of swab from different work stations in an IQF factory was carried out. Bulk feeder is the starting work point in an IQF system. The Total Bacterial Count at this station during the study period showed wide fluctuation. This could be due to the improper cleaning and sanitation of this work station. The raw materials in a factory are being received from different pre-processing and landing centres and there is every chance of variation in the contamination rate, bacterial population and their load. Since the bulk feeder is the receiving site of raw material for the IQF unit, it is advisable to properly clean and disinfect the site after the discharge of material from a particular source. The cooker belt showed the lowest Bacterial Count among all other work stations during the entire period of study. This may be due to the automatic sterilisation taking place at this site by the steam injection. The Total Bacterial Count of the chiller showed slight fluctuations indicating ineffective process control at this site. The Total Bacterial Count at the freezer showed less fluctuation except in December. Similarly the count in the glaze vibrator also showed less variation. Fluctuation in count was noticed at the last work site in the machine namely glaze hardening. This could be attributed to the human handling of the products at this stage.

2. Recommendations

1. There is a need to change the organisational structure and leadership style in seafood processing factories in Kerala to implement Total Quality Management in toto.
2. The organisational structure prevailing in the factories have to be restructured so as to accommodate Egalitarian Style which helps in total participation of employees at all levels and maximises productivity and quality conciousness.

Egalitarian style is also necessary for improving free communication among employees at all level (downward communication, upward communication and horizontal communication).

3. There are no motivational measures to improve the quality and productivity of factories. Motivated employees are very important in TQM set up. Hence factories should introduce various employee motivation measures.
4. None of the factories studied have Quality Circles, Zero Defect Concept, etc. Hence recommends introducing quality circles to get maximum participation in improving quality and productivity of the factories. Quality circle should represent employees at all levels.
5. Job enlargement and Job enrichment opportunities are also lacking in the seafood factories. Adequate measures should be taken to enlarge and enrich the jobs especially at lower levels. This is also essential to implement TQM.
6. Adequate training is very essential to introduce TQM in seafood factories. Proper training should be extended to workers at all levels.
7. Most of the seafood processing factories have not provided job security for the employees. Job security should be ensured to reduce the tension and stress of the employees.
8. Introduction of proper salary structure, incentive scheme and leave rules also can boost employee's morale.
9. Quality linked incentive scheme should be introduced in the factories.
10. Participatory type management can be introduced with open communication.
11. All seafood processing factories have basic infrastructural facilities as per IPQC system. It should be upgraded as per the EC Directive.

12. Wide variation is noticed in the processing methods that adopted in different factories for producing the same product. Sequence of operation is also found to be varying with factories. Standard flow charts have been worked out with required CCPs. This has to be introduced.
13. Layout studies shows that the internal arrangement of the factory causes cross contamination, cross movement of employees among risk areas in the factories leading to contamination and bottlenecks. Improper arrangement of facilities also leads to excessive handling, hence thesis recommends an improved layout suitable for seafood industry in Kerala.
14. Study shows that factories having freezing capacities from 5 –10 tonnes/day have better capacity utilization; hence a combination layout with a capacity of 10 tonnes/day each for block freezing as well as IQF is recommended.
15. Raw materials available in the seafood factories in Kerala are multi-species and multi-size during different seasons. The proposed layout will be useful for the utilisation of these resources.
16. Labour in Kerala is comparatively cheaper and easily available. A fully automatic product line requires huge investment, that too in foreign exchange. Since the product lines are product specific, it may not be possible for the processors to use it in all seasons due to seasonality in the availability of a specific species and the size of the raw material to be fed to the product line. The proposed layout will be useful for the utilisation of these resources. Individually Quick Freezing line in the proposed layout is mainly oriented on specific products whereas the block freezing line is meant to maximise the resource utilisation during different seasons.

17. Combination layout is flexible as it helps the management to use it to produce a variety of products using the same facility. Most of the machines and facility are general purpose and hence it can be used in all seasons. Capacity utilisation of flexible layouts and facilities will be higher in uncertain situations like the one experienced in the seafood industry in Kerala. The idle capacity if any in the block freezing section can be effectively utilised by processing the raw materials meant for the IQF line at the time of peak landings. These frozen blocks can be used as the raw material of IQF line during slack season.
18. Thesis recommends high-risk area in the processing factory to be clearly separated from the low-risk area to avoid any cross contamination of the cooked material with raw material. In addition to this, movement of men and material from low-risk area to high-risk area has also to be restricted as proposed in the improved layout.
19. Treatment of the material with chemicals is not recommended. However if the buyer specifies treatment of shrimp with STPP and salt for IQF processing, a combination of 2% STPP and 1% salt and a treatment time of 1 hour with continuous stirring is found to have maximum weight gain of about 25%.
20. Production fluctuation and huge idle capacity are noticed in most of the factories studied. Hence efforts should be made to utilise the idle capacity through product diversification and resource utilisation.
21. Majority of the quality problems of the purchased products are caused by vague specification or misunderstanding of the purchaser's requirements by the producer. To avoid these problems the concept of quality management or Total Quality Management can be applied to the purchased product also.

22. It is recommended to encourage direct supply from landing centres. If the raw material is purchased from suppliers, quality problem may arise from this point because of the delayed icing of the raw material, delayed transportation of raw material from landing centre, etc. If the material is purchased through suppliers, a panel of approved suppliers has to be maintained by the companies based on their past experience. Quality of raw material has to be assured by the companies by purchasing raw material from approved suppliers. This could be verified with every lot supplied. The firm should be well staffed in quality control with testing facility.
23. The factories have to specify quality norms for supply of raw materials and have to make suppliers comply with specifications for raw material.
24. Storage of the raw material for unduly longer time before processing, is to be avoided.
25. Government has to take necessary action to improve the infrastructural facility in the landing centres and fishing harbours in Kerala in order to upgrade the quality standard.
26. Proper waste disposal systems have to be evolved in most of the factories to protect the consumer and to protect the environment.
27. Adequate drainage facility must be provided in the pre-processing and processing factories.
28. Integrated pre-processing centre must be provided in the processing factory. Raw material must be thoroughly washed before sending it to pre-processing division. Floor of the pre-processing and processing hall must be washed at one-hour interval.

29. Cleaning and sanitation procedures followed in the IQF lines of the seafood industry were not satisfactory. It is recommended to ensure standardised cleaning and sanitation procedure in the production line.
30. Quality of water and ice used for processing in seafood factories were not satisfactory. It is recommended to improve the quality of water and ice used for processing. Drinking water or potable water has to be used for processing and ice manufacturing. Ice from outside source may have more chances of contamination than the ice produced in the factory itself due to higher handling and transportation. Hence it is discouraged. Proper chlorination procedure must be followed for tap water, processing water, and water used for ice manufacturing.
31. Layered icing must be followed for the icing of the raw material and an icing ratio of 1:2 (1 kg raw material : 2 kg ice) is recommended.
32. Defrosting and fumigation of the cold storage must be followed at one-week interval.
33. The frozen products stored in the cold storage should be stored code wise, grade wise and product wise.
34. Improve the packing material quality used for packaging.
35. During summer, special precautions are to be taken for preventing bacterial contamination for the processing of seafood. During this period bacterial load of the raw material, water, etc., are high and environmental conditions is also favourable for the growth of bacteria.
36. The thesis recommends to adopt the principle of prevention. This may increase the prevention cost but the total quality costs can be reduced considerably as suggested in TQM principles.

37. In order to eliminate unwanted activities and poor sequencing, work measurement has to be carried out for the production of any new product. Work measurement also helps to develop proper incentive scheme in the factories and reduce the process cycle time.

3. Conclusion

The study clearly shows that there is scope for the introduction of Total Quality Management (TQM) system in the seafood industries in Kerala. Introduction of the TQM in the seafood industries also helps for the successful implementation and operation of HACCP concepts. However, for this there is need to change the existing autocratic or feudal organisational structure existing in various factories. An Egalitarian structure is the most ideal for introducing TQM. Similarly the present leadership style, communication systems and motivational schemes have to be changed to participatory style of leadership with open communication. Quality Circles, according to this thesis, will help to boost the morale of the employees. These changes can be adopted without any financial commitment to the management.

Regarding other inputs and infrastructure, the modifications envisaged under the present EIA regulation for obtaining approval of the seafood factories are sufficient to introduce TQM. This means that there is no additional cost involved in transforming the present quality management system into TQM except the costs involved to convert an IPQC factory into a HACCP factory, which is mandatory.

