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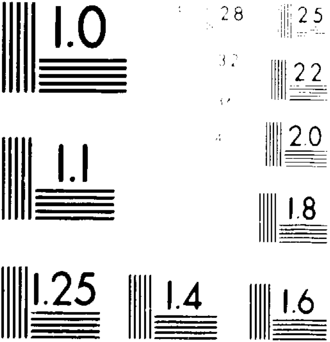

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ASSISTANCE TO THE DEVELOPMENT OF SMALL INDUSTRY IN INDONESIA

(PROJECT DP/INS/78/078)

DEPARTEMEN PERINDUSTRIAN

DIREKTORAT JENDERAL INDUSTRI KECIL

[redacted]

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

(ASSISTANCE TO THE DEVELOPMENT OF SMALL INDUSTRIES)

DP/INS/78/078

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REFERENCE:

No.: IE-84-38/II-7.

Bjørn Eidsvig:

Indonesia.

TAHU manufacture in Jakarta and in Indonesia.

Proposal for development and improvements.

Report No. 60.
4th June 1984.

1984

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
(ASSISTANCE TO THE DEVELOPMENT OF SMALL INDUSTRIES)
DP/INS/78/078

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REFERENCE:

No.: IE.84-38/II-07.

Jakarta 4th June 1984.

Att. Mr Zulkoflie Abbas,
Tahu production in Jakarta.

Mr Zulkoflie Abbas,
Head of BIPIK,
Jln. Merdeka Selatan 8-9
Jakarta - Pusat.

We refer to discussions in your office early April 1984.
As requested, we have completed a study of the Tahu industry in Jakarta.
No doubt, the tahu industry is working hard, and utilizes in general the opportunities they can find to do the best possible out of their industries.
Still we have worked out proposals for improvements and developments as we have seen it to be possible and realistic.

In fact the potentials are enormous. It appears that if following the proposals we have worked out in this report, annual savings in the range of 30 million Rp. is possible within an average industry with only limited investments.

We recommend you to study the report in detail, whereafter we will be glad to discuss with you the further steps that are required to implement the proposals.

Sincerely yours
UNIDO INS 78/078,

Bjorn Eidsvig,
Industrial Engineer

TAHU Manufacturing in Jakarta and Indonesia.
Proposals for development and Improvements.

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EXPRESSIONS AND ABBREVIATIONS USED IN THE REPORT.

BIPIK	=	Bimbingan dan Pengembangan Industri Kecil. Guidance and development agency for Small Scale Industry.
BULOG	=	Badan Urusan Logistic. Agency for Logistics for Essencial foods
Kopti	=	Koperasi Produsen Tempe Tahu Indonesia. Cooperative of Tahu and Tempe manufacturers in Indonesia.
Okara	=	The remainder of the ground and boiled soy-bean mass after extracting the soy milk.
Oncom (or Okara oncom)	=	A food cake made by fermentation of okara after adding of a binding agent and steaming the mass.
Soymilk	=	Extract of ground and boiled soybeans dis-solved or dispersed in water after sieving off the remaining solids of the beans.
Tahu (or Tofu)	=	Lightly pressed soybean cake made by coagulation of soybean milk, sieving of the liquid whey.
Tempe	=	Soybean cake made by fermentation of boiled and dehulled whole soybeans.

Whey = The liquid that remains of the soymilk after removing the coagulated tahu.

A = Surface area in m^2 (as a basis for heat transfere)

C = Specific heat. The amount of kilocalories required to increase the temperature of the medium 1^oC.

K = Heat transmission factor in $kcal/m^2h^oC$

per = Protein efficiency ratio. The ratio between the digestible and the total amount of proteins in a food or feed.

Q = Amount of heat or energy in kcal

Δt = Temperature difference in ^oC between the warmer and colder side.

V = air speed in m/sec.

α = Heat transfere factor between different materials in $kcal/m^2h^oC$

δ = Material thickness in m, in heat transfere calculations

λ = Heat conductivity of the material in $kcal/m\ h^oC$.

