KANTOR MENTERI NEGARA URUSAN PANGAN
REPUBLIK INDONESIA

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PRELIMINARY PLANT DESIGN AND ECONOMIC EVALUATION FOR TEMPE AND TEMPE-LIKE PRODUCTION

By
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For
Legume Products Development Center (LPDC),
State Ministry of Food Affairs,
Republic of Indonesia.

Kantor Menteri Negara Urusan Pangan
Republik Indonesia,
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1995

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(FTI-Unpar)

Letter of Transmittal

Sir :

We have the honor to transmit herewith the Report of the Preliminary Plant Design and Economic Evaluation for Tempe Production held in the Faculty of Industrial Technology - Unpar from April to May 1995.

Accept, Sir, the assurance of our highest consideration.

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Preface

Protein-Calorie-Malnutrition is still a major problem in South-South Countries. This is due to both lack of quantity and quality resulting from high costs of protein-rich foods, methods of processing and food habits and also attitudes. However, the basic causes are property in equitable distribution of income and resources, low food industries productivity and high population growth rate.

Those conditions could be realized using and effective short term solution is to increase small scale food industry productivity using training in pilot plant of tempe which it has high protein, low cost food, produced from locally available and abundant raw materials of soybean and legumes.

The south-south countries should consider having a pilot plant project of Tempe and Tempe-Like products that support the improvement and development of small scale industries as a part of training and technology transfer. This pilot plant of Tempe with a capacity of 1 - 3 tonnes soybean per day in Bekasi has proposed a project on food technology to be supported by JICA. This pilot plant of Tempe should be directed towards the development of small scale industries in south-south countries rather than for the purpose of supporting the development of large multinationals who are already self-sufficient. This pilot plant of Tempe which could encourage the development of small food industries which will become the nucleus of large industries in the future and also the renewable frontier of the future food not only in south-south countries but also in developed countries. This I believe will generate gainful employment as well as providing added value to the products that are processed. In conclusion, on behalf of plant design of Tempe production team, I would like to express our appreciation to the JICA and the Government of Japan for arrangements made for the assistance.

Sincerely yours

Prof.Dr.Ir. Ign. Suharto

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Abstract

It is one of the future challenges of solid substrate fermentation of soybean to establish Legumes Product Development Center which are based on total quality system and iso 9000 with ecologically sustainable techniques. Furthernore, Tempe cuisine has been consumed by Mataram people in the 1600's, so that Tempe might be developed long before that time. Technology of Tempe was inherited by Javanese people and closely related with their food habits, attitude and culture. Now, Tempe is very well known in whole country and it has been known and distributed all over the world. The objectives of this preliminary plant design of Tempe production are to study basic principles, procedures and techno-economic analysis involved in the development of a small scale Tempe industry with a capacity of 240 kg to 3,000 kg soybean per day and also to set-up a training center of solid substrate fermentation of legumes and soybean for the benefit of low income group people in south-south countries.

The method used in this preparation of preliminary plant design of Tempe production is derived from the first and secondary data of national survey on soybean and techno-economic analysis.

The results of preliminary plant design of small scale industry of Tempe according to total quality system which is not compete with the traditional Tempe factory are as follows (1). international trade of Tempe is expected to be increasingly based on government - to - government certification that Tempe has been produced according to the codex alimentarius, ISO 9000, general manufacturing practice, total quality and Tempe is safe for human consumtion, (2) Total capital investment of Yen 40,088,800; total investment equipment of Yen 26,400,000, manufacturing cost of Yen 53,286,960; working capital of Yen 4,008,800; sales revenue of Tempe of Yen 63,360,000; engineering, supervision and trial-run fees of Yen 7,680,000; pay out time is 4,25 years before taxes; 5,08 years after taxes; Break even sales per production volume is 650 tonnes Tempe per year or 1,2 tonnes soybean capacity per day, Break even sales is Yen 14,035,576; profit is Yen 6,797,500 before taxes and Yen 5,258,250 after taxes. The sensitivity analysis of Tempe production with a capacity of 1 - 3 tonnes soybean per day indicates that this project is not influenced to the existing small scale Tempe industries under KOPTI in Indonesia. The break even analysis also indicated that the project has a wide range of profitability not only direct profit but also economic justified and economic viability, technically feasible, socially desirable and social justice and ecological soundness, especially to overcome poverty in south-south countries.

Preparation of Tempe inoculum at a semi pilot plant of 250 kg inoculum per day with total capital investment of Yen 4,605,600; total investment equipment of Yen 2,500,000; manufacturing cost of Yen 4,720,000; working capital of Yen 460,000; engineering, supervision and trial-run fees of Yen 812,500; pay out time is 4,5 years before taxes; 5 years after taxes; Break even sales per production volume is 69,090 kg Tempe inoculum per year or 230 Kg Tempe inoculum capacity per day, Break even sales is Yen 6,909,000; profit is Yen 572,000 per year.

Part I

INTRODUCTION

I. Background Information

I.1. A Future Challenge

Diversification of food consumption pattern is one of efforts to reach health for all by the year 2020. Therefore, there will be needed several food consumption patterns such as fresh food, preserved food and ready to eat. All of theses foods can make contribution to combating "Protein-Calorie-Malnutrition" (PCM) problems. Protein Calorie Malnutrition can be seen at the children between 6 months to 5 years and pregnant woman. Children between 6 months to 5 years is about 33% of the total population and the under Protein-Calorie-Malnutrition followed by 33% of those children under lack of nutritional status and 14% of baby has body weight less than 2,500 gram. Therefore, children between 6 months and 5 years at the exponential growth rate for the future generation has to be added by additional high protein rich foods. South-south nations have a similar way of life and conditions. Legumes and soybean can grow well in south-south countries and these commodities using appropriate technology can be produced miracle protein rich food of many uses.

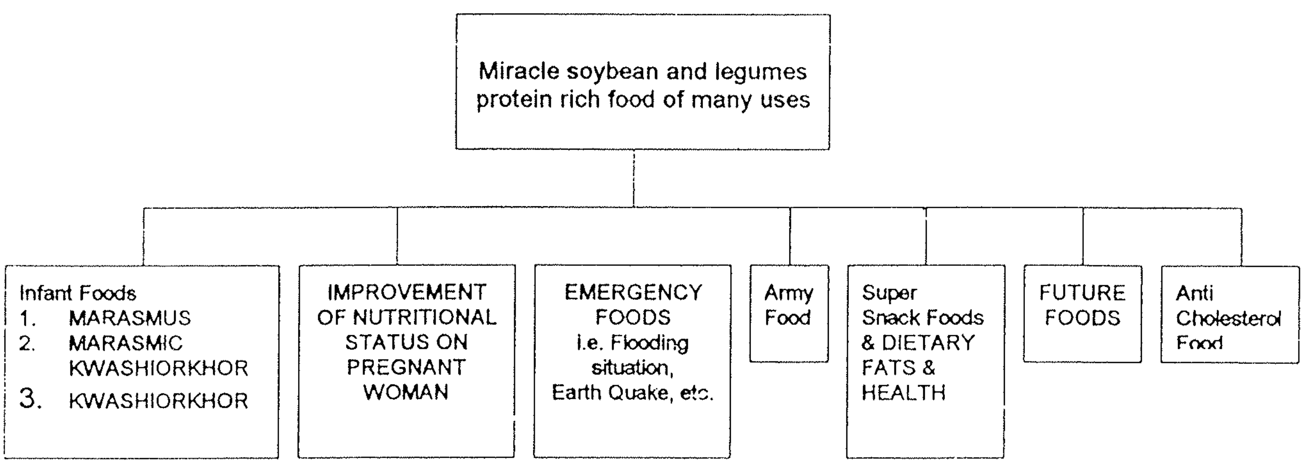

Figure 1 : Future Food of Fermented Soybean and Other Legumes

Biotechnological approaches in the traditional fermented foods has become very useful and popular approaches. Thus, biochemical engineering takes part in the fundamental substrate fermentation together with bioprocess of food development. Indeed, bioprocess should be developed faster when biochemical engineers jointthe research from the initial stage. Biotechnological approaches are made on the contribution of biochemical engineering from the transfer of research results at a laboratory into pilot plant scales and finally to commercial scale. This is very useful and important to improve all aspects of small and medium sized in order to obtain high standardized traditional food products for domestic and international markets.

The relationship among legumes resources, biotechnology, food industry, environment and human resources are not only bringing significant advances to economic growth but also the improvement of the quality life for mankind

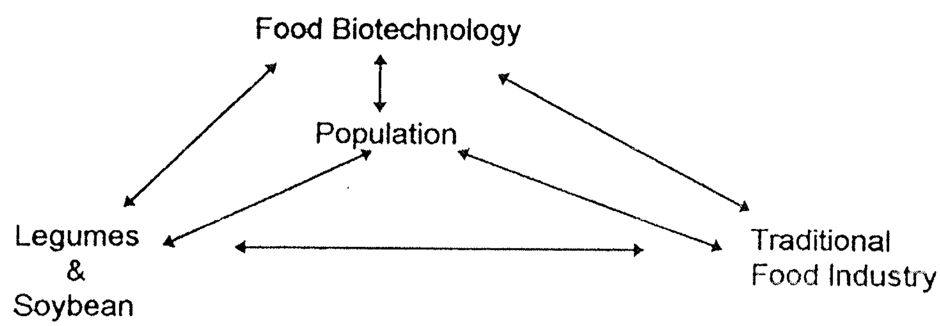

Figure 2 : The Population Triangle

Figure 2 shows that the improvement in any one area depend on improvements in the other two. That means there are strong interrelationship among various phenomena surrounding population, legumes, traditional food industry. Therefore, it is not sufficient to identify and understand, but it is essential to look at the full picture in a holistic way. Traditional food industry such as fermented soybean or Tempe is small sized but small sized is essential to developed and it is very dynamic traditional food industry, therefore, there will be needed cooperation for competition in order to obtain a better price of traditional food products.

1) Substrates

Legumes such as soybean, redbean (Phaseolus vulgaris), wingbean, can be used for single substrate or mixed substrate, because these legumes have chemical properties, pH value, density and hardness. Legumes can be divided into four groups, namely :

(1). Legumes which has been utilized, cultivated and developed as intensive as possible in the traditional fermented foods such as rice, soybean.

(2). Legumes which has been utilized, cultivated but it is not yet developed such as food waste materials

(3). Legumes which has been known and utilized but it is yet cultivated

(4). Legumes which hasn't been known its benefit.

2) Microorganism

Various types of microorganisms produce large amount of enzymes such as proteases, carbohydrates, lipases, and others. *Rhizopus oligosporus, Rhizopus oryzae, Aspergilus oryzae, Saccharomyces cerevisiae, Saccharomyces rouxii, Leuconostoc species, Clamydomucor oryzae, Neurospora sitophyla, Neurospora monilia*, etc. are microbial wellknown in biochemical genetics. Those microorganisms can be used for the solid substrate fermentation to produce fermented foods.

3) Economic Liberalization

The Impact of economic liberalization in 2020 to the development of science and technology in the food industry can be seen in the combination of productivities in food industry. The higher the capabilities of science and technology by the human resource development, the higher the combination of productivities in the food industry. In 2020, there are a lot of number of people living in south-south countries in slums and shanty towns is rising, not falling. A growing number lack access to high protein rich food and clean water. There is some progress but, on balance, property presists and its victims multiply. Natural resources is a development is increasing. There is a gap between natural resources and human resources at the level of low income group people so that the pressure of property has to be seen in a broader context. At the international level there are large differences in per capita income in north and south countries. In this situation, inequalities represent great differences not only in the equality of life today, but also in the capacity of societies in south and south countries to improve their quality of life in the future. in most of south and south countries depend for increasing export earnings or tropical agricultural products that are vulnerable to fluctuating or declining term of trade.

products that are vulnerable to fluctuating or declining term of trade. These pressures are reflected in the rising incidence of gap between industrial sector and training centers institutes and also higher education.

At present, malnutrition is still a major problem in south-south countries. This is due to both lack of quantity and quality resulting from high cost of protein foods, methods of processing, eating and food habits and also attitude. However, the first and main problems are property inequitable distribution of income and natural resources, low food industry productivities and high population growth. It is realized that an effective short term solution is the development of high protein, low cost foods, produced from locally available of raw materials such as legumes, and soybean.