The study leaves great scope for the development of national level project on this topic to assess the possibility of introducing TQM in other regions of the country and to develop TQM models applicable to these regions for the sustained growth of seafood industry.

References

Adam, E.E. and Ebert, R.J. (1995) *Production and Operations Management: Concepts, Models and Behavior*, 5th edn. Prentice Hall of India (Pvt) Ltd; New Delhi, 792 p.

Adams, J.P. and Otwell, W.S. (1982) Suitability of seafoods to retort pouch processing, In: *Proceedings of the 7th Annual Tropical and Sub tropical Fisheries*; Technological Conference on the Americas, (Nickelson, R., Ed.), USA, 48-57.

Anandavally, N. (1995) How to integrate HACCP with EC Directive 91/493, *Seafood Export J.*, **26** (6) : 9-14.

Ananthanarayanan, R. and Panicker, C.K.J. (1982) *Text Book of Microbiology*, Orient Longman, Madras, pp 7-23.

Anon (1980) Council Directive 80/778/EEC of 15th July 1980 relating to the quality of water intended for human consumption, *Official Journal of the European communities*, No. L 229/11, 10p.

Anon (1984) *Marine Fish Marketing in India*, Indian Institute of Management, Ahmedabad, India, **IIa** : 845p.

Anon (1985) *Pre-shipment Inspection and Quality Manual on In-Process Quality Control of Fish and Fishery Products*, Export Inspection Agency, Govt.of India, Madras, 113p.

Anon (1986a) *Total Quality Control at Enterprise Level: A Requisite for Successful Export Trade of Developing Countries*, International Trade Center UNCTAD/GATT, Geneva, (8), 141p.

Anon (1986b) Trade enquiries, *Seafood News Letter*, Marine Products Exports Development Authority, **LXXIV** (2): 50-65.

Anon (1990) *Quality Management Programme: Submission Guide*, Fisheries and Oceans, Canada, 105 p.

Anon (1991a) *Quality Control for the Food Industry: An Introductory HandBook*, International Trade Center UNCTAD/GATT, Geneva, **XIII,** 198p.

Anon (1991b) *Pre- Shipment Inspection and Quality Control Manual on Frozen Fish and Fishery Products*, Quality Development Centre. Export Inspection Agency, Madras, 173p.

Anon (1991c) Council Directive 91/493/EEC of 22nd July 1991 Laying Down the Health Condition for the the Production and Placing on the Market of Fishery Products, *Official Journal of the European communities*, No. L 268, 22p.

Anon (1992) Council Directive 92/48//EEC of 22nd July 1991 Laying Down the Minimum Hygienic Rules Applicable to Fishery Products Caught Onboard Vessels in accordance with Article 3 (1) (a) (i) of Directive 91/493/EEC., *Official Journal of the European communities*, No. L 187. 7.7.92, pp 40-44.

Anon (1993) *BS 5750/ISO 9000/ EN 29000: 1987 A Positive Contribution to Better Business*, Department of Trade and Industry, UK, 21p.

Anon (1994a) *Proposal to Establish Procedures for the Safe Processing and Importing of Fish and Fishery Products*, Food and Drug Administration, Rockville, USA, 453p.

Anon (1994b) *An Introduction to HACCP for Fish Processors*, Asean-Canada Fisheries Post Harvest Technology Project-Phase II, Marine Fisheries Research Department, Southeast Asian Fisheries Development Center, Singapore. 15p.

Anon (1995a) *Current good manufacturing practices for fish and fishery products, Federal Register: Food and Drug Administeration Regulations* : Part-1,2,3 : Section-1,2,3 : 1.2 , **60**(242) pp: 65198.

Anon (1995b) Export of fresh, frozen and processed fish and fishery products (Quality control, inspection, and monitoring), SO. 729 and 730 (E) dated 21st August 1995, Order and rules 1995, Minister of Commerce, Govt. of India.

Anon (1995c) *Application of risk analysis to food standard issues- Report of the Joint FAO/WHO expert consultation*, WHO/FAO of the United Nations, Geneva, Switzerland, 39p.

Anon (1997) *Marine Products Exports Review*, Marine Products Export Development Authority, Cochin, 92p.

Avault, J.W.Jr. (1995) Quality assurance and HACCP, What they mean to you, *Aquacult. Mag.* **21**(1): 65-71.

Badonia, R., Ramachandran,A. and Sankar,T.V. (1988) Quality problems in fish processing, *J. Indian Fish. Assoc.* (18) :283-287.

Balakrishnan, S. (1992) Significance of hazard analysis critical control point (HACCP) concept in Indian Export Scenario, *Seafood Export J.*, **24** (7): 12-13.

Balakrishnan, S. (1993) Quality upgradation through system's approach, *Seafood Export J.*, **25** (7): 7-18.

Basu, S and Khasim, D.I.(1985) Studies on the effect of leaching in the quality of ice stored fish. *Fish. Technol.*, **22**(2) : 105-108.

Bauman, H.E. (1992) Introduction to HACCP. In: *HACCP Principles and Applications*, p. 1-5 (Pierson, M.D and Corlett, D.A. Jr.,Eds.) Van Nosrand Reinhold.

Bedeian, A.G. (1986) *Management*, The Dryness press, Chicago, 533 p.

Bennis, W.G. (1966) *Changing Organizations*, McGraw-Hill, New York, 199p.

Besterfeild, D.H. (1986) *Quality Control*, 2nd edn., New Jersey, Prentice Hall, 216p.

Bogason, S. (1994) Implementing an ISO quality system in a European seafood company operating internationally, In: *Quality Control and Quality Assurance for Seafood* (Sylvia G., Shriver, A.L. and Morrissey, M. Eds.) May 16-18, 1993, Newport, 169p.

Bolton, A.(1997) *Quality Management System for the Food Industry, A guide to ISO 9001/2,* Blackie Academic and Professional an imprint of Chapman and Hall 2-6 Boundary Row, London, 191p.

Braekkan, R. O. (1982) Codex Alimentarius- International Codes and Standards for Fishery Products, *Infofish Marketing Digest*, 1: 23-25.

British Standard Institution (BSI). (1981) *Guide to the Determination and Use of Quality Related Costs*, BS 6143, U.K.

Brown, L and Sylvia, G. (1994) Trends in seafood quality assurance, In : *Quality Control and Quality Assurance for Seafood* (Sylvia G., Shriver, A.L. and Morrissey, M. Eds.) May 16-18, 1993, Newport, 169p.

Burns, T. and Stalker, G. M. (1961) *The Management of Innovation*, Tavistock, London, 316p.

Cash, W. (1986) Motivation, In: *Quality Management Handbook* (Marcel Dekker, Walsh, L.R., Wurster and Kimber R.J. Eds.) New York, 119p.

Chandler, A.D. (1962) *Strategy and Structure*, Mass: MIT Press, Cambridge, 406p.

Chandrasekharan, G. (1986) 'Quality Circles' *Seafood News Letter*, Marine Products Export Development Authority, **LXXIV** (4): 32-51.

Chung, C.Y. (1976). *On the black discolouration of shrimp - a review*. Report of the Symposium on Processed Seafood quality Assurance. No. 21 : 6-47.

Corlett, D.A.Jr. (1994) Using TQM principles to implement HACCP, In : *Quality Control and Quality Assurance for Seafood* (Sylvia G., Shriver, A.L. and Morrissey, M. Eds.) May 16-18, 1993, Newport, 169p.

Cronin, L.E. (1982) *Chesapeake Bay: A case history.* International Symposium on Utilization of Coastal Ecosystems: Planning, Pollution and Productivity, Rio Grande (Brazil) Atlantica, **5** (2) : 31p.

Crosby,P.B. (1986) Management and Policy, In: *Quality Management Handbook* (Marcel Dekker., Walsh, L.R., Wurster, R.J. and Kimber, R.J. Eds.) New York, 119p.

Dahlgaard, J.J., Kristensen, K. and Kanji, G.K. (1995) *The Quality Journey – A Journey Without an End,* Productivity Press (India) Pvt. Ltd., Madras. 211 p.

Davis, S.M. and Lawrence, P.R. (1977) *Matrix,* Addison-Wesley, New York, 316p.