INTRODUCTION

Industrial Engineer of UNIDO project 78/078 has been requested to make a study of some typical small scale Tahu production units in the Jakarta area, aiming at giving proposals for improving of the tahu industry in Indonesia in general.
Special emphasis has been expected to be laid on product shelf life, economy, and utilization of wastes.

As a back-ground for the report, industrial engineer together with the UNIDO national engineer and representatives from BIPIK, Jakarta and the Kopti organisation visited five tahu manufacturing units, three tempe manufacturing units, one oncom manufacturing unit, BIPIK Jakarta head office, KOPTI head office, East Jakarta KOPTI office and one machine supplier.
The report contains a brief description of the tahu production as it is practised in Jakarta and generally in Indonesia today.

The main emphasis of the report is laid on planning of improvements in the tahu manufacturing. A summary of the proposals are given in the continuation. The proposals have in general been worked out in such detail that necessary steps can be decided on, and implementing actions can be initiated.

Different manufacturers and different locations have different situations. Different alternatives of improvement may be selected for different areas and manufacturers. We therefore have tried to give guidelines for different alternatives of development and improvement.

As an indication of the possible savings or increased profits within, different fields of operation, selecting one of the specified improvement alternatives, we can roughly indicate the presence of a scope of improvement as follows:

Table 1:
POTENTIAL SAVINGS OR INCREASED PROFITS within different fields of development in the Tahu production in Indonesia. In Rp.000 based on an average production of 400 kg of beans per day per industry. (Rough Estimate)

Field of Development.	Expected results:	Individual initial Required Project Investment.	Individual project annual savings	Total potential annual savings based on 120.000 tons beans p.a. (or 4000 manufacturers).
- Soybeans selection and improved storage	Improved yield for imported beans (+20%)	-	4.800	19.000.000
- Use of soybean meals as limited material ingredient.	15% ingredient at 65% of price. Same yield	-	2.500	10.000.000
- Soaking improvements	Yield increase (2%)	-	900	3.600.000
- Improved soaking installation	Product improvement, Save space & labour & grinder	500	500	500.000
- Grinding improvements	Yield improvement (3%)	100	1.400	5.700.000
- Improved coaking	Yield improvement (3%)	100	1.400	5.700.000
- Improved cooker installations	Fuel saving (40%), product improvement	1.000	4.200	16.000.000
- Separate water heating	Fuel saving, space saving and capacity increase.	100	300	1.200.000

Field of Development.	Expected results:	Individual initial Required Project Investment.	Individual project annual savings	Total potential annual savings Based on 120.000 ton beans p.a. (or 4.000 manufacturers).
- Improved soy milk separation and okara pressing	Yield increase (6%) and okara drying.	500	6.000	24.000.000
- Improved sanitation.	Improved shelf life, less waste, A safer product	600	* (1.500)	* (6.000.000)
- Use of natural preservatives	Improved shelf life	(100)	(800)	(3.200.000)
- Chilled packaging or cold storage	Improved shelf life	4.000	5.000	20.000.000
- Tahu pasteurization (or sterilization)	- " -	(800)	(1.500)	(6.000.000)
- Manufacturing of intermediate products.	Prevent spoiling. Increase product value	300	(2.000)	(8.000.000)
- Improved utilization of the okara.	Increase value. 30 tons at Rp. 100.000	1.200	2.000	8.000.000
- Utilize the whey	For agriculture	300	300	2.000.000
- Improved factory lay-out.	Improved efficiency			
Maximum total		8.700	29.300	115.900.000

* Figures in brackets are duplicated by alternative savings.

According to the table, if utilizing all the saving possibilities, an annual saving of Rp. 29,3 million seems possible for the individual industry. That represent about 30% of the total operation costs including the cost of the beans.

It seems that this is possible through investing as little as 3.7 million Rp.
For Indonesia as a total with about 4.000 tahu industries using 100 - 150.000 t of soybeans for tahu production, if the whole tahu industry will be improved accordingly, this correspondsto a saving for Indonesia of Rp. 115.900.000.000, or over 100 billion Rp.

If the total potential is taken out as profit for the industries, their profits may be many doubled. It may however also become possible to increase the profits at the same time as one may decrease the sales prices with over 20%.