1.2. The Development of Low Cost Protein Food

Food and nutrition is a very important part of the south-south countries programmes that south-south countries should consider together to support other development activities. This view is held, bearing in mind that majority of south-south countries populations are very young and the new generation of the south-south countries will have to be provided with sufficient food and improved nutrition. The training centers of Legumes Product Development Center (LPDC) in Bekasi-Jakarta is indeed very encouraging the production and consumption of the different types of indigenous fermented and non-fermented foods from legumes and soybean. At present, in Indonesia, there are approximately 100,000 small scales food industries. These small scale factories and concerns are those that manufacture fermented soybean (tempe) and soy sauce. The training centre LPDC should be directed towards the problems of small scale food industries south-south countries so that the new food industries and the existing food industries will be improved according to the ISO 9000 regulation and also to ensure that the quality of the traditional tempe will achieve sufficient consumers satisfaction at international market and will not pose health hazard to the consumers.

Solid substrate fermentation is a well-known process in Indonesia. The study of substrate, microorganisms process conditions and appropriate biotechnology have been studied that will generate income for manufactures and the same time providing their families with a safe.

2. The Objectives

A. Laboratory Scale

The objectives of the study are :

1. To use agar plating to search for better strains of *Rhizopus oligosporus* and *Rhizopus oryzae* and other strains which grow on given a soybean and other legumes at a Laboratory scale and a commercial scale.
2. To use the optimal conditions of solid substrate fermentation at a laboratory scale into commercial scale.
3. To study the isolation and identification of strain, substrate, product at a laboratory scale and to study economic check to transfer to commercial scale.

B. Pilot Plant Scale

The objectives of this pilot plant are the carry-out training and trials at this pilot plant to overcome technical problems, quality control at production site with emphasizing quality control and sanitation in accordance with the food laws and regulations of the country. And also introducing proper flow of processing in order to improve productivity, and also introducing more efficient and appropriate technology and new products of fermented soybean.

3. The Goal

The goal of this study is to obtain one unit of pilot plant of Tempe with a capacity of 1 - 3 tonnes soybean per day.

Part II

TRANSFER OF BIOTECHNOLOGY

1. Translation of Laboratory Culture Data To The Production Plant

Solid substrate fermentation is a well-known process in the traditional food industry in Indonesia but some areas of transfer of research problems at a laboratory into commercial scales are a substrate concentration, environmental conditions of microorganisms, such as temperature, relative humidity (RH), Oxygen and pH. These problems of improving the existing traditional processing and developing new fermented food product from the under utilized raw materials are total quality.

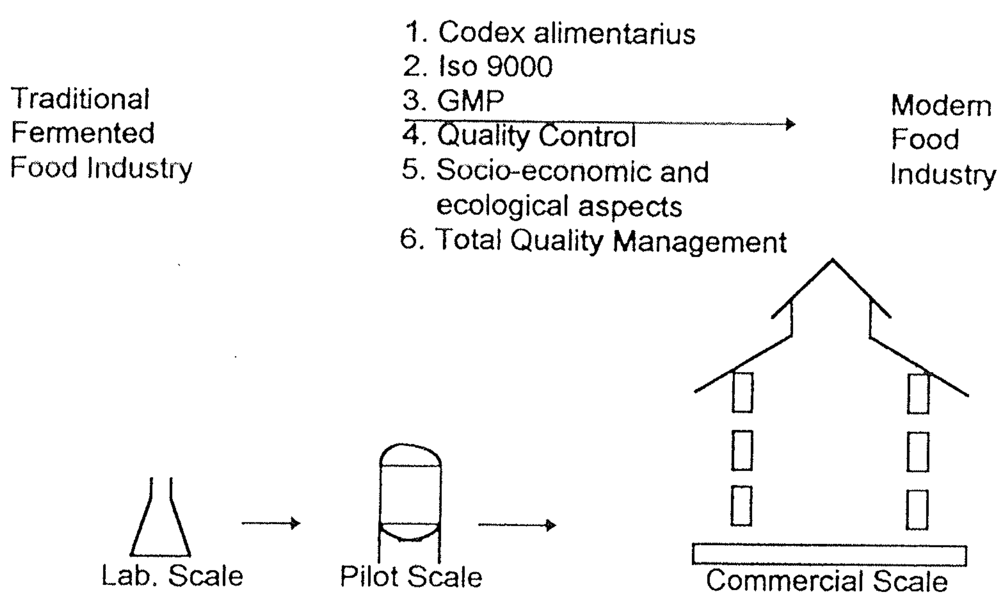

Figure 3 : Translation of Laboratory Into Commercial Scales

Transfer of research results at a laboratory into commercial scales must be considered three different kinds of phenomena, namely :

- thermodynamic phenomena (scale-independent)
- micro-kinetic phenomena (scale-independent)
- transport phenomena (scale-independent)

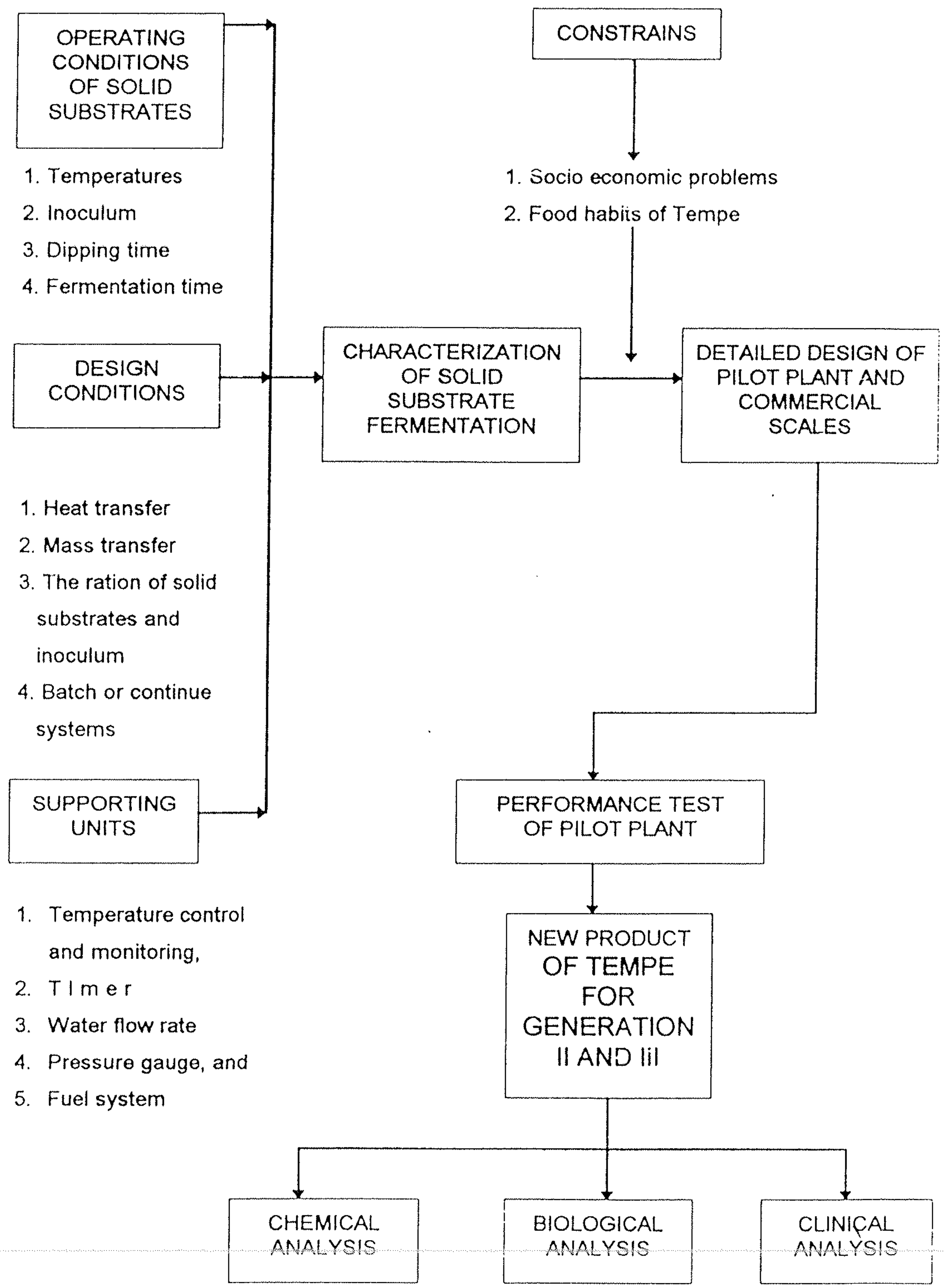

Figure 4 : Procedure of the Equipment Design from pilot plant into commercial scales, at Bekasi - West Java

Framework For Technology Transfer In South-South Countries.

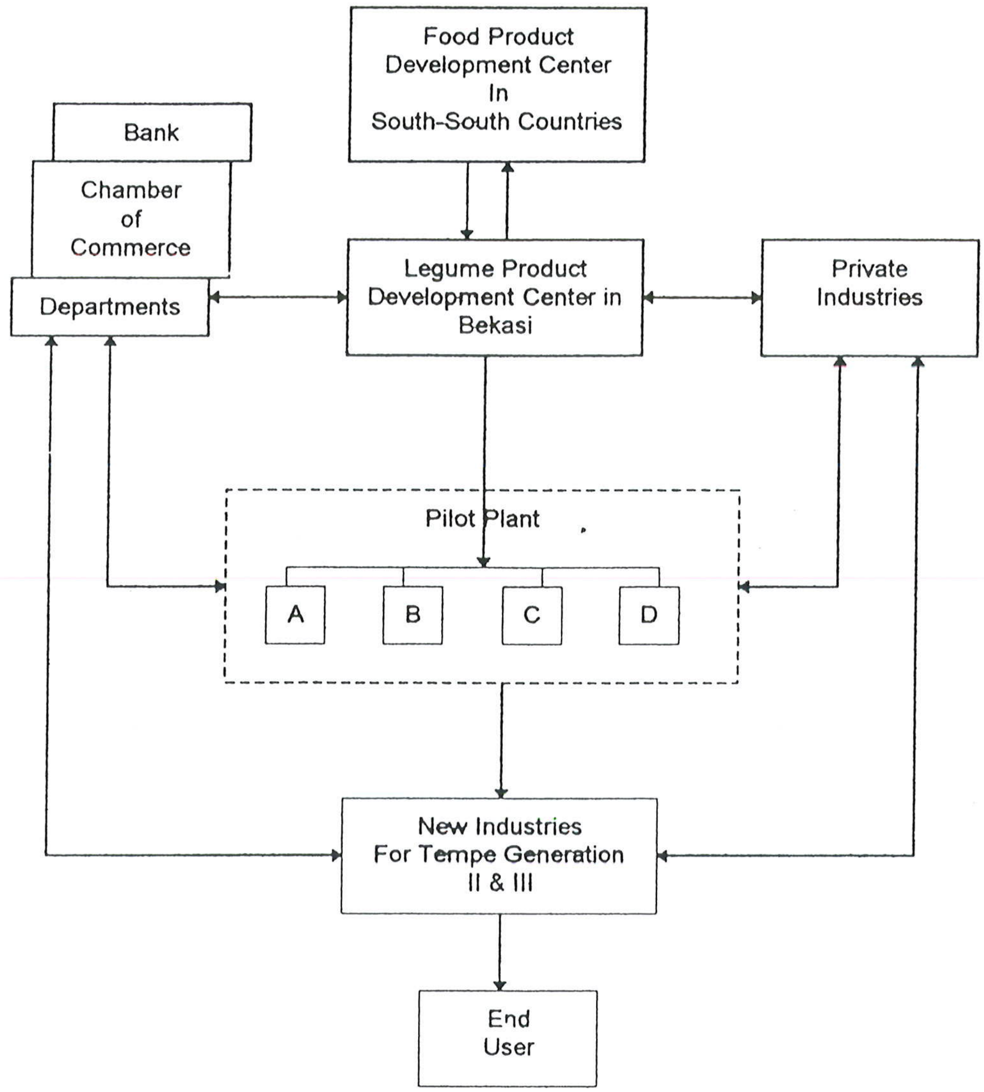

Figure 5 : Framework For Biotechnology Transfer In Solid Substrate Fermentation

Due to those conditions, the understanding productivity must be improved in south-south countries lack knowledge, expertise and resources for improving productivity. There are low in per capita income and standard of living, inflationary pressures, problems association with protein-calorie-malnutrition, all of these cause serious concern and force south-south nations to resort to improving productivity. The improvement of productivity will be reduced in inflation, increase in employment and also to combat protein-calorie-malnutrition problems. The term productivity means different things to different people - more output while maintaining cost; doing the right thing; working smarter and harder; faster output.