De beer, R.(1994) ISI 9000: The Sealord Experience (past lessons and future visions), In : *Quality Control and Quality Assurance for Seafood* (Sylvia G., Shriver, A.L. and Morrissey, M. Eds.) May 16-18, 1993, Newport, 169p.

Delvin, I. (1994) Evolving international inspection standards and impacts on U.S Seafood Trade, In : *Quality Control and Quality Assurance for Seafood* (Sylvia G., Shriver, A.L. and Morrissey, M. Eds.) May 16-18, 1993, Newport, 169p.

Deming, W.E. (1982) *Quality, productivity and competition position,* Institute of Technology, Center for Advanced Engineering study, Massachusetts, 166p.

Deming, W.E. (1975) My View of Quality Control in Japan, Reports of Statistical Applications Research, *Union of Japanese Scientists and Engineers* (JUSE), **22**(2): 25-32.

Deming, W.E. (1986). *Out of Crisis,* Cambridge University Press, Cambridge, Massachusetts. pp: 5, 179-181.

Dey, B.R. (1988) *Quality Circles- Concepts and Practices*, Macmillan India Ltd., New Delhi, 187 p.

Dixon, J.W and Frank, J.M. (1983) *Introduction to Statistical analysis*, 4th edn., Mc Graw- Hill Book Co., Singapore, 678p.

Dodge, H.F. (1943) A sampling inspection plan for continuous production, *Annals of Mathematical Statistics*, **14** (3): 264-279.

Dodge, H.F. (1969) Notes on the evolution of acceptance sampling plan, PART I, *J. Quality Technology*, **1**(2):77-88.

Dora, K.C. and Hiremath, G.G. (1987) Effect of chilled sea water storage of oil sardine (*Sardinella longiceps)* on quality changes during frozen storage, *Fish.Technol.*, **24** (2) : 109-111.

Durairaj, S. and Krishnamurthy, S. (1986) The Preservation of some Indian fresh water fish, *Fish. Technol.*, **23** (2) :115-119.

Fahri, M.A., Pennington, C.L., Cronholm, L.S. and Atlas, R.M. (1984) Bacteria associated with crabs from cold waters with emphasis on the occurrence of potential human pathogens. *Appl.Environ.Microbiol.* **47** (5): 1054-1061.

Farquhar, J.(1991) Retail overview of the FDA/NOAA Fish and Fisheries Product Inspection Programme, Paper presented in the 15th Annual Conference: *Tropical and Sub tropical Fisheries Technological Conference on the Americas*, USA,: 383-391.

Feigenbaum, A.V. (1974) *Total Quality Control*, Mc Graw-Hill, New York. 331p.

Feigenbaum, A.V. (1983) *Total Quality Control*, McGraw-Hill, New york.388p.

Felter, C. (1994) The use of total quality product and total quality management Programs in meeting new EEC regulations, In: *Quality Control and Quality Assurance for Seafood* (Sylvia G., Shriver, A.L. and Morrissey, M. Eds.) May 16-18, 1993, Newport, 169p.

Fernandez, R.R. (1996) *Total Quality in Purchasing and Supplier Management*, Productivity Press (India) Pvt. Ltd., Madras, India, 319p.

Flick, G.J., Knobl, G. and Enscore, T. (1992) Integrating HACCP (Hazard Analysis Critical Control Point) based Inspection with Quality Assurance in a Recirculating Production and Processing Facility., *Aquaculture-'92., Growing Toward 21st Century*, Dep. Food Sci. and Technol., Blacksburg, USA, 93p.

Garrett, E.S. and Hudak, R.M. (1991) *U. S. seafood inspection and HACCP in Microbiology of Marine Food Products*, Van Rostrand Reinhold, USA, pp 111-131.

Gates, K.W.,Perkin, B.E., EuDaly, J,G., Harrison, A.S. and Bough, W.A. (1982) Assessment of seafood processing and packing plant discharges and their impacts on Georgia's estuaries, *Tech. Rep. Ca. Mar. Sci. Cent.* 119p.

Georgala, D.L. (1957) *Quantitative and Qualitative Aspects of the Skin Flora of North Sea cod and Effect thereon of Handling on Ship and Shore*, Ph.D. Thesis, Aberdeen University, Aberdeen, Scotland.

George, C. (1985) *Biochemical Changes Associated with Processing of Shellfishes and Flavour Constituents of Body Meat and Claw Meat of Crabs*, Ph.D. Thesis, Cochin University of Science and Technology, Cochin, India.

George, J.P.(1979) Crisis in the Seafood Industry, Paper presented at Symposium on Lab to Land programme, Workshop on Ocean Management , *India Today Tomorrow*, Bombay, India, 5th April: 111-112.

Gitlow, H.S.and Gitlow, S.J. (1987) *The Deming Guide to Quality and Competitive Position*, Prentice-Hall, Englewood Cliff, New Jersey, 168p.

Gopakumar, K. (1993) Marketing of value added products, *Seafood Export J.*, **XXV** (5) :81-86.

Gorga, C. (1994) Quality assurance internal and external organisational requirements, In: *Quality Control and Quality Assurance for Seafood* (Sylvia, G., Shriver, A.L. and Morrissey, M. Eds.) May 16-18, 1993, Newport, 169p.

Govindan,T.K. (1971) Problems of leaching in iced fish, *Indian Food Packer*, **25** (1): 27-32.

Grinath, A.C. and Vess, P.H. (1983) Making SQA Work: The development of a software quality system, *Quality Progress*, **XVI**(7) : 18-23.

Hackman, J.R. (1977) *Work Design – Improving Life at Work*, Santa Monica, California, 129 p.

Hammer, T.H., Currall, S.C. and Stern, R.N. (1991) Worker Representation on Boards of Directors: A Study of Competing Roles, *Industrial and Labour Relations Review*, Winter issue, pp.661-680.

Hansen, B.L. and Ghare, P.M. (1987) *Quality Control and Application*, Prentice-Hall, Englewood Cliffs, New Jersey, 496p.

Hayes, P.R. (1985) *Food Microbiology and Hygiene*, Elsevier Applied Science, Amsterdam, 316p.

Hood, A.F. and Flick, G.J. (1995) *Total Quality Assurance and Hazard Analysis Critical Control Point Manual for the Cat fish Processing Industry*, Blacksburg, Virginia Sea Grant, USA, 120p.

Hoskin, G.P and Wilson, S.E. (1990) Food and Drug Administration and National Marine Fisheries Service Joint Seafood Initiative: Status Paper presented in the 15th Annual Conference: Tropical and Sub tropical Fisheries Technological Conference on the Americas, USA : 46-54.

Hosotani, K. (1996) *The QC Problem- Solving Approach-Solving Work Place Problem : the Japanese Way*. Productivity Press (India) Pvt. Ltd., Madras, 167p.

Hotta, M. (1982) The Japanese market for squid and cuttle fish, *Infofish Marketing Digest*, No.4: 12-19.

House, R.J and Wigdor, L. (1967) Herzberg's dual-factor theory of job satisfaction and motivation: A review of the Empirical Evidence and a Criticism, *Personnel Psychology*, Winter issue, pp.369-380.

Howgate, P. (1994) Import Standards and Regulations for Seafood sold in the EEC, and In Plant Quality Assurance,. In: *Quality Control and Quality Assurance for Seafood* (Sylvia G., Shriver, A.L. and Morrissey, M. Eds.) May 16-18,1993, Newport, 169p.

Hudak, M.R., Garrett, E. S., Meaburn, G.M., Regier, L. and Tennyson, J. (1991) Relative prevalence of economic fraud in the seafood industry, 15th Annual Conference: *Tropical and Sub tropical Fisheries Technological Conference on the Americas*, USA, pp 46-54.

Huss, H. H. (1993) *Assurance of Seafood Quality*, FAO Fisheries Technical Paper No 334. FAO, Rome, 169p.

Hutchins, D. (1993) *Just in Time*, First Indian Edition, Productivity Press Pvt Ltd, 213 p.

ICMSF, (1988) *Microorganisms in Foods- Application of the Hazard Analysis Critical Control Point (HACCP) System to ensure Microbiological Safety and Quality*, ICMSF (International Commission on Microbial Specification for Foods), Blackwell Scientific Publications, 116p.

Imholte,T,J. (1984) *Engineering for Food Safety and Sanitation*, Crystal, MINN: The Technical Institute of Food Safety, 259p.