We recommend to work out a plan of implementation, based on the suggestions in "Summary of Proposals".

Table 2:

SUMMARY OF PROPOSALS.

Problems Concerning.	Para	Proposal	Proposed Initial measures.
The use of Raw materials not well fit for tahu.	1.1	To establish test norms and test procedures for soy beans, especially for tahu production.	Discussions with BULOG and the Food Institute.
	1.2	To seek to import beans for tahu production according to its suitability for tahu production.	Discussions with BULOG.
	1.3	The Cooperatives to buy and distribute beans according to quality.	Discussions with Kopti.
	1.4	To base small quantity purchase of beans on historical data of the beans, and to seek to develop market pricing accordingly.	Discussions with Kopti and the food Institute.
	1.5	Feed back to the Agricultural sector about beans yield in order to improve variety selection and storage fit for tahu production.	Discussions with Ministry of Agriculture.
	1.6a	Arrangements about returning to the cooperative, substandard performing beans, better yielding for other purposes.	Discussion with Kopti.
	1.6b	Arrangement between tahu and tempe manufacturers to sell Soaked beans, substandard for tahu, to tempe manufacturers.	Meeting with tahu manufacturers.
Use of soy bean meal as raw material	2.	To extract oil from a portion of the soybeans before using the residues as an ingredient in the tahu production.	Tests by the Food Institute.

Problems Concerning	Para	Proposal	Proposed initial measures.
Deteriorating of beans quality during storage.	3.1	To import beans in bulk and to establish silo storage with air conditioning.	Discussions with BULOG.
	3.2	Provide air conditioned storage for BULOG and for the Cooperatives.	Discussions with BULOG and Kopti.
Reduction of dust and dirt following the beans	4.	To establish simple screening of beans before soaking.	Meeting with tahu manufacturers.
Optimize soaking conditions	5.1	Optimize soaking time and soaking conditions.	Meeting with tahu manufacturers.
	5.2	Optimize soaking temperature.	- " -
	5.3	Improve soaking tubs for new Installations.	Pilot plant and results reporting.
Optimize grinder operation.	6.1	Relationship between yield and quality on the one side, and distribution of particle size from the grinder on the other to be established.	Tests by the food institute.
	6.2	The manufacturers to do grinding testing.	Kopti to provide the manufacturers with test screens and information.
	6.3	Improve the use and maintenance of grinding mills.	Kopti to inform and follow up.
	6.4	To optimize the water mixing ratio and to provide cold water for mixing.	Meeting with tahu manufacturers
	6.5	Advanced producers to establish a spare grinding mill.	Meeting with tahu manufacturers.

Problems concerning	Para	Proposal	Proposed Initial measures.
In-economical cooking.	7.1	To establish a better cooking pan arrangement, with higher height/diameter ratio, increased heating surface, lid, tangential burner arrangement with turbulent gas circulation evacuating colder smoke, combustion air control, outside shell insulation and pan lifting possibility.	Pilot plant developments.
	7.2	Bottom outlet from cooking vessel.	Pilot plant testing
	7.3	Testing of cooking by central heating and circulating a heating medium, oil or steam.	Pilot plant.
Dilution ratio during cooking.	8.1	Optimize water/bean ratio for increased recovery of proteins and solids.	Meeting with manufacturers and further test cooking.
Cooking time	8.2	Optimize cooking time and	- " -
Water heating	9.	To establish a separate over head water heater, utilizing the rest heat of the combustion gases.	Meeting with manufacturers. Pilot plant with heater according to sketch.
Soy milk separation.	10.	To press the remaining okara so as to recover additional soymilk and to reduce water content in the residue.	Test pressing with and without redilution/recooking.
Adding of Coagulant	11.	Further testing of type and concentration of coagulant for increased yield, improved and varied flavour and texture.	A test programme for the food institute.