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

2. Development of Fermented Soybean (Tempe)

1. Research and Development at a Laboratory Scale

⇓

2. Pilot Plant of Food Product Development

⇓

3. Commercial Scale

In order to transfer biotechnology from laboratory to commercial scales, there will be needed a pilot plant which acts as a centre for the dissemination of low cost biotechnology. To do this transfer of biotechnology, there will be needed 3 important areas, viz. :

- Source of biotechnology to be transferred
- Medium for biotechnology transfer
- Recipient of the transfer of biotechnology

Source of biotechnology, medium for transfer and recipient will be discussed as the following.

1) Source of Biotechnology

The main sources of biotechnology are universities and research institutes. Before a process can be transferred to pilot plant and commercial scales have to be considered to determine whether it is suitable for the intended purpose. Evaluation of biotechnology must be developed to the existing conditions and safely be given to commercial stage.

2) Medium For Transfer

There are two methods of transfer :

(1) Indirect transfer, i.e., transfer of technology through industrial training either to universities or research institutes.

(2) Direct transfer, i.e., the research results are directly applied by industry. Criteria which have to be considered when selecting the technology available for transfer to industry are based upon the following :

a. Appropriateness of technology

b. Status of development

c. Total Cost including Rate of Return, etc.

3) Recipient of The Transfer of Technology

The facts that industries will influence the socio-economic milieu in the recipient environments must be taken into consideration.

3. Sanitation of Food Safety and Public Health of Tempe

Sanitation of Tempe production is the key to food safety amd public health aspects. At present, tempe production is still in a traditional way, so that the codex alimentarius ISO 9000 and total quality of Tempe production are essential needed to obtain high quality Tempe at international market. The implementation of an overa all sanitation program combined with the Hazard Analysis and Critical Control Point (HACCP) system, can help to ensure that tempe is produced free of microbial or chemical hazards.

4. Evolution of A Quality System

Tempe is a traditional fermented food therefore it is necessary to increase the total quality of tempe in order to compete in the international market, especially in the year 2020. One of the solutions is to train industrial people to increase the awareness between south and north countries and also the total quality of tempe.

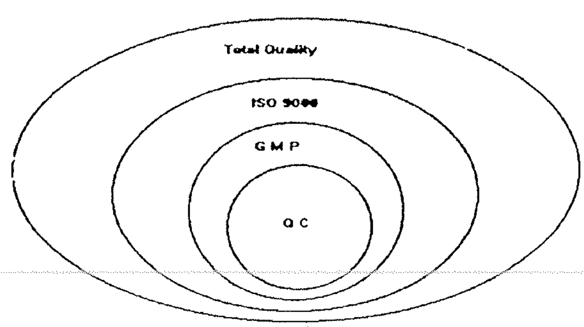

Figure 6 : Evolution of A Quality System

Part III

SOLID SUBSTRATE FERMENTATION

OF

SOYBEAN

I. Fermented Soybean

Soybean or other beans should be cleaned to remove dirt, weed seed and any other matters. Dehulling is essential needed to remove the soybean skin. Soybean is soaked in water in the ratio of 1 : 2 for 4 hours. That single substrate is cooled at room temperature and those substrates are poured into tray. Inoculum of *Rhizopus oligosporus* of 3g is inoculated into those substrate at the trays. Perforated plastic bags filled by those substrates. It is incubated at temperature of 30 °C and 37 °C, respectively. At a certain period of fermentation time, the sample is taken out from incubator for chemical and microbiological analysis.

Soybean
⇓
clean
⇓
wash
⇓
soak for 4 hours
⇓
dehull
⇓
Sterilized at 120 °C for 20 minutes
⇓
cool
⇓
inoculum of *Rhizopus oligosporus* ⇒ inoculated
⇓
wrap
⇓
incubate at 30 °C for 48 - 72 hours
⇓
Fermented Soybean/Tempe

Figure 7 : Flowsheet of Soybean Fermentation

2. Chemical analysis

The sample is analyzed for the pH, water activity and protein. Protein concentration is determined by the methods of Lowry, et al, (1951)[5] and bovine serum albumin is used as standard. Samples of culture broth of 1.5 mL is centrifuged 10,000 rpm for 10 minutes in the temperature of 4 °C in Centrifuge. This protein in supernatant is determined by measuring the Optical Density (OD) at maximum wave length of 610 nm in a Spectrophotometer. The pH value of samples were determined by pH meter.

3. Microbiological Analysis

Rhizopus oligosporus growth is determined by measuring the Optical Density (OD) of culture broth, after diluting appropriately, at maximum wave length of 540 nm in a Spectrophotometer. Total viable cells are determined by Total Plate Count method and cell mass is determined by centrifuged and drying methods.

4. Waste of Soybean Skin

The increased in the economic growth rate which is derived from the increased in industrial development that bad been enjoyed by the developed and developing countries. But the utilization of the natural resources using technology to produce a certain product without referring to the environmental acpectcan produce a group of phenomena a social syndrome - relating to pollution, the contamination of the environment, and the westage and depletion of resources and energy. Therefore, at present the issues of environmental problems are not only in Indonesia but also in the other developed and developing countries. There are strong interrelationship between the several phenomena surrounding pollution, the environment, natural resources and energy, because this is not occurred individually. It is essential to look at the holistic way and in comprehensive way. This social syndrome is closely bound up with the increased in the economic growth rate due to the industrial development. The present decade has been marked by environmental degradation such as waste materials in the environment and also the questions of population problems. The interrelationship among renewable resources, science and technology, industry, environment and human resources are not only bringing significant advances to the economic growth but also the improvement of the quality life for mankind.

Part IV

QUALITY SYSTEM AND SANITATION TOWARDS TEMPE ENGINEERING EQUIPMENT

1. Quality of Tempe and Appropriate Equipment

The global marked for Tempe and Tempe-like products are becoming more competitive and there are a number of factors that will influence the future competitiveness of Indonesian's Tempe Industry and these include :

- Tempe quality
- Tempe and Tempe-like development
- Customer service
- Consumer acceptance and satisfaction
- Sanitation and quality system of Industrial Tempe equipment
- Quality control for inspection testing; General Manufacturing Practice; Iso 9000 for processing, R & D, purchasing; and total quality for marketing sales, finance, and personnel.

This legume products development center in Bekasi is an extremely powerful center to increase national capabilities and also south-south countries capabilities in order to increase the status of Tempe from the traditional way of thinking into modern food industries. These are some items should be considered.

The tempe processing equipment bought from food processing unit vendors are not always designed and constructed according to tempe industry sanitation conditions, it is quite difficult to prevent pathogen microbe growth in soybean materials, therefore sterilization methods using disinfectant is not always effective. One important thing is the discussion and change of experiences among the managers. Common understanding about microbiology principles should be known and understood through all of tempe processing units. The prevention efforts of pathogen microbial growth i.e.:

1) The design and construction of tempe processing equipment manufacturing must follow sanitation principles in food industries. Inappropriate design and construction in food processing equipment, including imperfect welding and

using inappropriate conveyor, will result a pathogen microbe contaminant disaster.

2) Education and training manager and employees about microbial growth principles in tempe industry. Maintenance training, such as welding quality in piping system maintenance, should be conducted.

3) Cleaning and sanitation training for employees to give better understanding about the areas where pathogen microbe might be growth and training about pathogen microbe growth in the areas with less sanitation are very recommended.

4) Environmental monitoring for critical areas where the pathogen microbe could be growth. Checking and monitoring of where water is available, wet products remain, and food industry equipment where pathogen microbial could be growth. Taking the sample to observe the existence of pathogen microbe including microbiology test as the amount of E. coli microbe and molds.

5) Cleaning in place monitoring need to be conducted for monitoring detergent flow velocity, temperature, and tempe processing equipment cleaning operations conductivity. This CIP monitoring usually performed in tempe industry. The flow velocity unit, conductivity and temperature could be controlled by computers. CIP monitoring system in tempe industry could be done by using 2 or 3 circulating tank.

6) Sediment and corrosion prevention effort in boiler is part of the most important maintenance in tempe industry. Cooling water control need to be done to prevent undesired sediment and also microbe growth in the cooling water.

2. Sanitation Control and Water Sources Installation

The sanitation installation needs :

1. Processing water supplier
2. Sanitation and waste disposal installation
3. Plumbing
4. Toilet
5. Hand wash
6. Trash disposal

Water quality needed in tempe industry must meets the drinking water conditions to prevent contaminant in tempe product. Water in tempe industry can be used as washing water, sterilization water, cooling water, steam boiling water, and heating process water.

The water need for food industry and alcoholic drink can be grouped in :

1. Water for general process
2. Process water
3. Cooling water
4. Critical area controlling system.

1) Water for general process

The amount of water used for washing, cleaning and preparation is very big. The water must be clean, not coloured, smell and taste-free, toxic ion-free and bacteriologically accepted.

2) Processing Water

The amount of processing water need depend on the type of process. The water softening is needed to remove the brine that could cause texture change in tempe and have possibilities to form sediment in heat exchanger.

3) Cooling water

The quality of cooling water must not be contaminated. Decolorization, make it smell and taste-free, are important to prevent the formation of sediment. Re-use of cooling water is very recommended after it has been observed that the water is not contaminated.

4) Critical Area Controlling System

The hardness of water must be removed to prevent sediment. For tempe industry, sanitation control, the integration between employee, food processing material installation and tight control of soybean and soybean supplier are necessary. Beside this, it is necessary to introduce "Hazard Analysis Critical Control Point" (HACCP) that can give information about the systematical procedure to know and monitor the possibilities of microbe, chemical and physical contaminants source to tempe makers. The HACCP programmes also giving the knowledge about the systematical procedure of tempe process evaluation and tempe distribution. Controlling temperature, pH, viscosity and time must be done in the right way. Sanitation control is performed by tempe production supervisor by in-place evaluation. The key of sanitation control are inspection of tempe factory environment, factory building construction and factory building site. Tempe industry equipment must be inspected and observed periodically to increase tempe factory sanitation as also the supporting units such as water supplier, soybean skin disposal installation.

5) Ground Water

The ground water is very delicate to human disposal, animal disposal and industrial waste contaminant. The ground water usually has dark colour, contains minerals, organic compounds, pathogen microbes and smell bad.

Therefore the ground water that will be used for food processing need more treatment. The type of contaminants in the ground water are

1. Suspended solid
2. Microorganism
3. Organic compound like color, smell and taste
4. Dissolved minerals
5. Fe and Mn
6. Dissolved gas

6) Suspended solid removal

The ground water that contains suspende solid is water contaminant that need to be removed. Suspende solid in ground water is consist of big size to very small size particles. Big size particles can be removed by sedimentation, as the small size particles or colloid can be removed by coagulation. Therefore, beside of sedimentation, the flocculation and coagulation are also needed.

(1) Sedimentation

The sedimentation can be conducted to some amount of water in the reservoir tank and let it there for several times until suspensioned solid material can be settled by gravity.