Ingle, S. (1982) *Quality Circles Master Guide*, Prentice-Hall, Englewood Cliffs, New Jersey, 436p.

Ishikawa, K. (1967) Tributes to Walter A. Shewhart, *Industrial Quality Control*, **22**(12): 115-116.

Ishikawa, K. (1976) *Guide to Quality Control*, Asian Productivity Organisation, Nordica International Ltd., Hong Kong. UNIPUB, New York, 372p.

Ivancevich,J.M. (1969) Perceived Need Satisfactions of Domestic versus Overseas Management, *J. Applied Psychology*, August, pp.274-278.

Iyer, K.H., Rao, P.S., Unnithan, G.R., Nair, K.A.R. and Nair, R.G. (1982) Idle capacity of the fish processing (Freezing) plants in India-II: East coast., *Fish.Technol.*, **19** (1) : 9-14.

Iyer, T.S.G. (1990) Seafood quality control, Paper presented at the Training Programme on Seafood Quality Control, (EIA & MPEDA) Cochin, India, 22p.

Iyer, T.S.G and Srivastava, K.P. (1989) Incidence of low temperature survival of *Salmonella* in fishery products, *Fish. Technol.*, **26**(1) :39-42.

Iyer, T.S.G and Varma, P.R.G. (1990) Sources of contamination with *Salmonella* during processing frozen shrimp, *Fish. Technol.*, **27**(1) : 60-63.

Iyer,T.S.G. (1998) The HACCP concept in Seafood Industry, Paper presented at the Symposium on Advances and priorities in Fishery Technology, (SOFT (I) & CIFT) Cochin, India, 11-13 February.

James, D.(1993) The Changing status of fish inspection, In: *Proceedings of the work shop on Fish Inspection* (Limpus, L.G and Yamagata, M. Eds.) Jakarta, pp 3-5.

Johney, R. (1985) Handling and transportation of fish, In : *Harvest and Post harvest Technology of Fish* (Ravindran, K., Nair, N.U., Perigreen, P.A., Madhvan,P., Pillai, A.G.G., Panicker, P.A. and Thomas, M. Eds.) Society of fishery Technologists (India), Cochin, pp 343-346.

Jose, V.T. and Sherief, P.M. (1993) Glaze hardner – A new recruit to Indian seafood processing machinery, *Seafood Export J.*,**52**(9) : 7-10.

Joseph, J., Perigreen, P.A., George, C. and Govindan, T.K. (1980) Iced and frozen storage characterestics of cultured *Chanos chanos* (Forskal) *Fish. Technol.*, **17** (1): 21-26.

Joseph, J.,Varma, P.R.G. and Venkataraman, R. (1977) Iced and frozen storage of squid (*Loligo* sp). *Fish. Technol.*, **14**(1) : 13-20.

Juran, J.M. and Gryna, F.N. (1980) *Quality Planning and Analysis*, 2nd edn.,New York, Mc Graw-Hill Book Co., 325p.

Kangi, G. K. and Asher, M. (1995) *Total Quality Management Process – A Systems Approach*, Productivity press(India) Pvt Ltd., 185 p.

Karthiayini, T.C. and Iyer, K.M (1971) Seasonal variations of bacterial flora of fresh oil sardine (*Sardinella longiceps*) *Fish. Technol.*, **8**(1) : 69-79.

Katz, D. and Khan, R.L. (1966) *The Social Psychology of Organisation*, John Wiley & Sons, Inc., NewYork, 239 p.

Kaul, P.N., Iyer, K.H. and Kandoran, M.K., (1989) Adoption of recommended quality control practices by fish processing factories, *Fish. Technol.*, **26**(1) : 62-66.

Keith , G.L., John, S.O. and Clive, H.D. (1983) Work study techniques, Omega *Int. J. Management Sci.*, 11 (3): 293-302.

Kim, J. (1993) Application to HACCP system to catfish producers and processors, In : *Proceedings of the Aquaculure Products Safety Forum*, AL-USA, pp: 125-134.

Kivenko, K. (1984) *Quality Control for Management*, Prentice-Hall, Englewood Cliffs, New Jersey. pp:13-14

Kossen, S. (1991) *The Human Side of Organisation*, 5th edn., Harper-Collins, 588p.

Kumar, K.R. (1990) Packaging of fish and fishery products, *Industrial Fisheries Association Annual*, School of Industrial Fisheries, Cochin University of Science and Technology, Cochin, 7 : 43-48.

Kume, H. (1996) *Management by Quality*, Productivity Press (India) Private Ltd., Madras, 249 p.

Lakshman, P.T., Mathen, C., Varma, P.R.G. and Iyer, T.S.G. (1984) Assessment of quality of fish landed at the Cochin fishing harbour, *Fish. Technol.*, **21** (2): 98-105.

Lal, H. (1990) *Total Quality Management- A Practical Approach*, Wiley Eastern Ltd., New Delhi, 229p.

Lalitha, K.V and Iyer, K.M. (1986) Incidence of *Clostridium perfringens* in fishes. *Fish.Technol.*, **23**(2)::152-157..

Larusson,T., Balaban, M.C., Yerslan, S. and Otwell, W.S. (1991) Application of computer vision to seafood quality evaluation, 15th Annual Conference:

Tropical and Sub tropical Fisheries Technological Conference of the Americas, USA, pp 383-391.

Lawrence, P.R. and Lorsch, J.W. (1969) *Organisations and Environment*, Irwin, Homewood, 288p.

Lee, J.S. (1991) An introduction to HACCP, *Mar.Technol. Soc. J.*, **25**(1) :60-62.

Levin, I.R. (1972) *Production/Operation Management*, McGraw-Hill, Inc; New York, 542 p.

Licciardello, J.J. (1990) Freezing (seafood/fishery industry), In: *The Seafood Industry*, (Martin, R.E. and Flick, G.J. Eds.) pp 205-218.

Likert, R. (1961) *New Patterns of Management*, McGraw-Hill, New York, 115p.

Luthans, F. (1977) *Organisation Behaviour*, 2nd edn., McGraw Hill Kogakusha Ltd., Tokyo, 568 p.

Majumdar, D.C. (1985) Quality control of marine products, In: *Souvenir in commemoration of the 6th Seafood Trade Fair*, Bangalore, (Marine Products Export Development Authority and the Seafood Exporters Association) Cochin, India, 4p.

Marti, O.R and Rodriguez, A.R. (1992) *Application of the HACCP system to the processed fishery products of fish sticks and frozen peeled shrimp tails produced by the company* , Pesquera Industrial Regia in Havana, Cuba, FAO : 48-63.

Mathen, C. (1979) Fundamental aspects of quality control in sea foods, In : *Quality Control in Fish Processing*, (Central Institute of Fisheries Technology), Cochin, pp 1-8.

Mathen, C. and Thomas, F. (1988) Solid loss and weight gain in prawns during storage in ice, *Fish. Technol.*, **25** (2) :110-111.

Mayer, R.R. (1975) *Production and Operations Management*, 3rd (edn). McGraw-Hill Kagarusha, Ltd. New Delhi, 658p.

McEachern, V.(1995) The application of HACCP in a government food inspection programme, In: *Proc. of the Workshop on the Management of South Pacific Inshore Fisheries*, (Dalzell, P. and Adams, T.J.H.Comp. Eds.) **2** (12), pp. 287-297.

Moor, K.B and Nickleson, R. (1982) The effect of packing on the microbiology of sea foods in Transit, In: *proc.of the 7th Annual Tropical and Sub tropical Fisheries Technological Conference on the Americas*, USA, pp. 216-223.

Moore, G.F and Hendrick, F.T. (1978) *Production/Operations Management*, 2nd edn. Mc Graw – Hill Book Co., New York, 762 p.

Nair, K.A.R., Rao, P.S., Unnithan, G.R. and Kaimal, P.N.R. (1979) Observations on the wastage of raw material and recovery of meat in prawn processing industry, *Fish.Technol.*, **16**(1): 1-15.

Nair, M.R., Iyer, K.M., Appukuttan, P.N. and Jacob, C. (1962) Storage characterestics of prawns held in crushed ice and chilled sea water , In : *Proc. of India Pacific Fisheries Council*, **10**(20): 294p.

Nair,P.B. (1995a) Fish inspection in different countries, *Fish.World.* **2** (4&5) : 46-51.