Problems concerning.	Para	Proposal	Proposed Initial measures.
Improved sanitation and product shelf life.	12.1 (1)	To rearrange equipment and to improve procedures to get a bacteria free coagulant.	Meeting with manufacturers. Bacteria tests.
	(2)	To exchange filter frames, ladles and other equipment with more hygienic utensils, and to establish sanitation procedures.	Meeting with manufacturers. Kopti to identify alternatives for purchase.
	(3a)	To omit reheating of tahu in the tins and in stead to increase the hygienic conditions.	Meeting with manufacturers.
	(3b)	To ensure bacteria free cold water supply or to take measures for debacteriation of the water for tahu packaging.	Meeting with the manufacturers and Bacteria tests for them.
	(3c)	To enable the manufacturers to get press lids for the tahu tins.	Kopti to make arrangements with metal manufacturers and offer lids to the manufacturers.
The use of natural preservatives.	12.2	To do preservation of excess production, alternatively by salt, vinegar or agar, and sell as an alternative an additional long lasting product.	Food institute to do tests with conservation and cooking.
	12.3 (a)	An insulated transport tin and 3 cooling elements to be manufactured by a small scale industry and offered to the tahu manufacturers.	Manufacturer for equipment to be identified and prototypes to be made and tested
	(b)	Cooling packs for use in the transport container to be manufactured by a small scale industry and offered to the tahu manufacturers.	

Problems concerning	Para	Proposal	Proposed initial measures
	(c)	Freezing facilities for ice making and cooling pack freezing to be offered to the manufacturers.	Practical pilot plant to be established, testing the whole system.
Chilled packaging alternative.	12.4 (a)	To establish small scale production of a PU-foam insulated transport container to be sold to the tahu manufacturers.	Manufacturer for equipment to be identified and prototypes to be made.
	(b)	Fitting a flake ice machine for the tanu manufacturers and use it for chilled tahu packaging, using also the mentioned PU-foam transport containers.	A Practical pilot plant to be established, testing the whole system.
	(c)	Establishing of small scale manufacturing and installation of the required freezing machinery.	Initial preparation for production to be plannec, implementation pending practical tests.
Tahu tin sealing and pasteurization.	12.5	To equip the tins with an air tight lid and to do heating in water bath before water cooling.	Food institute to test equipment and results.
Product sterilization alternative.	12.6	Packing tahu in sealed plastic bags heated in autoclave, arranged for pressure cooling.	Food institute laboratory tests.
Processing into intermediate products and utilization of left overs.	13.1	Manufacturing of firm tahu by press compacting of finished tahu.	Pilot production
	13.2	Manufacturing of smoked tahu arranged in a simple smoking chamber for the tahu manufacturer.	Pilot production.
	13.4	Deep fried tahu production and packed distribution.	Pilot production

Problems concerning	Para	Proposal	Proposed initial measures.
	13.5	Making tahu burgers from tahu mash pieces and left overs	Pilot production
	13.6	Manufacturing of sundry ready made tahu dishes for sales and distribution.	Pilot production
	13.7	Manufacturing of vitamine/ mineral enriched tahu.	Food institute laboratory tests.
Use of the okara.	14.1	Homogenization of the soy milk okara dispersion and letting the okara remain as an ingredient in the tahu.	Food institute laboratory tests.
	14.2	Improved and increased oncom production, involving; a better controlled starter culture, improved binding, improved packaging, cooled distribution, to establish some new higher standard manufacturing units, to make an information compaign for potential consumers.	Pilot production.
	14.3	Production of special qualities of tempe.	Pilot production by tempe manufacturer
	14.4	Manufacturing of food "soysages"	Pilot production
	14.5	Arrangements for the use of okara in baked products.	Test production by bakeries.
	14.6	To use okara as an ingredient of different food, in production for sales, and in the house-holds.	A public recepie competition and food institute trials.