(2) Coagulation

Coagulation materials addition will settle the small particles. Coagulant materials used are :

- Aluminum Sulfate $Al_2(SO_4)_3 . 14H_2O$
- Ferrosulphate $FeSO_4 . 7H_2O$
- Ferri Chloride $FeCl_3$
- Natrium Carbonate Na_2CO_3

The chemical reaction is as follow :

Aluminum sulfate salt reacts with water :

$$Al_2(SO_4)_3 + H_2O \rightarrow 2\ Al\ (OH)_3 + 3H_2SO_4$$

$$3H_2SO_4 + 3Ca(HCO_3)_2 \rightarrow 3CaSO_4 + 6H_2CO_3$$

$$6H_2CO_3 \longrightarrow 6CO_2 + 6H_2O$$

$$Al_2(SO_4)_3 + 3Ca(HCO_3)_2 \rightarrow 2\ Al\ (OH)_3 + 3CaSO_4 + 6CO_2$$

The Al(OH)3 solubility depends on the pH value between 5 to 7,5 while ferri salt can coagulate at pH value 4,5 and ferro salt can coagulate at pH value 9,5. The combination between sedimentation and coagulation can give small particle separation in short time.

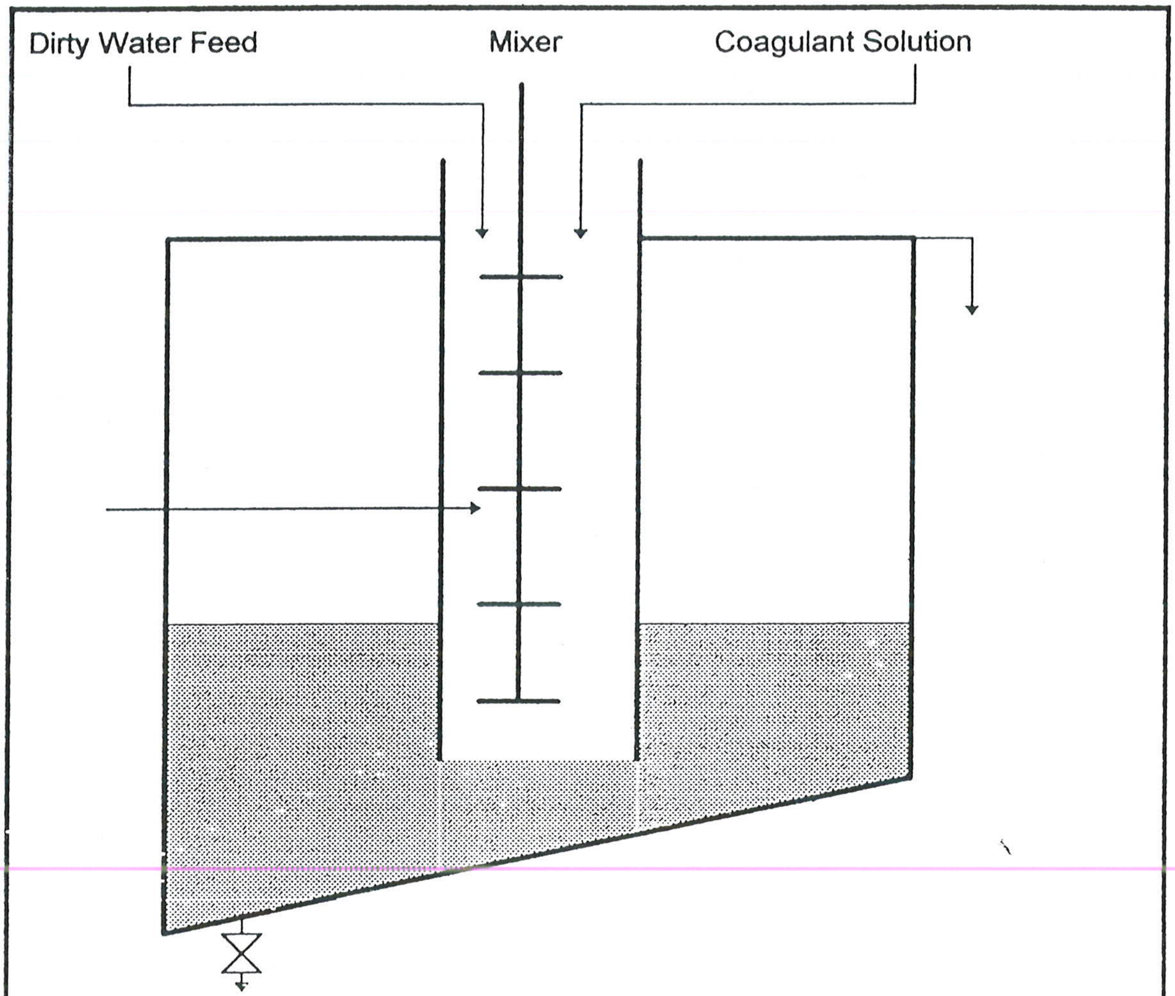

Figure 8: Water Flocculation Tank

7) Filtering

The type of water filtering used in tempe industry is pressurized Sand Filter, Multi Media Filter and the other pressurized filter in order that all suspended solid substance remain can be removed. Sand filter capacity is about 0,5 m3 water per minute per m2 area of sand filter. High pressure sand filter tank of blanching water is 2 m3 water per minute per m2 sand area.

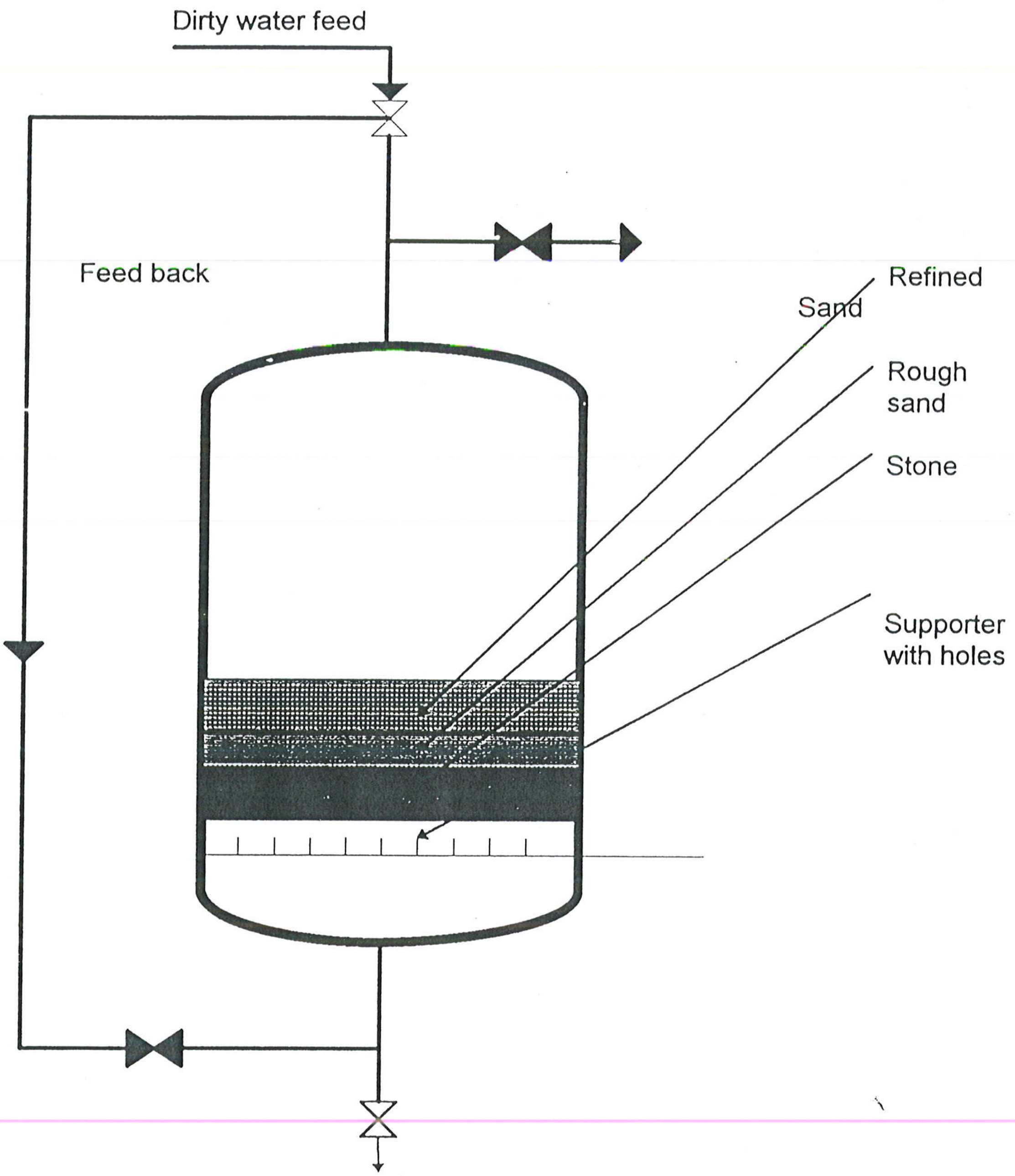

Figure 9 : Pressurized Sand Filter for Water

8) Microorganism

Microorganism like diatom, algae, protozoa, rotifera, nematodes and various non-pathogen bacteria, pathogen bacteria in ground water, need to be removed. If these are not removed, it will affect colour, taste and smell in equipment and food materials and also the existence of pathogen bacteria will defect food materials and cause food material poisoned.

Contaminant microorganism can be removed by sterilization with chemicals like chlorine and chlorine dioxide. Some factors that can influence chemical sterilization are :

(1) Chlorine and Chlorine dioxide concentration
(2) Time of reaction
(3) Temperature
(4) Value of pH
(5) The amount of organic compound in the water

The amount of chlorine needed for perfect reaction called chlorine demand. The reaction between chlorine and water is as follow :

$$Cl_2 + H_2O \rightleftharpoons HOCl + HCl$$

Hipochlorite acid reacts with NH3

$$HOCl + NH_3 \longrightarrow NHCl + H_2O$$

$$2\ HOCl + NH_3 \longrightarrow NHCl_2 + 2H_2O$$

The bigger the amount of chlorine used, the bigger the chlorine residue. This is because chlorine is absorbed by organic compound and the formation of chloramine. The addition of chlorine cause chloramine oxidation and the residue of chlorine will grow bigger.

The condition where chlorine concentration is minimum is called "*break point*". The chlorine "*break point*" means that the amount of chlorine residue is minimum but all types of microorganism has been exterminated without leaving taste and smell in the water. Beside this, the chlorinating "*breaking point*" can oxidize all organic compounds, iron, mangan, and another compound residue in the water and also oxidize ammonia in the water.

Chlorinating without filtering can be done effectively if the conditions bellow is met :

- The amount of contaminant microorganism is not too big
- Turbidity and colour in the water are not more than 5 - 10 units
- Iron (Fe) or mangan (Mn) contents in the water is not more than 0,3 mg/ml
- At least 15 minutes contact time between chlorine addition with consumed water.

9) Organic Compound, Colour, Smell and Taste Removal

The ground water that contains organic compound contaminant is muddy and dark coloured. The water dark colour is caused by the existence of colloidal suspension from ultra microscopic particles and also the existence of iron and mangan. Fish smell and taste is caused by the existence of iron (Fe) in the water and also the existence of dead algae, dead microorganism, leaves decomposition, and the growth of molds in the water. These contaminants are undesired in tempe industry. Therefore the efforts to remove undesired smell and taste in the water, as follows, is needed:

- Flowing air (aeration) in to the water
- Combined treatment between coagulation, sedimentation and filtering
- Chlorinating and super-chlorinating
- Active carbon treatment
- Oxidation treatment by ozone

10) Dissolved Minerals Removal

All nature water contains water soluble minerals like sulfate, chloride, natrium carbonate, magnesium, iron, flour, silica, nitrate and radio-active waste. The treatment for dissolved minerals in water removal are as follow :

11) Alkalinity

Almost all water have alkaline property due to the existence of dissolved compound like $Ca(HCO_3)$, $MgCO_3$, Na_2CO_3 and K_2CO_3. Alkalinity can be determined by acid and alkaline volumetric titration with phenolphthalein and methyl-orange indicator.

$$Ca(HCO_3) + Ca(OH)_2 \rightarrow 2\ CaCO_3 + 2\ H_2O$$

$$Na_2CO_3 + CaCl_2 \rightarrow CaCO_3 + 2\ NaCl$$

$$Na_2CO_3 + CaSO_4 \rightarrow CaCO_3 + Na_2SO_4$$

If water alkalinity is low then this water is very appropriate for mineral water, beer industry, and also appropriate for boiler water.