Nair, P.B. (1995b) Fish Inspection System in India, Paper presented at the Work shop on Hazard Analysis Critical Control Point System in Seafood Industry, (Central Institute of Fisheries Technology, Cochin and Natural Resources Institute, United Kingdom) Feb7-11.

Nair, R.P., George, C., Thampuran, N., Perigreen, P.A.and Gopakumar, K. (1987) Studies on the frozen storage characterestics of individually quick frozen and block frozen mackeral, *Fish. Technol.*, **24** (2) : 103-108.

Oberlender, V.T., Finne, C. and Nickolson, R (1982) Controlled Atmosphere Packaging of Swordfish steaks (Flow through system), In: *Proc. of the 7th Annual Tropical and Sub tropical Fisheries Technological Conference on the Americas*, USA, pp 340-350.

Olmstead,P.S. (1967) Our debt to Walter Shewhart, *Industrial Quality Control,* **24**(2):72-73.

Ostergard, J (1995) Record keeping, verification final steps in implementing plan, *Fish. Prod. News*, **10** (1): 6-7.

Otwell, W.S. and Garrido, V. (1995) *Mandatory HACCP for Processing Molluscan Shellfish, Annual meetings of National Shell Fisheries Association- Pacific coast section and Pacific coast oyster growers Association*, **14** (1): 230p.

Patchin,R.I (1983) *The Management and Maintenance of Quality Circles*, Dow Jones Irwin, Homewood, **III**, 315p.

Pawsey, R.K. (1994) Quality loss and hazard analysis in transported frozen marine products, In :Symposium on Nutrients and Bioactive-Substances in Aquatic Organisms, (P. 222-234) (SOFT)(I) and CIFT); Cochin, India.

Perigreen, P.A., Joseph,J., Surendran,P.K. and Gopakumar, K. (1987) Studies on iced storage on common Murrel, *Fish. Technol.*, **24**(2):99-102.

Pillai, R.R. (1996) Guidelines for getting clearance statutory set up in the Pollution Control Board, Seminar on the waste water Treatment of seafood Industry. SGS India Ltd., 15 - 16 march 1996,Cochin,15p.

Plunkette, J.J and Dale, B.G. (1987) A review of the literature on quality related costs. *Int.J. Qual. Rel. Mgmt.*, 4(1) : 40-52.

Porter, J.L. and Reyner, P. (1992) Quality costing for total quality management, *Int.J. Pro. Econ.*,(27) : 69-81.

Pottinger, S.R. (1950) Fish fillets at varying temperature, *Quick Frozen Foods*, 14(7) : 79-90.

Price, R.J. (1995) Processing of mussels-The HACCP way, *Food Sci. and Technol.*, USA, 43p.

Rai, K.K. (1984) Worker's involvement in productivity, *Indian Management*, April, 72 (8): 49-52.

Raj, H. and Liston, J.(1963) Effect of processing on public health bacteria in frozen seafoods, *Food Technol.*, 17(10) :83-89.

Ramachandran, A. (1988) *Studies on the Production Management in the Seafood Processing Industry in Kerala* : Ph.D Thesis, Cochin University of Science and Technology Cochin, India.

Ramachandran, A. (1990a) Work measurement for the production of frozen headless shell-on shrimp in seafood processing plants in Kerala, In : *Proc. of the2nd Kerala Science Congress* (Balakrishnan Nair,N. Ed.) State Committee on Science, Technology and Environment, Govt. of Kerala, Trivandrum,India pp: 188-189.

Ramachandran, A. (1990b) Human factor and productivity in seafood industry with special emphasis on 'Quality Circle', *Industrial Fisheries Assn. Annual*,School of Industrial Fisheries, Cochin University of Science and Technol., Cochin. pp. 87-90.

Ramachandran, A. (1994) Simple priority rule for processing in seafood processing plants, *Seafood Export J.*, **XXV** (19): 1-6.

Ramachandran, A., Samuel, C.T. and Ranganathan, N. (1993) Raw material purchase patterns in seafood plants in Kerala, *Fish. Technol.*, **30**(1): 72-74.

Ramachandran, A., Renganathan, N. and Samuel, C.T. (1992) Observations on the process control factors in the seafood plants in Kerala, *Fish. Technol.* **29**(2):132-135.

Ramamurthy, V.D. (1981) Seafood quality control: Fish preservation at sea. *Seafood Export J.*, **13**(9): 19-21.

Ramamurthy,V.D. (1978) Seafood Quality Control: Fishing Vessels. *Seafood Export J.*, **10**(11): 11-18.

Ramos, M.E.M. (1993) Seminary work shop on Hazard Analysis Critical Control Point (HACCP), *Bol. Inf.* 4: 54.

Reilly,A., Bernarte, M.A. and Dangla, E. (1984) Storage stability of brackish water prawns during process export. *Food.Technol.*, **36**(6) : 283-286.

Reily, L.A and Hackney, C.R. (1982) Survival of *Vibrio cholerae* 01 in seafood during frozen and refrigerated storage, In: *Proc. of the 7th Annual Tropical and Sub tropical Fisheries; Technological Conference on the Americas* (Nickelson, R. Ed.) USA, pp 239-249.

Robbins, S.P. (1997) *Organizational Behavior*, 7th edn., Prentice-Hall of India (P) Ltd., New Delhi, 752 p.

Ronsivalli, L.J.and Baker, D.W.(1981) Low temperature preservation of seafoods: A review, *Mar. Fish. Rev.*, **43** (4) : 1-15.

Sadgrove, K. (1996) *Making TQM Work*, Kogan Page India Pvt. Ltd, New Delhi, 122p.

Sanjeev, S., Iyer, K.M., and Rao, C.C.P.(1985) Antibiotic sensitivity of *Staphylococcus aurius* strains isolated from fishery products, *Fish. Technol.*, **22** (1): 58-61.

Sankar,T.V and Nair, P.G.V.(1988) Effect of pre-processing iced storage on deteriorative changes in lipids of silver pomfret at –18 C. *Fish.Technol.*, **25**(2) : 100-104.

Saralaya, K.V. (1979) Fish processing and diversification, *Seafood Export J.*, **11**(3): 9-14.

Sastry, C.H.H and Srikar, L.N. (1985) Protein and related changes in cuttlefish (*Sepia aculeata*) during ice storage, In: *Harvest and post Harvest Technology of Fish*, (Ravindran, K., Nair, N.U., Perigreen, P.A., Madhvan, P., Pillai, A.G.G., Panicker, P.A. and Thomas, M. Eds.) Organised by Society Fisheries Technologists (India), Cochin, pp 386-388.

Sathiadas, R. (1998) Exploitation, employment, earnings and marketing aspects of marine fisheries in Indian economy, Paper presented at the Symposium on Advances and Priorities in Fishery Technology, (SOFT (I) & CIFT) Cochin, India, 11-13 February.

Schilling, E.G. (1982) *Acceptance Sampling in Quality Control*, Marcel Dekker, New York,186p.

Schmidt,F. (1973) Implication of a measurement problem for expectancy theory research, *Organizational Behaviour and Human Performance*, April issue, pp. 243-251.

Serrao, A.D., Hiremath, G.G. and Dora K.C. (1992) Quality changes in white sardine, *Kowala coval* (Cuv) during frozen storage, *Fish. Technol.*, **29** (2): 127-131.

Shassi, S. and Ramachandran. A. (1998) Changing market demand for Indian seafood, In: *Technological Advancements in Fisheries* (Hameed, M.S. and Kurup, B.M. Eds.), Cochin, pp: 417-425.

Shenoy, A.V., (1976) Freezing characteristics of tropical fishes III – Spotted Seer *(Scomberomorus guttatus) Fish. Technol.*, **13**(2): 105-110.

Shenoy,A.V and James, M.A. (1972) Freezing characterestics of tropical fishes: 1.Tilapia (*Tilapia mossambica*) *Fish. Technol.*, **9** (2):34-41.

Sherief, P.M. and Kumar, S.K. (1994) Phosphate in Seafood processing, *Seafood Export J.*, **25**(13) :19-28.

Shewan, J.M. (1961) The Microbiology of seawater fish, In: *Fish as Food* **1**, (George Borgsrom. Ed.), Academic Press, New York, London, pp 487-560.

Simpson, R,J. (1959) Vertical and Horizontal Communication in Formal Organisation, *Administrative Science Quarterly*, pp: 188-196.