Problems concerning.	Para	Proposal	Proposed initial measures.
	14.7	Production of dried okara flour. (By the tahu manufacturer or within the estate of the manufacturers).	Pilot production
	14.8	Manufacturing of a balanced poultry feed, partly based on okara.	Arrangements with existing or potential feed manufacturers.
	14.9	Drying okara and selling directly, as feed for cattle, pigs and sheeps	Pilot production and encouragement of tahu manufacturers.
Use of the Whey.	15.	To arrange with nearby farmers to get hold of a transport tank to collect the whey from liststock tahu manufacturers, using it for life-stock drenching, for gardens and vegetables.	Information to tahu manufacturers and farmers.
Production lay-out.	16.	To improve arrangements in the production buildings according to a general lay-out proposal.	Planning and discussion of the Pondok Gede estate and other new estates before starting the constructions.
Bicycle transportation.	17.	To rebuild becaks evicted from passenger transport, as tahu transporting vehicles.	Rebuilding and trying out of a proto type.

THE PROCESS AS AT PRESENT:

The processing is done batchwise, each batch = 10 kg dry beans. The batches are kept separate throughout the processing. 400 kg soybeans are processed daily = 40 batches. The work last from 9.00 a.m. to 5.00 p.m., 7 days per week. 6 people are working directly in the production. 32 sellers are also engaged to sell the daily production. The sellers use about 1 hour in the production for moulding and finishing of the Tahu before spending 4 - 5 hours selling their batches, normally 1 batch per seller per day = 10 kg beans, or equivalent 30 - 50 kg tahu, 3 = 4 x 18 liter tins.

Including the sellers production assistance, the total man-days in the production hence comes about to 10 per day. It appeared that everybody works very hard and have achieved a high extent of working efficiency in their job.
The steps in the production are the following:

1. Soaking and washing:

10 kg beans is soaked in water for about 3 hours in a wooden tub, 45 cm diameter x 30 cm high. 15 - 20 tubs are being used. The beans are very dirty and extensive washing is required both before and after the soaking period. The water is being exchanged many times, and extensive movement of the tubs is required. Some beans are lost on the way. The tubs have a flat bottom and separation of stones is not very easy. No screening of the beans takes place before the soaking.

The arrangement of the tubs appears a bit messy and cumbersome and a floor space of about 5 m^2 is required for the tubs alone.

The used wash water flows on the floor and later drains in a drainage groove.

2. Paste grinding.

Buckets are used to transfer the beans from the soaking tubs to the grinding machine funnel, not large enough to contain the 10kg charge. Water is during the grinding continiously added from the top at a random.
The grinder works with stone discs and produces a fairly fine paste, again collected in 2 wooden tubs for transfer to the cookers.
One must expect that the grinder at times require exchange of grinding stones and other servicing. But no spare grinder is available, and the production will hence cease during servicing.

3. Cooking.

4 cookers are present, consisting of a plastered brick work basin 90 x 90 cm square, 35 cm deep. A 80 cm diameter curved iron bottom is fixed into the brickwork bottom. From one side, underneath the cooker, is arranged a petroleum burner with a simple evaporation spiral in front. The burners are commonly connected to a petroleum tank, pressurized by a hand pump. Smoke outlet is 180 ° across, under the cooker bottom.

Over the smoke outlet is arranged a stand for cooking the 18 liter tins filled with finished tahu.
All the combustion gases with the remaining heat is left into the air of the production room after passing arround the tin. One of the cookers is used for water heating.

The beans paste is diluted with warm water and transfered by buckets during the filling of the cookers.
The cooking takes 15 minutes, but much longer including filling and emptying done by help of buckets.
It can not be avoided that the content at times boils over the edge, spilling on the floor. Also it appears that sedimentation on the bottom takes place, and when not very careful, the paste may burn slightly in the bottom.

4. Filtering.

For filtering of the diluted soybean mass from the cooking is used a 1 m diameter open bambu tray, loosely covered by a larger filter cloth. The mass is filled over from the cooking vessels by buckets. The mass and the cloth is moved around to obtain a best possible drain of the dissolved material, retaining the coarse particles. Wooden sticks are used to move the mass around on the cloth for a quicker filtration. Water is added to the mass 2 times so as to get out as much as possible of the dissolved material. However, no pressure is being applied, and the mass (okara) when discharged still contains large amounts of water, and probably also reasonable amounts of soymilk.
The dissolved product is filtered down into a wooden round tub, 80 cm diameter, 70 cm high, containing the total filtrate, about 150 liter. 8 tubs are lined up for the filtrate.