12) The Hardness of Water

The influence the hardness of water in tempe industry will give negative impact to Tempe processing.

13) Water Softening

Water softening can be conducted by :

- Sedimentation
- Cation exchange
- Demineralization

14) Sedimentation

Water with high hardness level is added with Calcium Hydroxide and Natrium Carbonate. Reaction occurred is as follow :

$$Ca(HCO_3) + Ca(OH)_2 \rightarrow 2CaCO_3 + 2H_2O$$

$$Mg(HCO_3)_2 + Ca(OH)_2 \rightarrow MgCO_3 + CaCO_3 + H_2O$$

In this reaction, calcium hydroxide transfers temporary hardness of water while Natrium Carbonate salt removes the permanent hardness of water.

$$CaSO_4 + Na_2CO_3 \rightarrow CaCO_3 + Na_2SO_4$$

This bicarbonate, sulfate, nitrate, calcium and magnesium can be removed. After that, flocculation, coagulation, sedimentation and filtering processes can be conducted to obtain clean water.

15) Ion Exchange Process

This ion exchange process can be called zeolit process. Nature zeolit can transfers natrium, and calcium, magnesium, iron and mangan ions. The chemical reaction can be written as follow :

$$Ca(HCO3)_2 + Na_2Z \rightarrow 2\ NaHCO_3 + CaZ$$

Water flown down into the plastic tube until Ca and Mg ions exchange with Na in the zeolit. The regeneration of zeolit that has been used several times need to done by washing with clean water and then move the zeolit through the brine. Ca and Mg ions change into chloride form.

The chemical reaction is as follow :

$$CaZ + 2\ NaCl \rightarrow Na_2Z + CaCl_2$$

or

$$MgZ + 2NaCl \rightarrow NaZ + MgCl_2$$

The zeolit can soften water until the hardness of water minimum. Referring the importance of zeolit in water purification, nowadays, the artificial zeolit from hydrogen kation exchange has been developed. The chemical reaction is as follow :

$$CaSO_4 + H_2Z \rightarrow CaZ + H_2SO_4$$

or

$$MgSO_4 + H_2Z \rightarrow MgZ + H_2SO_4$$

16) Demineralization Process

The demineralization process is necessary to obtain the specific use of water.

17) Iron and Mangan Removal

Iron and mangan are always found in the water so they have to be removed suppose that food processing process is not disturbed. Iron and to water piping because they form sediment in the pipe surface and inside the water reservoir tank. These iron and mangan bacteria grow rapidly and produce unpleasant smell. The most appropriate prevention is by flow the air followed by settling and filtering at pH value 8 - 8,5 until bicarbonate occurred.

Mangan can not be oxidized by following the air into but by giving chlorine followed by filtering. Fe and Mn contents more than 0,2 - 0,3 mg/l must be removed.

18) Dissolved Gas in the Water Removal

Nature water always contain carbondioxide, oxygen, nitrogen and hydrogen sulfite. As the organic compound in the water is higher, the carbondioxide contain is also higher. Oxygen and nitrogen source are came from aeration and oxygen is produced by photosynthesis process.

Part V

PLANT LOCATION

The location of pilot plant of Tempe production in Bekasi can have strong influence on the success of an industrial venture. The following factors should be considered in selecting a plant site :

1. **Raw material of legumes and soybean.**

   The capacity of pilot plant of Tempe production 1 - 3 tonnes soybean per day, that means the availability of soybean is not large volumes and there is no problem in transportation and storage.

2. **Markets of Tempe and Tempe-Like Products**

   The location of markets or intermediate distribution centers is surrounding the location of pilot plant, there is no influencing the local market of Tempe. One of Tempe manufactures in Yogyakarta has a capacity of 2-3 tonnes soybean per day, and there is no effect to the local markets.

3. **Energy Availability**

   Power and steam requirements are high in Tempe production and fuel is required to supply these utilities. This location is very close to the electricity installation, because this location is an industrial area.

4. **Climate**

   This pilot plant of Tempe is located in a warm climate, so that there is no additional cost to maintain the temperature around 30 °C to 37 °C.

5. **Transportation Facilities**

   There is a new highway to transport this product and raw material of soybean and others.

6. **Water supply**

   This pilot plants use large quantities of water for soaking, sterilization, steam, washing and as a raw material. Deep wells is made to produce the amount of water.

7. Waste Disposal

Waste material from the pilot plant is soybean skin and waste water. Soybean skin using biotechnological approaches can be used for the production of single cell protein for broiler chicken and others.

8. Labour Supply

The type and supply of labour available in the surrounding of this location.

9. Site Characteristics

This area is very far from flooding area and hurricane damage.

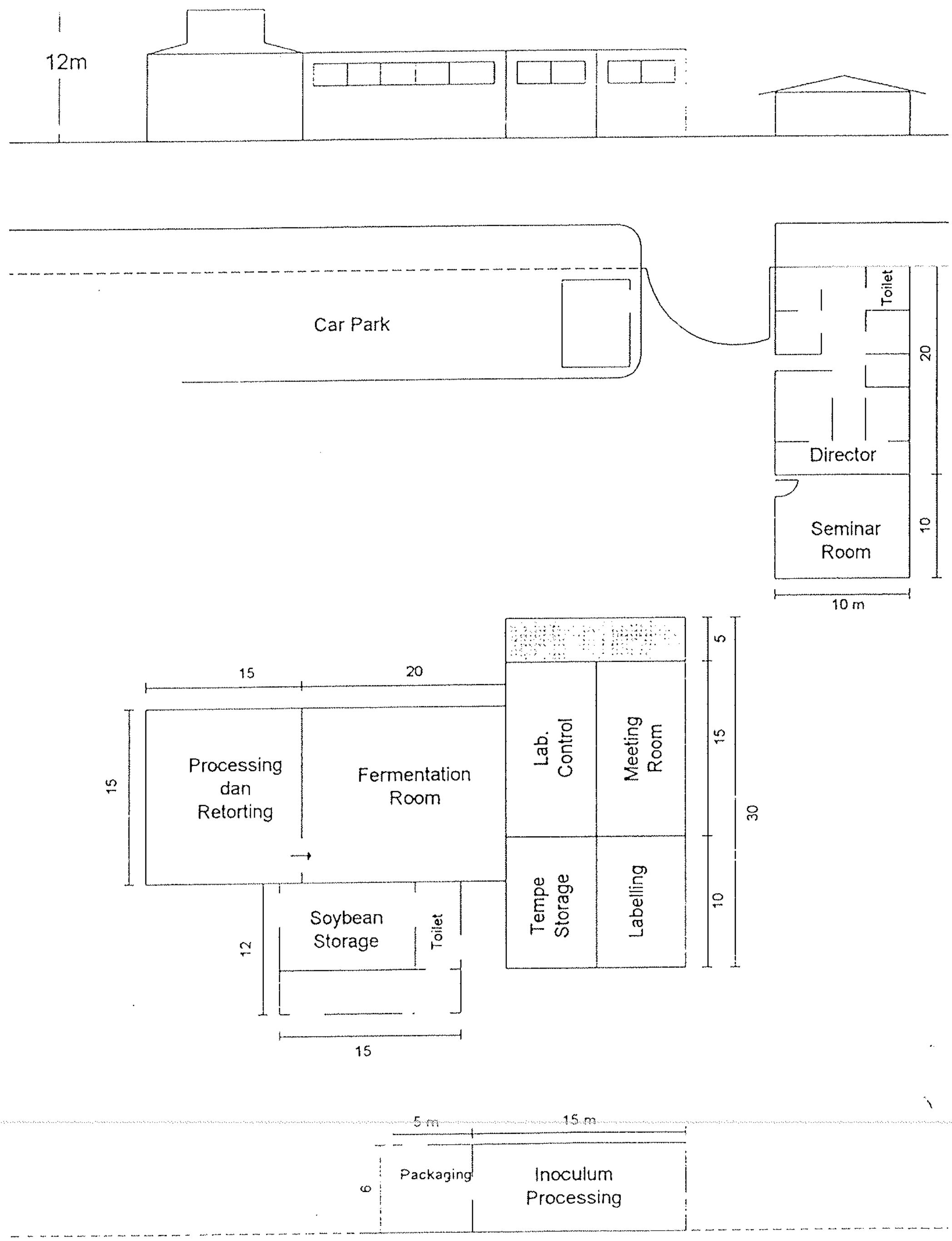

Figure 10 : Site Characteristic

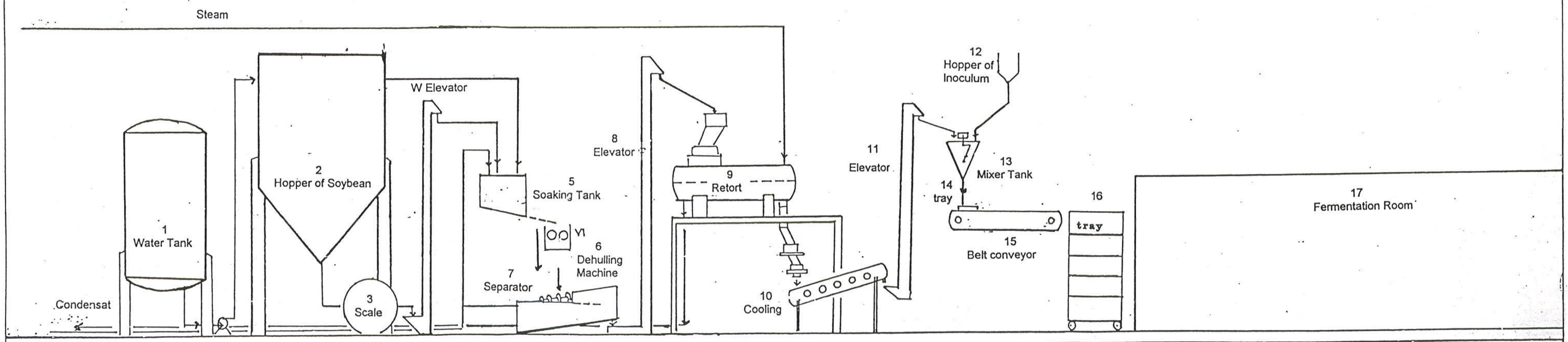

Figure 11: Qualitative Flow Diagram of Fermented Soybean (TEMPE)

PART VII

COST ESTIMATION

1. Purchased Equipment

No.	Item		Amount	Total
1.	Sorting and Grading of soybean capacity : 250 kg/hour			
	1.1. Recieving Hopper	: Yen	300,000	
	1.2. Elevator (5 M)	: Yen	700,000	
2.	Water storage tanks, 10 M^3/day	: Yen	1,000,000	
3.	Technical balance, 1 unit	; Yen	400,000	
4.	Soaking vessel, 9 units @ 0,5 M^3	: Yen	200,000	
5.	Dehulling machine, 3 units	: Yen	200,000	
6.	Separator, 3 units	: Yen	2,000,000	
7.	Retort, 3 units	: Yen	6,000,000	
8.	Cooling unit, 3 units (complete with cooling belt conveyor)	: Yen	3,700,000	
9.	Inoculum Hopper, 3 units	: Yen	200,000	
10.	Mixer tank, 3 units	: Yen	600,000	
11.	Container or trays	: Yen	600,000	
12.	Fermentation chamber	: Yen	2,000,000	
13.	Air conditioner	: Yen	1,000,000	
14.	Stem and cooling piping	: Yen	1,000,000	
15.	Packaging Machine with labelling	: Yen	2,000,000	
16.	Water treatment, piping and centrifugal pumps	: Yen	3,000,000	
17.	Compressor, 1 unit	: Yen	500,000	
18.	Elevator, 3 M, 2 units	: Yen	1,000,000	+
	Purchased equipment	:		Yen 26,400,000

2. Total Capital Investment (TCI)

TCI = Fixed-Capital Investment + Working Capital

1. Direct Costs = Material + Labour + Installaton			
1.1. Purchased equipment	: Yen	26,400,000	
1.2. Purchased equipment Instalation, piping, Insulation, painting, electrical instalation	: Yen	2,000,000	+
Direct costs	:		Yen 28,400,000
2. Indirect Costs			
2.1. Engineering and supervision 20 % of direct costs	: Yen	5,680,000	
2.2. Trial - run	: Yen	2,000,000	+
Indirect costs	:		Yen 7,680,000
3. Fixed capital investment	: Yen	36,080,000	
4. Working Capital (10 % of total capital investment)	: Yen	4,008,800	+
Total Capital Investment	:		Yen 40,088,800

3. Total Product Costs

1. Manufacturing Cost (MC)

MC = Direct production costs + Fixed charged + Plant overhead costs.