Smith C.W. (1983) Unifying customer needs with workers satisfaction, *Management Review*, **72** (8):49-52.

Sobsey, M.D. (1989) Inactivation of health related microorganisms in water by disinfection process, *Wat. Sci. Tech.*, **21**(3): 179-195.

Solanki, K.K. and Venkataraman, R. (1978) Ice storage characterestics of fresh and brined shark fillets, *Fish. Technol.*, **15** (1): 7-11.

Surendran, P.K and Gopakumar, K. (1982) The bacteriology of oil sardine (*Sadinella longiceps*) and mackeral, (*Rastralliger kanagurta*) caught from tropical waters off Cochin, *Fish. Technol.*, **19**(2) : 83-88.

Surendran, P.K and Iyer, K.M. (1985) Ice storage characteristics of pearl spot (*Etroplus suratennsis*) caught from Cochin back water, In: *Harvest and Post Harvest Technology of Fish* (Ravindran, K., Nair, N.U., Perigreen, P.A., Madhvan, P., Pillai, A.G.G., Panicker, P.A. and Thomas, M. Eds.) Society of Fishery Technologists (India), Cochin, pp 370-372.

Surendran, P.K., Iyer, K.M. and Gopakumar, K. (1985) Succession of bacterial genera during iced storage of three species of tropical prawns: *Penaeus indicus, Metapenaeus dobsoni, Metapenaeus affinis, Fish.Technol.*, **22**(2) : 109-111.

Surendran, P.K. and Iyer, K.M. (1976) Bacterial flora of fresh and iced Indian mackeral (*Rastralliger kanagurta*) and its response to Chlortetracycline (CTC) treatment, *Fish.Technol.*, **13**(2):139-145.

Suwanrangsi, S. (1992) HACCP concept and its applicability, In: *Proc. of the work shop on Fish Inspection Thailand*, (Limpus, L.G and Yamagata, M. Eds.) Jakarta, pp 17-23.

Sylvia, G., Murphy, M and Larkin, S. (1994) Demand for Seafood Quality Standard and grades: The case of Pacific Whiting fillets, In: *Quality Control and Quality Assurance for Food-A Conference* (Sylvia G., Shriver, A.L. and, Morrissey, M. Eds.), May 16-18, 168p.

Szilagyi, A.D. (1981) *Management and Performance*, Scolt, Foresman and Co, Illinors, 750 p.

Szilagyi, A.D. and Wallace,M.J. (1980) *Organizational Behaviour and Performance*, 2nd edn., Santa Monica, California, pp.149-157.

Taliat, J. (1993) General constraints in maintenance of quality in Indian seafood industry in light of HACCP system, *Seafood Export J.*, **25** (10): 5-10.

Tall, A.(1995) *Workshop on Seeking Improvements in Fish Technology in West Africa,* 7-9 November-1994, (Teutscher, F., Tall, A. and Jallow, A. Eds.) Cotonou Benin, FAO, pp: 66-75.

Taylor, F. W. (1911) *Principles of Scientific Management*, Harper & Brothers, New-York, 416p.

Temri, L. (1994) Technological strategies in the Seafood Industry, In: *Proc. of the 6th Conference of the International Institute of Fisheries economics and Trade*, 6-9 July 1992,(Antona. M., Catanzano, J. and Sutenen, J.G. Eds.) pp: 979-982.

Thampuran, N. (1988) *Quantitave and Qualitative Studies on the Bacteriology of Frozen Fishes and Prawns*, Ph.D. Thesis, Cochin University of Science and Technology, Cochin, India.

Thomas, F. and Mathen, C. (1979) Process water quality, In: *Quality Control in Fish Processing*, Central Institute of Fishery Technology, Cochin, India, 61-74.

Thomas, F. and Mathew, K. (1990) Filth and decomposition in prawns for peeling sheds around Cochin, *Fish.Technol.*, **27** (2) : 130-132.

Toyofuku, H. (1997) Quality requirements of fish and fishery products – Japan, *Infofish Int.*, 3: 43-47.

Troller, J.A. (1983) *Sanitation in Food Processing*, Academic Press, 459p.

Udapa, S.R (1983) 'Quality Circles' Enriching Work life, *Business Standard*, 26-11-1983.

Vardaman, G.T and Halterman, C.C. (1968) *Managerial Control Through Communication*, John Wiley & Sons Inc., New York, pp 3-4.

Varma, P.R.G and Iyer, T.S.G. (1990) Viability of *Vibrio cholerae* in water. *Fish. Technol.*, **27** (2) : 151-152.

Velankar, K.A., Govindan, T.K., Appukuttan,P.N. and Iyer, K.M. (1961) Spoilage of prawn at 0°C and its assessment by chemical and bacteriological tests, *Indian J. Fish.*, **8**(1) : 241-251.

Venugopal, T.N. (1996) Quality: Is it costly, *Seafood Export J.*, **27**(9) : 5-8.

Virulhakul, P. (1995) Processing traditional fishery products – quality and safety considerations, *Infofish Int.*, 5: 50-56.

Wadsworth, H.M., Stephens, K.S. and Godfrey, A.B. (1986) *Modern Methods for Quality Control and Improvement*, Wiley, New York, 259p.

Ward, R.A. (1996) Methodologies for assessing post harvest fish losses, *Infofish Int.*, 6: pp 44-50.

Warne,D. (1991)HACCP and quality assurance in the tuna industry, *Infofish Int.*, 6: 51-56.

Weber, M. (1947) *The Theory of Social and Economic Organisation*, Oxford University Press, New York, 330 pp.

Wheaton, F.W. and Lawson, T.B.(1988) *Processing Aquatic Food Products*, John Wiley & Sons, New York : 329-348.

Zugarramurdi, A., Partin, M.A. and Lupin, H.M. (1995) *Economic Engineering Applied to the Fishery Industry*, FAO Technical Paper. No.351. Rome, 295p.

Appendix-I

QUESTIONNAIRE

1. Name of the factory/firm

2. Factory address

3. Telephone number/Fax

4. Nature of business

5. Nature of the company
   Proprietary
   Partnership
   Public Ltd.

6. Name and address of the sister concern(s)

7. Type of industry (small-scale, medium-scale and large -scale)

8. Year of establishment

9. Total area of the company
   Covered
   Uncovered

10. Total number of employees

11. Whether adequate facilities are available for
    Electricity
    Fire fighting
    Water supply

12 Foreign collaboration if any,
   Name and address of the collaborator

13. Years of collaboration

14. Details of factory and machine
    Please give important equipments only

Raw material purchase section

1. Which are the sources of raw material purchased
   Direct
   Supplier
   Both

2. Are you satisfied with the raw material availability at your company? YES/NO

3. Which is the nearest fish landing centre / Fishing harbour to your factory?

4. Which are other landings centres within reach?

5 What is the maximum quantity of raw material purchased / day?

6 Do you get adequate quantity of raw material from a particular supplier or any purchase depot? YES/NO

7. Do you inform the purchase specification or buyer's specification to the suppliers? YES/NO

8. Do you inform the suppliers regarding the change in quality policy of your company? YES/NO

9. Do you evaluate the suppliers according to the raw material quality, availability, rate etc? YES/NO

10. Do you select most suitable supplier from this evaluation? YES/NO

11. Are your suppliers willing to supply adequate quantity of raw material at right time? YES/NO

12. What is the type of arrangement with your suppliers to get adequate quantity of raw material at right time?

13. Does the company maintain adequate reserve stock to insulate itself against interruption in supply of raw material? YES/NO