5. Coagulation.

A coagulating agent, an acid (1% of the bean weight), is now being added to the tub from a solution stock, and the product is left to coagulate and settle. That may take another 10 - 15 min, whereafter the liquid (whey) is discharged to the floor over a filtering bambu tray placed down on top of the coagulate with a ladle. The filtering tray is coarsely platted, and limited amounts of coagulate follows the liquid through the holes in the bottom of the tray to the discharge.

6. Moulding.

The coagulate is now spooned over from the tubs to the moulds. The moulds consist of a wooden square frame, inside 45 x 45 cm, with an filter cloth inside.

After filling, the moulds are placed on top of each other, providing a slight pressure . Further whey evacuates, and after another 10 minutes the tahu is fairly firm, is taken out of the mould and cut into cubes with a knife.

7. Preparation for Sales.

The cubes will be piled up into 3 - 4 x 20 liter tins and filled up with hot clean water. The tin is placed over the oven smoke outlet for a short heating aiming at sterilization. Thereafter the water is exchanged with cold fresh water and the product is ready for distribution.

8. Distribution.

The 4 or 5 tins of tahu from the 10 kg batch of beans, weighing now all together over 80 kg, is placed in special wooden racks on the back of an ordinary bicycle and the distribution starts. When 32 salesmen can distribute 40 batches, it is because some salesmen carry more than one standard charge.

The salesmen use 4 - 5 hours to sell the 30 - 50 kg tahu. When the speed of the sales is limited to averagely 10 kg/hour, it is because definite and determined customers exist only to a certain extent, it is because several salesmen visit the same area without having agreed on any sales zones for the individual seller, but it is of course first of all because tahu is a fresh product that can not be stored, and the consumer will not buy more than for their daily consumption. Generally the sales is distributed as follows:

- 50% to market stalls and small shops for resale
- 30% to small restaurants and mobile meal vendors
- 20% to private households.

The sales price for the batch varies from approximately Rp. 8.500 to resellers to Rp. 9.000 to private.

9. Treatment of residues.

The residue mass from the beans paste that remains on the filter cloth after separating the soy milk for the tahu, the okara, is simply dumped into a concrete basin 1 x 2 m x 1 m deep.

The basin has a bottom drainage leading to the sewer, allowing some further liquid separation before packaging. The liquid that drains, the whey, still contains some soy milk.
The okara is thereafter filled into small woven bags, and further liquid is pressed out of the bags manually, and drained, before the bags are being collected by farmers once or twice per day and used as cattle feed. The sales of okara amount to around Rp. 3.000 per day or Rp. 15 per kg for the dry weight of the residue, said to amount to about 50% of the dry weightof the beans.

Individual variations.

The industries we have seen, are all in general using the same principles, the same raw materials, and somehow the same sort of equipment and layout.

Some have electrical motors and light, with power either from PLN or from their own generator, while others have a small engine with old belt and pully systems to power grinder and water pumps.

The standard of the equipment varies, and so does the building standards. While some have glazed tiles on walls and floors, good light and space, others have bambu walls, hardly any concreted floors at all, congested space and poor light. Hence also the hygienic conditions wary. Well organized production seem hardly giving any smell at all, while the less hygienic operations stinks terribly and is a source of extensive pollution and nuisance.

Some have a relatively practical layout, but none are arranged anything near ideally, something that is important for good flow and control of the production, especially with the extensive carrying around of mases and liquids in buckets and ladles.

OTHER MATTERS AS OBSERVED.

The Raw Materials.

Most of the raw materials come from Bulog and are imported, mostly from USA. When these quantities will not be sufficient, the manufacturers use to get additional supplies from the open market. The price for imported beans has been indicated to be 25 % lower than for local material, but the yield still very much lower. About 50% of the requirements have been covered by imported soybeans.

The manufacturers inform that much of the beans they receive are substandard for tahu production. Of late this has been the case for about 10% of the beans. The results have been that no tahu can be made, or the taste of the product has been so poor that the total batches have had to be wasted, or used as animal feed.

Life time of the product.