1.1. Direct production costs

1. Raw materials (soybean + inoculum)	: Yen 38,844,000		
2. Operating /Labour	: Yen 2,937,600		
3. Utilituies (10 % no. 1)	: Yen 3,884,400		
4. Maintenance (2 % E)	: Yen 528,000		
5. Lab. charges	: Yen 2,000,000		+
Sub-Total	:	Yen 48,194,000	

1.2. Fixed charged/year

1. Depreciation (10 % fixed capital investment for equipment)	: Yen 2,640,000		
2. Local taxes (1 % of fixed capital investment)	: Yen 360,080		
3. Insurance (1 % of FCI)	: Yen 360,080		+
Sub-total	:	Yen 3,360,160	

1.3. Plant Overhead Costs

50 % of (Operating Labour + Maintenance)	:	Yen 1,732,800	+
Manufacturing costs	:	Yen 53,286,960	

2. General Expenses

1. Administration costs (15 % of op. labour + maintenance)	: Yen 519,840		
2. Selling Costs	: Yen 400,000		
3. Research and Development	: Yen 2,355,600		+
General Expenses	:	Yen 3,275,440	

3. Total Product Cost

Total product costs = manufacturing costs + general expenses

: 53,286,960 + 3,275,440

: Yen 56,562,500

TOTAL INCOME : 1,440 Tonnes Tempe	: Yen 63,360,000
Total Product Cost	: Yen 56,562,500 –

4. Gross earnings (Profit) : Yen 6,797,500

4. Pay-Out-Time

(Pay-Out-Time (POT) Before Income Taxes

$$POT = \frac{\text{Total Capital Investment}}{\text{Profit} + \text{Depreciation}} = \frac{40{,}088{,}800}{6{,}797{,}500 + 2{,}640{,}000} = 4.25 \text{ Years}$$

5. **Taxes**

   1. Profit Up to Rp. 25,000,000
      Taxes = 10 % (Yen 1,000,000) = Yen 100,000
   2. Profit Up to Rp. 50.000.000
      Taxes = 15 % (Yen 2,000,000) = Yen 300,000
   3. Profit above Rp. 50.000.000
      Taxes = 30 % (Yen 3,797,500) = Yen 1,139,250 +
      Total Taxes = Yen 1,539,250

6. **POT after income taxes** = $\frac{40{,}088{,}800}{7{,}898{,}200}$ Years = 5.08 Years

7. **The Rate of Return (ROR)**

   ROR before taxes $= \frac{\text{Profit}}{\text{Total Capital Investment}} \times 100\%$

   $= \frac{6{,}797{,}500}{40{,}088{,}800} \times 100\% = 17\%$

   ROR after taxes

   ROR $= \frac{5{,}258{,}250}{40{,}088{,}800} \times 100\% = 13{,}12\%$

8. **Calculation of Break Even Point (BEP)**

   $$\text{BEP} = \frac{\text{Fixed Capital}}{1 - \frac{\text{Variable Costs}}{\text{Sales}}}$$

   $$= \frac{3{,}360{,}160}{1 - \frac{48{,}194{,}000}{63{,}360{,}000}} = \text{Yen } 14{,}035{,}576$$

   1) Break-Even-Sales = Yen 14,035,576 per year

   2) $\frac{\text{Break Even Sales}}{\text{Production Volume}}$ is 650 tonnes Tempe per year

   3) $\frac{\text{Break Even Sales}}{\text{Production Volume}}$ is 1,2 tonnes soybean per day.

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Appendix

PRELIMINARY PROCESS DESIGN
AND
ECONOMICS EVALUATION
FOR
INOCULUM OF Rhizopus sp PRODUCTION PLANT

By

Team of The Faculty of Industrial Technology
-Unpar, Bandung 40141, Indonesia

For

Legume Products Development Center (LPDC)
Ministry of Food Affairs
Republic of Indonesia

Kantor Menteri Urusan Pangan
Jl. Gatot Subroto No. 49
Jakarta-Indonesia
1995

PART I

BIOTECHNOLOGY IN INOCULUM OF Rhizopus sp PRODUCTION

1. Biotechnology In Inoculum of Rhizopus sp Production

The use of biotechnology in the manufacture of inoculum of Rhizopus sp has been practised for more than several years. Futhermore, Rhizopus sp inoculum derived from the cells of microorganisms for use as a dried starter inoculum is cultivated on a large scale by using fermented and non-fermented methods.

Biotechnology is one of the frontier area of science, which will create new concepts in the fields of genetic manipulation and other traditional biological methods which can produce new process and high value product of food, agriculture, healt and industry. Biotechnology is a broad spectrum from the traditional to the modern one. Biotechnology is concerned which mass conversion by microorganism on an industrial scale. Biochemical engineering is a new engineering discipline concerned with all technological and economical aspects of microbial conversion. This include the development and optimization of new technical biochemical processes and equipment as well as planning, design, construction and operation.

Food biotechnology is relatively new and an important emerging field in the world. Now are entering new era to establish in the important decade in history human culture. New era which is indicated by the speed up of the innovation of technology, the economic opportunity and its global impacts. Food biotechnology can be identified according to traditional food biotechnology as a fermentation technology and modern food biotechnology as a genetic manipulation.

Fermentation is one of the oldest and the most economical methods of producing and preserving foods highly acceptable to man. fermentation is to develop food product having certain desirable characteristic such as flavour, aroma, texture and keeping quality. Fermentation is enzyme-induce chemical alternation in food. fermentation is commonly any industrial microbiological process.

Traditional fermented soybean are profitables due to the fermentation processing can produce several changes in terms of :

- Preserving of Tempe which highly perishable
- Reducig of volume of soybean
- Replacing of undesired factors in the soybean
- Increasing in nutritional values
- Improving texture and taste
- Reducing of energy for cooking
- Increasing in acceptable Tempe
- Increasing in Tempe security

Those changes are not only due to the role of microorganisms which can convert complex compounds into simple compounds and easy to digest but also the microorganism can synthesize several vitamins such as vitamin B_{12}, precursor of anti cholesterol.

The changes of nutritional values of fermented soybean such as several fatty acids can be converted into simple compounds so that they are easy to absorb. therefore, afer fermnetation processes of soybean, the fermented soybean can reduce stomach problem.

The high content of Net Protein Utilization (NPU) of fermented soybean of Tempe = 56 and protein content of Tempe is 19.5 %, this means that 56 % of its protein content can be used directly by the human body. Therefore, 100 gram of Tempe can give (100)(0.56)(1.195) = 10.9 gram of protein which can be used for the human body. This total amount of protein requirement per day per adult people, and this total amount of protein equivalent with 300 gram of beef stick or 1.5 cups of milk or two pieces of eggs.

2. Environmental Conditions of Rhizopus sp

Traditional fermented soybean is derived from activities of microorganisms, therefore, in order to obtain a good fermentation process, some environmental factors are essentially needed to be considered. Those factors are substrate, temperature, oxygen, and water, which can be described as follows :

1) Temperature

Temperature is an important environmental factor to be considered in the fermentation processes. temperatures can be classified according to the microorganism as follows :

a. Minimum temperature where under this temperature, micoorganisms can't grow
b. Optimum temperature where microorganisms can grow well
c. Maximum temperature where above this temperature , microorganism can't grow

Therefore, moulds have optimum, minimum, and maximum temperatures. Every moulds has different growing temperatures and moulds have an optimum temperature of 30 - 37 °C.

2) Oxygen

Oxygen or air in the fermentation processes have to be controlled as good as posible to increase or inhibit the microbial growth. According to the requirement of oxygen for the metabolism, microorganisms can be devided into four groups as follows :

- Aerobic organism where oxygen is used to grow
- Anaerobic organisms where this microorganism is unable to grow in the presence of oxygen
- Facultative anaerobic organisms where oxygen will be used for growing if oxygen available, but if there is no oxygen, this organism can grow in the anaerobic condition.
- Microaerophilic organism is microorganism which can grow well at a lower of oxygen content than the oxygen content in the atmosphere.

Moulds can grow well in the presence of oxygen, and yeast *of Saccharomyces cerevisiae and Saccharomyces ellipsoides* can grow well in the anaeribic conditions.

3) Water

Microorganism can't grow without water. Water of soybean content will be used for microbial growth is called water activity or a_w

$$a_w = \frac{P}{P_0} = \frac{E.R.H}{100}$$

Where,

a_w = Water activity
P = Partial pressure of water vapour
P_0 = Saturated pressure of water vapour at the same tempeature
E.R.H = Equilibrium Relative Humidity

According to Roult's law :

$$a_w = \frac{M_w}{M_w + M_S}$$

Where,

M_w = Total mol of water
M_s = Total mol of solute

Moulds can grow well in the medium of aw values of 0.80 - 0.87. Moulds need a_w which is smaller than yeasts.

4) pH values

Most microorganisms prefer to grow in the range pH 6.0 - 8.0 and pH values outside the range 2.0 to 10.0 are usually destructive.

Studies on the preparation of Tempe inoculum using Rhizopus oligosporus and Rhizopus oryzae showed that more nutrient was needed in the substrate for preparing the Tempe inoculum. Rhizopus oligosporus produced more proteolytic ensyme where as Rhizopus oryzae produced more amylolytic enzymes.

$$\text{Soybean} \xrightarrow{\text{R. oligosporus}} \text{Amino acids + Peptida}$$

$$\text{Soybean} \xrightarrow{\text{R. oryzae}} \text{Dextrin + Maltosa}$$

3. The Objectives

The objectives of the preparation of Tempe inoculum are :

1) To study preliminary or quick estimate designs
2) To study the technical and economic factors of the preparation of Tempe inoculum

4. The Goal

The goal of this preliminary plant design is to obtain process development on a semi pilot-pilot scale ot Tempe inoculum with a capacity of 250 kg/day Tempe inoculum per day.

PART II

PROCESS DEVELOPMENT

1. Microorganisms

Rhizopus oligosporus and Rhizopus oryzae were obtained from the research results of laboratory scale and a program to obtain this information is being done.

2. Subatrate For Rhizopus sp Inoculum

Price and rice bran are used as substrate for Tempe inoculum preparation.