14. If yes, please explain

15. What is the quality of the raw material used
    Good, Satisfactory, Not satisfactory

16. Does the machine have adequate capability to maintain important quality parameters? YES/NO

17. Does the supplier firms have well staffed quality organisation and a working quality control programme? YES/NO

18. Do you have any specification in the purchase of raw material? YES/NO

19. Who decides the quality specifications for the purchased raw material?

20. Do you in person inspect purchased raw material regularly? YES/NO

21. Do you maintain quality record of the purchased raw material? YES/NO

22. Are you satisfied with the raw material handling in the landing centre? YES/NO

23. What is the type of floor at the landing centre?

24. How are the material weighed and loaded into the vehicle?

25. Do you periodically clean the vehicle after completion of unloading in each batch? YES/NO

26. Do you suffer any delay in transporting the raw material? YES/NO

27. Do you wash the vehicle/ container before loading the raw material? YES/NO

28. Are you using boxes or baskets for taking the raw material, if yes, of what make?

29. Details of containers / vehicles used

30. What is the average quantity of raw material used / day?

31. Whether raw material is being properly washed?
YES/NO

32. Is the raw material adequately iced? Specify icing ratio? YES/NO

33. Do you check temperature of the raw material?
YES/NO

34. Is there a chill room for storing the raw material?
YES/NO

35. What is the area of your chill room?

36. Is the waste disposal facility satisfactory or not?

Processing Section

1. Are there adequate facilities for
   a. Raw material receiving YES/NO
   b. Peeling/ pre-processing YES/NO
   c. Processing YES/NO
   d. Freezing and Frozen storage YES/NO
   e. Toilet and personal hygiene YES/NO

a. Raw material receiving division

1. Do you have separate raw material receiving hall?
YES/NO

2. What is the total area of raw material receiving hall?

3. Do you wash the raw material before sending it to the pre- processing division? YES/NO

4. If yes, what is the method of washing?

5. Do you use chlorinated water for washing the raw material? YES/NO,
If yes at what level of chlorin

6. Any equipment/ machine is being used in this division (specify important equipments)

7. Quality standards of the equipments

No	Equipments	Quality standards

b. Peeling/ Pre- processing division

1. What are the types of floor, roof, wall, ventilators and doors in this section?
2. What are the utensils and equipments used in this section?
3. How many processing tables are there in your pre-processing division?
4. What is the total capacity of peeling section?
5. What is the average capacity utilised/day?
6. What is the mode of washing the raw material?
7. From where do you get the water for processing?
8. What is the rate of chlorination?
9. What is the type of drainage?
10. Are you doing organoleptic or microbiological analysis on the peeled material? YES/NO
11. Are you doing on-line inspection in this section? YES/NO
12. Where is the pre-processing hall is situated?

c. Processing division

1. Lay out of the factory
2. Is the Movement/ flow of raw material and semi-finished products Smooth? YES/NO

3. What is the method of washing the raw material for processing?

4. What are the handling equipments used in this section and number?

5. If washing is by machine, give details of make, capacity efficiency and year of installation?

6. What is the quantity of ice used / kg of material per day?

7. What is the frequency of re-icing?

8. What is the source of water and level of chlorination practiced?

9. How many tables and equipment in this section?

10. Quality standards of equipments used and source

No.	Equipments	Source	Quality standards

11. Type of wall and floor

12. Type of drainage

13. How many workers are engaged in processing?
    Male
    Female

14. How many quality related staff / workers are there in the processing division?

d. Freezing and Frozen storage

1. What is the type freezing equipment and capacity?

2. What is the freezing medium used in the equipment?

3. Mention the prescribed time for freezing a batch of raw material.

4. What is the actual time required for freezing?

5. How much time is taken for loading and unloading each batch?

6. What are the temperature limits attained in the freezer?

   Maximum
   Minimum

7. How do you wash and defrost the freezers?

8. Do you check final product every time you unload each batch after processing/ freezing? YES/NO

9. How many cold storages do you have in your factory and their size?

10. What is the cold storage capacity?

11. Mode of handling the final product in the cold storage.

12. What is the range of temperature fluctuation experienced in the cold storage?

13. Which system do you follow to stock the different products in cold storage?

14. How often do you fumigate the cold storage?

15. What is the periodicity of defrosting?

Packing

1. Mode of packing of different products

2. What are the equipments used in the section and its cost?

3. What is the quality of packing material used?

4. Do you have any specification for packing material? if yes, specify.

5. Do you keep the carton and packing material separately in hygienically maintained areas? YES/NO

Availability and source of supply of other raw materials and their unit price

Sr. No.	Materials	Source	Price
1	Master carton		
2	Wax carton		
3	Baby carton		
4	Polythene rolls		
5	Other polythene bags		
6	Gar straps		
7	Tightner		
8	Sealer		
9	Clip/1000 No.		
10	Chlorine/ litre		
11	Marker		
12	Rayon strap /roll		
13	Rubberband /bag		
14	Teepol		
15	Other detergents		
16	Refrigerants		
17	Water		
18	Electricity		
19	Generator and its capacity		
20	Media for bacteriological sample		
21	Other chemicals used		

Quality control analysis

1. Are there adequate facilities for

   a. Fly proofing, vermin and rodent control YES/NO
   b. Self closing doors YES/NO
   c. Toilet/worker, rest room facility (toilet1/ 9 workers) YES/NO
   d. Hand washing and leg dipping YES/NO
   e. Non-hand operable type taps YES/NO
   f. Washable type ceiling YES/NO
   g. Wall to wall and wall to floor joints are rounded, free from projections YES/NO
   h. Protected lights, adequate ventilation and exhaust fans YES/NO
   i. Others

2. Details of equipments used for processing and quality testing and its quality standard

No.	Equipments	Quality standards

3. Are you using non-corrodable type material for trays, tables and flooring of the processing hall? YES/NO

4. Are your workers wearing mouth-piece, working clothes, apron, headgear, boots, gloves, etc?

5. Is drinking, smoking, spitting, or talking in the processing hall prohibited? YES/NO

Quality of water and ice

6. Is potable water available in adequate quantity ? YES/NO

7. Is the water used for processing chlorinated to the acceptable level? YES/NO

8. Is water tested regularly, if yes, how often?

9. Is the ice used made from water of approved source?

10. Is the ice used for processing obtained from external source and if so what is the quality of ice used?

    Satisfactory
    Not satisfactory

Inspection system or quality control system

11. What is the type of quality control system followed in your factory?

    Finished product inspection
    IPQC/
    EEC Directives/
    ISO 9000/
    All/
    Any other

12. Why do you follow this system?

13. Do you experience any difficulties in following this system, if so please explain?

14. Does your company possess any certification of HACCP, ISO 9000, IPQC or any other quality system, specify?

15. What is the quality concept according to you?

16. Effects of company's quality policy and its objectives?

17. How does quality effects the company's sales and profitability?

18. Do you think whether increasing quality grade gives additional value and cost to your product? YES/NO

19. How many quality-related staffs do you have in your factory and what are their responsibilities?

20. What is the experience and educational qualification of the quality staff?

21. Are you regularly carrying out on line inspection and strict documentation ? YES/NO

22. Are you doing organoleptical and bacteriological inspection? If yes, mention the method adopted for inspection

23. Are you doing swab testing in your factory? YES/NO

Production

1. Do you have regular production in your factory?
2. What are the different types of products?
3. How much additional weight is added for different products to compensate drip loss?
4. What is the yield Percentage of different products from raw material?
5. What percentage of different finished goods are lost due to spoilage, deterioration and other causes?
6. peak season of production
7. Slack season of production
8. How many shifts in the factory? Give timing also.
9. How do you adjust the requirement of work force and shifts in peak season or slack season?
10. How do you schedule your raw material for processing?
11. How do you schedule your finished products for export?
12. What do you think on product diversification?
13. Is there any product development in your factory?
14. What is the capacity utilisation of your factory?
15. What is the average capacity of your factory?