In general the product will be sold and is expected to be consumed the same day as it is produced. However, the salesmen are not always able to sell the total available quantity. About 5% of the total production will hence be left over to the next day. To enable sales the following day, the water will be exchanged and the product will be cooked again in the tin before presenting to the market again. In this way 80% of the left over product can be sold with a price reduction of about 25%.

The rest goes for animal feed. No refrigeration facilities exist with any of the manufacturers and ice is not used.

Sales force availability.

The salesmen are most often farmers related to the manufacturers.
They come to town, stay in the house of the factory owners, and do the sales job. They order daily from the manufacturer the amount of tahu they expect to sell, pays Rp. 7.000,- for the 10 kg bean batch and sell it again at Rp. 8.500 - 9.000.

However, during the busiest farming seasons, 1 1/2 - 2 months per year, they are required home on the farm and leave the salesman job for that period.
This similarly reduces the sales volume and the activities in the production.

It has been tried to look for other salesmen, but any stable solution has not been found.

Demand Seasonality.

The cooperative has experienced that the consumption is slightly seasonal or periodic. They have notice that the sales have varied as follows:

- During the first 8 days of the month: About 70% of normal consumption because people have recently got salary, and can afford other food alternatives.

- 1 month period before Ramadhan: About 130% of normal consumption due to extra social activities etc.

- 1 month period during Ramadhan: About 70% normal consumption due to the fasting.

The variations create an undesireable unevenness in the tahu production.

Organization and Volume of Activities.

The industries as visited belong to the East Jakarta Cooperative Society of Tahu and Tempe manufacturers, who have 719 member industries divided 40/60 on tahu and tempe manufacturing, and are said to cater for 70% of the market in Jakarta.
The cooperative does common purchase of raw materials for the member industries, negotiate price and charges a fee built into the price of the raw material. They store and distribute raw materials and have the task of assisting the member industries in general promotion activities.

According to the society, and according to a report of 1983 from the Chemical Research Institute in Bogor, the number of tahu manufacturing industries on Java are about as follows:

Jakarta	411
West Java	844
Central Java	1.156
Yogyakarta	87
East Java	864
Total Java	3.362

The cooperative sells, for tahu and tempe manufacturing in Jakarta, imported beans about 3 - 4.000 tons per month. According to the above, that may correspond to, for the total of Java, included the consumption of local beans for Tahu alone, something like 100 - 150.000 tons per month. Per capita this may amount to something 10 kg tahu per year or 20 gram per day, catering for a considerable portion of the human protein demand.
The product is hence of the highest importance for health and family economy.

Planned Estate at Pondok Gede.

We are being told that the Tahu and Tempe manufacture in East Jakarta will be sought moved to a new estate for the purpose within the Pondok Gede area. Planning of the new estate is presently under way.

The Present Economical Situation.

The economical picture of the daily production generally looks as follows:

A. With imported soybeans from Bulog via the Cooperative.

Costs:

400 kg soybeans at Rp. 400	Rp. 160.000
200 liter petroleum at Rp. 175 (In 20 liter tins at Rp. 3.500)	Rp. 35.000
4 kg coagulating agent at Rp. 425	Rp. 1.700
Electricity or diesel oil	Rp. 5.000
6 Operators at Rp. 2.500	Rp. 15.000
	Rp. 216.700

Sales (ex factory).

40 batches of Tahu (less 10% wasted and less 5% unsold) = 34 batches at Rp. 7.000	= Rp. 238.000
4% = 1,6 batches at (25% reduction Rp. 5.250)	= Rp. 8.400
Cattle feed, 200kg (dry weight) at Rp. 15	= Rp. 3.000
Spoilt products as cattle feed, 20 kg dry weight	= Rp. 300
	= Rp. 249.700
Daily gross profit ex factory = 15%	= Rp. 33.000

Salesmen's Sales:

17 batches at Rp. 9.000	= Rp. 153.000
17 " at Rp. 8.500	= Rp. 144.500
1,6 " at Rp. 6.563	= Rp. 10.500
Total	= Rp. 308.000
Less purchase cost	= Rp. 246.000
32 salesmen at Rp. 1.925	= Rp. 61.600

B. **Manufacturing Economy based on local Beans from the open Market.**

400 kg soybeans at Rp. 525	= Rp. 210.000
Other costs as above	= Rp. 56.700

	= Rp. 266.700
	============

Sales:

8/7 of the yield as from imported beans, comparatively	= Rp. 272.000
4% at reduced price as above	= Rp. 9.600
Cattle feed and spoilt products	= Rp. 3.300

	= Rp. 284.900

Daily gross profit = 7%	= Rp. 18.200
	============

THE FINANCIAL SITUATION OF THE ENTREPRENEURS.