Rice + Nutrien —(Mixed culture of R. oligosporus and R. oryzae)→ A Stable Tempe Inoculum

Red bean or Phaseolus vulgaris
⇓
clean
⇓
wash
⇓
cook for 1 hour
⇓
soak for 4 hours
⇓
peel/dehull
⇓
sterilized at 120°C for 20 minutes
⇓
cool
⇓
⇒

soybean
⇓
clean
⇓
wash
⇓
cook for 1 hour
⇓
soak for 4 hours
⇓
peel/dehull
⇓
sterilized at 120°C for 20 minutes
⇓
cool
⇓
⇐

mixed
⇓
inoculum of Rhizopus oligosporus ⇒ inoculation
⇓
wrapp
⇓
incubate at 30°C for 48-72 hours
⇓
TEMPE

3. Preparation of Tempe Inoculum At a Laboratory Scale

3.1. Rice As A Substrate

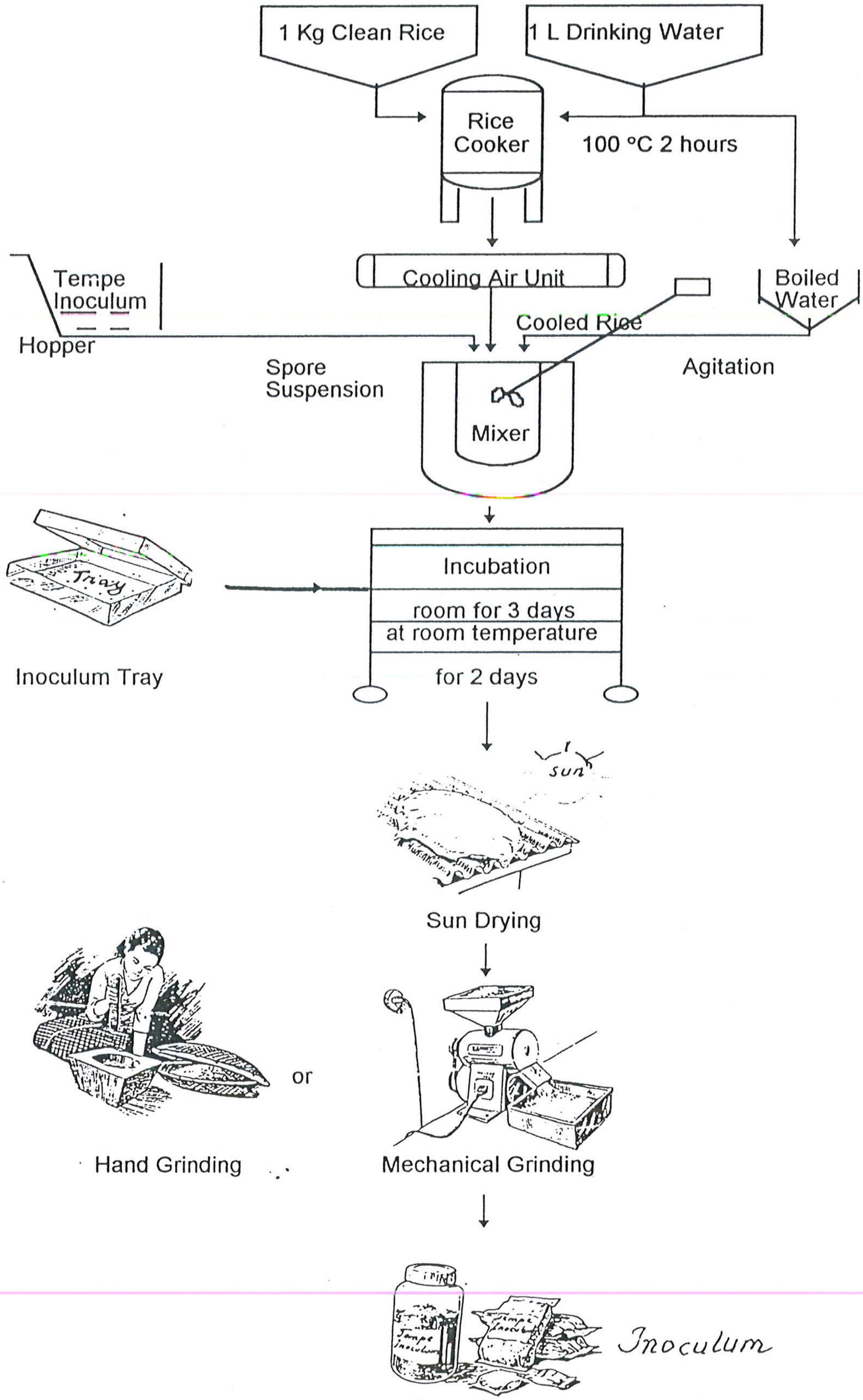

Figure 1 : Preparation of Tempe Inoculum At A Laboratory Scale With A Capacity of 1 Kg Rice

3.2. Tempe Inoculum Preparation At A semi Pilot Plant Scale

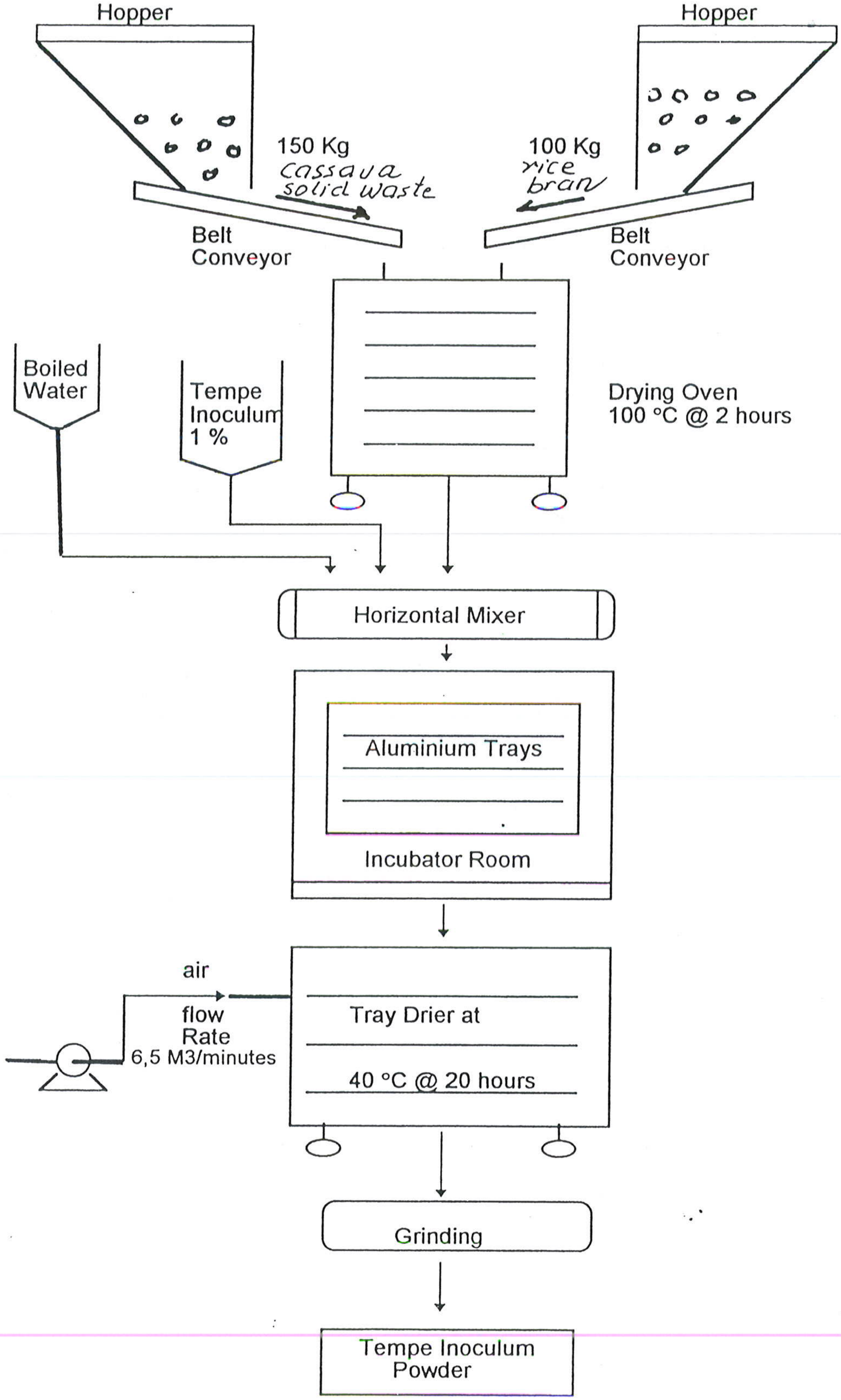

Figure 2 : Tempe Inoculum Prepatratin At A Semi Pilot With A Capacity of 250 Kg Tempe Inoculum Per day

PART III

COST ESTIMATION

1. Total Capital Investment (TCI)

1.1. Direct Costs

1) Equipment :	• Hopper, 2 Units @	Yen	190,000
	• Elevator, 3 Units	Yen	150,000
	• Water Tank, 2 Units	Yen	130,000
	• Compressor, 1 Unit	Yen	100,000
	• Drying Oven, 1 Unit	Yen	300,000
	• Horizontal Mixer, 1 Unit	Yen	250,000
	• Al Tray	Yen	150,000
	• Incubation Chamber	Yen	150,000
	• Tray Dryer, 1 unit	Yen	200,000
	• Grinding, 1 Unit	Yen	200,000
	• Packaging, unit	Yen	100,000
	• Piping, Wiring	Yen	200,000
	• Others	Yen	380,000 +
	Total Equipment (E)	Yen	2,500,000

2) Instalation, Insulation dan Painting		
25 % E	Yen	625,000 +
Direct Costs (DC)	Yen	3,125,000

1.2. Indirect Cost

1) Engineering & Supervision, 20 % DC	Yen	625,000
2) Trial - run, 6 % DC	Yen	187,500
3) Contingency, 5 % (FCI)	Yen	207,500 +
Indirect Costs	Yen	1,020,000

1.3. Fixed-Capital Investment = Direct Cost + Indirect Cost (FCI)	Yen	4,145,000
1.4. Working Capital, 10 % TCI	Yen	460,000 ++
1.5. Total Capital Investment (TCI)	Yen	4,605,600

2. Total Product Costs

2.1. Manufacturing Costs

1) Direct Production Cost	Yen	3,000,000
2) Fixed Charged	Yen	1,120,000
3) Plant Overhead Cost	Yen	600,000 +
Manufacturing	Yen	4,720,000
2.2. General Expenses	Yen	1,200,000 +
Total Production Costs	Yen	5,928,000

3. Total Income (250 Kg/day)(300 Days)(Yen 100/Kg) = Yen 7,500,000

4. Profit = Yen 7,500,000 - Yen 5,928,000 = Yen 572,000

5. Pay-Out-Time Before Income Taxes

$$= \frac{4,605,600}{572,000 + 460,560} = 4,5 \text{ Years}$$

6. Taxes
   Profit up to Yen 1,000,000
   Taxes 10 % (Yen 572,200) = Yen 57,200

7. POT after income taxes =

$$\frac{4,605,600}{514,588 + 460,560} \approx 5 \text{ Years}$$

8. The Rate of Return (ROR)

$$\text{ROR before taxes} = \frac{\text{Profit}}{\text{Total Capital Investment}} \times 100\ \%$$

$$\frac{572,000}{4,605,600} \times 100\ \% = 12,5\ \%$$

ROR after taxes

$$\text{ROR} = \frac{514,800}{4,605,000} \times 100\ \% = 11,2\ \%$$

9. Calculation of Break Even Point (BEP)

$$\text{BEP} = \frac{\text{Fixed Capital}}{1 - \dfrac{\text{Variable Costs}}{\text{Sales}}}$$

$$= \frac{4,415,000}{1 - \dfrac{3,000,000}{7,500,000}} = \text{Yen } 6,909,000$$

1) Break-Even-Sales = Yen 6,909,000 per year

2) $\dfrac{\text{Break Even Sales}}{\text{Production Volume}}$ is 69,090 Kg Tempe Inoculum per year

or 230 Kg Tempe inoculum per day

Curriculum Vitae

1. Name : Prof. Dr. Ir. Ign. Suharto

2. Position : Dean, Faculty of Industrial Technology, Catholic University of Parahyangan (Unpar) - Ciumbuleuit 94 Bandung 40141, Indonesia.

3. Education :
   1. Chemical Engineering-University of Gadjah mada, 28 May 1965, Yogyakarta.
   2. Training in Chemical Engineering, T.H. Delft, Netherlands, 1967-1968.
   3. Post Graduate Study In Food Technology - University of New South Wales - Sydney - Australia, 1975.
   4. Ph.D. in Biochemical Engineering - State University of Gadjah Mada Yogyakarta, 1986.
   5. Passed from School of Staff and Administration Leader (SESPA) Jakarta, 20 December 1990.
   6. Visiting Professor in Research Institute For Food Science in Kyoto University, Uji, Kyoto, Japan, 1991.
   7. Visiting Professor in Environmental Program Under USAID, 1994.