Market analysis

1. Which are your export markets?

2. Which are your main markets?

3. Have you conducted any market survey or analysis at any time? YES/NO

4. If yes, explain which are the main things, meeting the customer needs?

5. What are the requirements and expectations of the customers?

6. Explain current and future customer expectation about the quality of the product

7. Do you try to collect the feed back from the customers to assure the quality of the product supplied, if yes why?

8. Do you get any customer complaints regarding your existing products? YES/NO

9. Mention the number rejections in the various products over a period of one year

10. What is the peak season of the demand of your product?

11. Do you have any idea about temperature fluctuation during transportation to different ports?

12. Have you got separate marketing wing/section?

13. How do you find different prospective markets?

14. What are your marketing expansion projects and plans?

15. What are the major sale promotion techniques used by you?

Appendix-II

QUESTIONNAIRE

Top management

1 Name of the factory and address

2 State whether ownership factory/ partner-ship factory / public Ltd company

3. Name and designation of the person interviewed, educational qualification. Male/Female

4. Are you aware of the latest developments in the field of quality assurance in seafood in India? YES/NO

5. Do you support quality improvement programme in your company? YES / NO

6. Is the management in your factory give any quality motivating benefits to lower level worker/worker level? YES / NO

7. Is there any motivational techniques prevailing in your factory? YES / NO
If yes, please specify
a. Incentive system
b. Job enrichment
c. Job enlargement
d. Zero defect
e. Quality circle
f. Any other

8. State the nature of incentive system

9. Does this incentive system help to improve the quality and quantity of your product? YES / NO

10. Do you organise any training or awareness programmes to your workers / middle level/ top managers? YES / NO

11. If yes, what is the nature of training implemented?

12. Have you formulated any motivational techniques? YES / NO

13. Have you ever heard` quality circle? YES / NO

14. What is your opinion about quality circle?

15. Are you following this quality circle in your factory? YES / NO

16. Are you interested to implement quality circle in your factory? YES / NO

17. Is there any quality oriented incentive system in your company? YES / NO

18. Do the employees have any promotion scope in your organisation? If yes, at what level ?

19. Is there any job rotation system in your factory ? YES / NO

20. Is there any production- profit linked incentive system in your company ? YES / NO

21. If yes at what percentage at each level?
    Manager level
    Middle level
    Worker level.

22. Are your workers involved in quality improvement programme ? YES / NO

23. Do they express any suggestion for improving quality and quantity of your product? YES / NO

24. Do you consider their suggestion and straight away implement it? YES/NO

25. If the suggestion made is not worthwhile, do you discuss the drawbacks of the same with the workers?

26. What is the nature of employer-employee relation ship in your factory?
    Good
    Satisfactory
    Bad

27. How many employees are there in your factory?, their qualification, age, experience and wage structure

	No	Qualification	Age	Experience	Wage
WORKERS a. Casual b. Contract c. Permanent					
SUPERVISORS a. Contract b. Permanent					
EXECUTIVES					
MANAGERS					
DIRECTORS					

28. Is there any over time system prevailing?, if yes explain

29. Is there exists any trade unions in your factory? If yes, when was it started, and the reason if any for the commencement of these trade unions?

30. How many permanent employees are there in your factory?

31. Mode of recruitment of employees:
    Workers
    Supervisors
    Executives
    Managers

32. Did you experience any strike in your company?, If yes (a) give reasons
    (b) How much days employees went on strike?

33. How did you solve the issue?

34. If there was no strike in your factory, what is the reason?

35. Give details on the shift system in your company

36. Is there any allowance given for night shift employees?

37. Is this work force sufficient or in excess. If so why?

38. How do you balance the number of workers required during slack and peak seasons?

39. Do you usually experience any shortage in the availability of-
    Skilled workers
    Unskilled workers

40. What is the type of communication between top management and workers in your company?

41. If any quality defects reported from buyer countries how will you communicate with subordinates?

42. What are the possible disadvantages encountered by the company due to improper communication between workers and management at different levels?

43. Which type of communication technique is used in your company ?

44. What is the contribution of the employees in improving the quality standards and productivity of the factory?

Middle level

1. Name,
2. Designation,
   Educational qualification,
   Address and
   Family size
3. What do you feel about the attitude of the top management on the quality improvement programme of your company?

4. Are you aware of the latest developments in the quality assurance of seafoods in India and abroad?

If yes, Mention

5. Do you support quality improvement programme in your company?

6. Is there any motivational techniques prevailing in the company?

7. Is there any incentive system followed? YES / NO

8. If yes, Explain, Whether it is production, quality, profit linked incentive system or combined one?

9. Do you have any financial incentive?

   if yes, what are the criteria for getting the incentive?

10. Are you satisfied with your work? YES/NO

11. Are you satisfied with your present salary and perks?

12. Any other additional work entrusted up on you apart from your routine work.

13. Type of recruitment

14. Types of leave availed

15. Type of wage structure

16. Do you participate in the decision making of the factory?

17. What is the turn over of the middle level staff/year?

18. How many workers have resigned, have been dismissed or suspended? State reasons behind that.

19. What is your opinion about entrusting more responsibility to you in improving the quality and productivity of the factory?

20. Are you willing to accept such responsibility?
    If not why?

21. Do you have any job rotation system? YES/NO
    If yes what is your opinion about it?

22. Have you been promoted? If yes from what post to which post?

23. Do you have adequate rest room facility? YES/NO

24. Are you receiving any training from your company? If yes explain the nature of training

25. What are the facilities available for training in your company?

26. What is the type of communication between you and your superiors? Explain the formal and informal methods used. Explain the media and techniques used for

27. What is the type of communication between you and your colleagues? Explain the formal and informal methods used, the media and techniques used for the same

28. What is the type of communication between you and your subordinates? explain the formal or informal methods used, please explain the media and techniques used for it, if any

29. Do you like to contribute your service in the same company? If yes, why? If not, why?

30. Do you feel that job is secured in this factory?

31. What sort of activities in your job gives you most satisfaction?

32. What changes in your opinion, would be needed to make your job more effective?

33. What sort of activities take up a lot of your time, do these please you?

34. How far are you responsible for planning the way to use your time?

35. What proportion of your activities do you have no choice about?

36. What aspects of your work interest you the most, which the least?

37. Do you often come under pressure for quick results? Where does the pressure come from? How do you react?

38. How are your standards of performance set, by whom?

39. How do you get feed back on the results of your work?

40. How and by when does the work, your are doing, get stopped?

41. Do you find yourself working very much in committees?

42. Do you have much to do with union or staff association?

43. Do you find the job different from what you are expecting?

44. Has any job you have been involved, which failed to reach completion because of lack of technical knowledge in someone else's part

45. Do you feel that your skills are inadequately used in your company?

46. Where do you see your career going over the next year, next five years?

47. What training do you have? Do you remember any training as particularly useful, or useless, why?

Floor level

Name,

Designation,

Qualification,

Address, and

Family size

1. Attitude of the top management about the quality improvement programme of your company

2. Are you aware of the latest development in the quality assurance programme in India? If yes, please mention
3. Do you support quality improvement programme in your company?

4. Is there any motivational technique in your company?

5. Is there any incentive system in your company? YES / NO

6. If yes, please explain, is it production or quality or profit incentive or a combined one?

7. On what basis do you get your incentive?

8. Are you satisfied with your work? YES / NO

9. What are your duties in your company?

10. Any other work you are doing in addition to your work? YES / NO

11. Type of recruitment, please explain briefly

12. Type of leave available

13. Type of pay structure

14. Type of participation in decision making in your company

15. What is the turn over of workers per year?

16. How many workers have resigned, dismissed or suspended and what is the reason for that?

17. What is your opinion about giving more responsibility to you in improving quality and productivity of the factory?

18. Will you accept such responsibility or not, if you are willing to accept, what is the reason?

19. Do you have any job rotation system? YES / NO

20. If yes what is your opinion about it, if not, is it enough?

21. Do you have job promotion? If yes please explain

22. Do you have adequate rest room facility? YES/NO

23 Are you get any training from your company? YES/NO

24. If yes, explain the nature of training

25. What are the facilities available in your company?

[redacted]

c. [redacted]
d. canteen
e. education facility for children

26. What is the type of communication between you and your superiors? Explain the formal and informal methods used. Explain the media and techniques used for

27. What is the type of communication between you and your colleagues? Explain the formal and informal methods used, the media and techniques used for the same, please explain

28. All the time are you doing the same job? YES / NO., If yes, do you like it?

29. Do you like your job?

30. Do you like to work in the company till you retire; if yes, why? if not, why?

31. What do you feel about job security in this factory?

32. What sort of things in your job gives you most satisfaction?

33. What changes, in your opinion, would be needed to make your job more effective?

34. What sort of activities take up a lot of your time, does these please you?

35. Are you responsible for planning the way to use your time, if yes, to what extent?

36. Which aspects of your work is most interesting, which the least?

37. Do you often come under pressure for quick results, where does the pressure come from, how do you react?

38. How are your standards of performance set, by whom?

39. How do you get feed back on the results of your work?

40. How and by when does the work, you are doing, get stopped?

41. Do you find yourself working very much in committees?

42. Do you have much to do with union or staff association?

43. Do you find the job different from what you are expecting?

44. Has any job which you have been involved, failed to reach completion because of lack of technical knowledge in someone else's part

45. Do you feel that your skills are inadequately used?

46. Where do you see your career going over the next year, next five years?

47. What training do you have? Do you remember any training as particularly useful, or useless, why?