4. Experiences :
   1. Director of The National Institute For Chemistry-Indonesia Institute of Science (LIPI), 1975-1986 for 10 years.
   2. Project Leader of The ASEAN-AUSTRALIA Economic Cooperation Programme of Food Protein and Food Technology, Started 1975 - 1990.
   3. Fourty five (45) times Leader of Indonesian delegations to attend international seminar as speakers and participants.
   4. Seventy five (75) times attended international seminar as speakers and participants.
   5. Supervisor for Ph.D. and M.Sc. students at the State University of Padjadjaran, Bandung, Indonesia.
   6. Vice President of the ASEAN Institute of Food Science and Technology, started 1988 - 1992.
   7. Vice Chairman of the Association of the Indonesian Catholic University (10 universities) or APTIK, 1988 - 1992.
   8. Secretary of the Catholic University of Parahyangan Foundation, Bandung, 1988 - 1992.

5. President of The Republic of Indonesia Awards :
   1. Tanda Kehormatan Bintang Jasa NARARYA (President Award In the Achievement of Science and Technology), dated 5 August 1982 by President Decree.
   2. Tanda Kehormatan Bintang Jasa Satya Lencana Klas I (President Award in The Government Services more than 25 years), dated 17 July 1990 by President Decree.
   3. Indonesia Minister For Enviromental Award, The Republic of Indonesia On March 11, 1983

. Other

1. First Asian Conference on Food Safety, 2-7 September 1990, Kualalumpur, Malaysia.
2. The Australian and New Zealand Institute of Food Sccience and Technology, 6-10 May, 1990, Australia.
3. Codex Alimentarious Commission, FAO/WHO, 5-12 February, 1990, Thailand.
4. Congregation Educationist Vatican, 18-25 April, 1989, Vatican, Italy.
5. Australian Institute of Food Science and Technology, 30 April to 5 May 1989, Perth, Australia.
6. Workshop on Competitive Technology for Food Industries in Asia, Pro-Pak Asia 89, 30 May to 2 June, 1989, Bangkok, Thailand.
7. First Asian-Australian Biotechnology Conference, 21-23 August 1989, Perth, Australia.
8. ASEAN Workshop on Thermal Conversion of Biomass, 26-28 September 1988, Prince of Songkla University, Thailand.
9. ASEAN Food Conference 88, 23-26 October 1988, Thailand.
10. International Conference on Biotechnology and Food, 20-24 February, 1988, Hohenheim University, Stuttgart, West Germany.
11. The ASEAN Fluidized Bed Combustor Study Group, 18-23 May, 1987, Kualalumpur,Malaysia.
12. UNESCO Regional Workshop on Bioinformatic Data Base, System Analysis and Process Control in Biotechnology, 10-14 November, 1987, Osaka University, Osaka, Japan.
13. ASEAN Conference on Energy from Biomass Development Towards Efficient Utilization of Biomass Energy, 13-15 October, 1986, Penang, Malaysia.
14. ASEAN-Australia Energy Study Tour To Australia, 30 April to 15 May, 1983, Australia.
15. Visited Chemical and Food Laboratories, Materials Laboratory to Dutch, West Germany, Japan, and France, 25 September to 29 October 1983.
16. ASEAN Food Conference 82, 16-20 May, 1982, Singapore.
17. First ASEAN Workshop Fermentation Technology Applied to the Utilization of Food Waste Materials, 22-24 February 1982, Kualalumpur, Malaysia.
18. The Second ASEAN Food Habits Workshop, 7-11 July, 1979, Kualalumpur, Malaysia.
19. First Seminar Workshop, ASEAN Sub-Committee on Protein, 6-11 November, 1978, Manila, Philippines.
20. International Seminar on Technology Transfer, 1972, New Delhi, India.
21. Third ASEAN Science & Technology Week, Food Science & Technology Conference, 20-24 September, 1992, Singapore.
22. The Colloquium On Faith and Science (Special Question On Technology and Environmental Care), Federation of Asian Bishop Conferences, University of STO Thomas, Manila, January 30 - February 6, 1993
23. The 11th Conference of ASEAN Federation of Engineering Organization, 18-19 November 1993, Organized By The Institution of Engineers, Singapore.
24. The Third Asia-Pacific Biochemical Engineering Conference, 13-15 June 1994, National University of Singapore.

Experiences

1. Government of the Republic of Indonesia Official and services :

   Past Positions

   1) 1 June 1965,
      Research Assistant at The National Institute For Chemistry, Bandung.
   2) 1 April, 1972 to March 1975
      Assistant Director, National Institute For Chemistry, Indonesian Institute of Sciences, Bandung.
   3) March 1975 top July 1986
      Director of The National Institute for Chemistry, Indonesian Institute of Sciences, Bandung.
   4) September 1987 to February 1991
      Head of Transfer of Technology on Food, Animal Feed and Chemicals Product, Indonesian Institute of Sciences.

5) From 1980 to 1992

Employer	:	Chairman, Indonesian Institute of Sciences.
Position held	:	Prime Senior Research Scientist/Research Professor.
Description of Duties	:	To formulate and carry-out in Science and Technology policy interms of chemical product, pharmaceutical products, animal feed products, food products, and environmental aspects. And also to give supervisor to the junior research scientists.

2. International Experiences :

1) 1972 : I have already initiated and proposed ASEAN Project on Soybean Processing in Kualalumpur, Malaysia. This project became ASEAN Australia Project on Protein Rich Foods in 1975.

2) From 1976 to 1986 :

Employer	:	Prof. Dr. Ir. H. Tb. Bachtiar Rifai
Position Held	:	Project Leader, ASEAN-Australia Project on Protein, in Indonesia.
Description of Duties	:	To manage as well as initiate, foster and work in collaborative projects on Protein within Indonesia with 9 institutes involed in that project.

3. From 1982 to 1990 :

Employer	:	Prof. Dr. Ir. H. Tb. Bachtiar Rifai and Prof. Dr. Doddy Tisna Amidjaja.
Position Held	:	Project Leader, ASEAN-Australia project on Food Technology Research and Development.
Description of Duties	:	To carry out coordination, integration and synchronization on Food technology and its evaluation.

4. From 1976 to 1987	:	Member of ASEAN SUB-Committee on Protein.
5. From 1983 to 1990	:	Member of ASEAN Working Group on Food Technology Research and Development.
6. From 1991 to 1992	:	Member of ASEAN Project Management Committee on Food Technology.
7. From 1987 to 1988	:	Project Leader, ASEAN-Australia Project on Biomass Energy of Fluidized Bed Combustor.
8. From 1980 to 1987	:	Project Leader, Indonesia-Dutch Project on Bioconversion on Lignocellulosic Materials.

3. Number Countries of Experiences :
   1. Developing Countries (ASEAN) : 5 Countries
   2. Developed Countries (Japan, Australia, Dutch)

4. Language Proficiences :
   . English : Very Good

Project Experience in Indonesia and South East Asia.

I have done project preparation, appraisal, implementation and Leadership of the projects as follows :

1. Position	:	Project Leader of the ASEAN -Australia on Food Technology
Project Name		Food Technology Research and Development
Year		1982-1990 (8 years)
Description of Duties		To coordinate and supervise all researches to do research and development in terms of selection of raw materials, optimization of processing, clinical evaluation, biological evaluation, chemical evaluation and transfer of technology from laboratory results to large scale.
2. Position		Leader of Indonesian Delegates
Project Name		ASEAN Working Group on Food Technology
Year		1982-1990 (8 years)
Description of Duties		To attend the ASEAN Working Group on Food Technology Research and Development in Singapore, Thailand, Malaysia, Philippines and Indonesia every 6 months started in 1982 until 1990. And also to present all research results of Indonesia to the ASEAN forum.

.3. Position: Leader of the ASEAN -Australia Project
Name: ASEAN -Australia Project on Protein Rich Foods
Year: 1976 - 1982
Description of Duties: To coordinate, supervise and control all researchers within 9 Government Research Institute in Bandung, Jakarta, Bogor and Yogyakarta.

.4. Position: Leader of The Research on Chemical Processing
Project Name: Project on Increasing of Chemical Processing.
Year: 1973-1978 (5 years)
Description of Duties: To formulate, planing, coordination, supervise and implementation of research and development on chemical processing and chemical analysis based on the Chairman of Indonesian Institute of Sciences Decree.

.5. Position: Leader of the Research and Development on Chemistry
Project Name: Project on the Increasing of Chemical Research
Year: 1978 - 1979 (1 years)
Description of Duties: To formulate, planning, coordination, supervise and implementation of research and development on chemical processing and chemical analysis based on the Secretariat Negara Decree.

.6. Position: Leader of the Research and Development on Food Technology
Project Name: Research and Development on Food Technology
Year: 1979-1980
Description of Duties: To develop or improve the existing food technology in terms of improving quality and safety of traditional fermented food.

.7. Position: Staff and Expert
Project Name: Planning of Science and Technology Center, PUSPIPTEK-Serpong.
Year: 1976-1978
Description of Duties: To generate a lot of data and information and given remarkable experience to the people who are working in the planning, construction and evaluation of Chemical Laboratory and pilot Plant on Chemical Processing in the area of SERPONG based on State Ministry for Research Decree.

.8. Position: Expert
Project Name: Treatment & Utilization of Waste & Biological Effluent
Year: 1978-1983
Description of Duties: Formulation and Planning on the Utilization of Biological Effluent.

.9. Position: Leader of the Utilization of CO2 in the Cement Slurry in Gresik-East Java.
Project Name: Utilization of CO2 in the Cement Slurry
Year: 1972
Description of Duties: To Utilize the CO2 in the stack gases to reduce moisture content in the cement slurry in order to reduce fuel consumtion in the rotary Kiln. This result was used as a basic policy in the Cement Factory using dry process in Gresik.

.10. Position: Leader of Animal Feed Production
Project Name: The Technology of Animal Feed Production Utilization of Food Waste Materials.
Year: 1982-1986
Description of Duties: To carry-out planning, formulation and processing of Agricultural Waste product for animal feed in rural areas of Gunung Kidul, Yogyakarta and Denpasar, Bali according to the President of the Republic of Indonesia decree.

11. Position: Leader of Food Technology Transfer
Project Name: Development of Weaning Food Product & Packaging
Year: 1987
Description of Duties: To Speed-up the research and development on food processing and preservation to obtain the high nutritional status of formulated food for children and also to obtain the possibility of high calorie formulated food for army and emergency purposes. This location has been set-up in Yogyakarta.

12. Position — Leader of Fluidized Bed Combustor
    Project Name — ASEAN-Australia Non-Conventional Energy
    Year — 1988
    Description of Duties — To carry-out mathematical model for design, construction and instalation of Fluidized Bed Combustor of Rice Hulls for Heat and Power in Indonesia.

13. Position — Chairman
    Project Name — Training Course on Safety and Loss Prevention in Chemical Industries.
    Year — 18-12 September 1989.
    Description of Duties — To set up a program on safety and Loss Prevention in Chemical Industries which has been attended by Private Company such as PT. Astra, PT. Petrosida, PT. Pupuk Bontang, PT. Pupuk Kujang etc.

14. Position — Expert/Consultant
    Project Name — Waste Water Treatment of Pesticide Industry
    Year — 1988
    Description of Duties — To Study the environmental condition in the PT. Alfa Abadi Pestisida Cirebon. And also to present this result to Deparment of Industry and West Java Local Government.

15. Position — Consultant Adviser
    Project Name — Treatment and Utilization of Non-Hazardous Waste Materials in Cilegon areas of 27 Chemical Industries.
    Description of Duties — To prepare a Preliminary study on the possibilities of setting-up a common service facilities of an appropriate model to process solid industrial waste in Cilegon, West Java

Academic Services
1. State University of Padjadjaran (Government University) : As a supervisor for Ph.D students
2. Private University of Pasundan : Supervisor
3. Private Catholic University of Parahyangan : As Senior Lecturer in Chemical Engineering.

No of publication : 82 scientific papers.

Membership in Professional Societies :
1. Member of Indonesian Association of Food Technology
2. Member of Biochemical Societies in Indonesia
3. Member of Indonesian Engineers Association
4. Member of Indonesian Engineers Societies.
5. Vice President, Federation of Institute of Food Science and Technology in the ASEAN Countries, 1988-1992.

: 1. Total amount of 80 international and national scientific papers in the proceeding and international journals.
2. Two textbooks have already published by University of Santo Tomas, Manila and Local publisher.

Bandung, 20 May 1995
Sincerely yours,

Prof. Dr. Ir. Ign. Suharto.