The manufacturers get the beans from the cooperative at a price of Rp. 400 per kilo. An arrangement between the cooperative and the members has been made, that the members actually pay Rp. 425 per kilo, the excess Rp. 25 per kilo being their savings within the cooperative, ment preferably for investing in improving their business when required. It appears that most members are joining the saving scheme.

A saving of Rp. 25 per day x 400 kg/day x 300 days/year makes an annual saving of Rp. 3 million. This of course means that the members in general have sufficient equity available to consider investing in any of the proposals specified in the continuation. It further-more means that the cooperative are controlling huge funds for lending to earn interest for the members.

It seems reasonable to expect that lending further means to the members for further development financing is a prime goal.
Hence, in general it may be expected that most of the entrepreneurs are financially able to invest in any of the proposed improvements without even requesting any loan from any bank.

PROPOSALS FOR IMPROVEMENT AND MODERNIZATION OF THE TAHU INDUSTRY:

According to our observation from the visited industries, expecting these to be generally representation for the Tahu industry, we can indicate the following possibilities:

1. PRETESTING AND DISPOSITION OF RAW MATERIALS.

The requirements to the soy beans are quite different for Tahu and Tempe. Beans that are totally unsuitable for Tahu production, may still be fit for manufacturing of Tempe. Still such raw materials are presently being used for Tahu production, frequently resulting in total wastage.
The problem is partly that a manufacturer receiving a small quantity of beans first after soaking and partly final processing discovers that the beans are substandard for his purpose and he wastes the total lot.

This is a great problem that destroys the economy of the Tahu production and makes tahu more expensive than it need to be. Even if these beans most often will be utilized as cattle feed, the wastage of food for the Indonesian people is high, and may possibly represent as much as 10.000 tons or 4 billion Rp. per annum.

However in reallity the loss is far greater than this, considering the reduced yield for all substandard products.

Qualities of beans and their importance for tahu production

Much is already known about the relations between the different qualities of soy beans and their usefulness for tahu manufacturing. According to USA standards, 1st class beans must individually conform with the following:

- Bulk weight: Min 56 lbs/bushel. Normal bulk weight = 60 lbs/bushel or 0,77 kg/liter.

- Moisture content: Max 13%. The moisture content is very important for the quality and the possibility to store the beans. With a higher water content in present or past, the beans deteriorate quickly. The yield in the form of recovery of proteins and solids in the tahu goes drastically down and fermentation and mold may develop.

- Splits: Max 10%. Split beans are no longer protected by the covering skin. It means that the "seal" is broken and the bean rancifies quickly.

- Total damage: Max 2%.

- Heat damage: Max 0,2%.

- Foreign matters: Max 1%, Stones and iron may easily damage grinding stones and others.

- Dark beans: Max 1%. Discolours and make a grey tahu.

Americans usually use the 1st grade beans themselves and export 2nd and lower grades.
The normal analysis of soybehas and some soybeans by-products are as follows (7) calculated on the content of dry matters:

Table 4:

CONTENT OF SOYBEANS AND SOYBEAN BY-PRODUCTS
(in percent calculated on dry matter).

Content:	Soy-bean seeds whole dried.	Soy bean flour. Solvent extracted	Soy bean flour. Press extracted	Soy-bean hulls.
Dry matter, total	90 %	92 %	91 %	88 %
Digestible protein	34 %	41 %	37 %	8 %
Total digestible nutrients	88 %	74 %	78 %	37 %
Total Composition average:				
Protein	38 %	48 %	44 %	12 %
Fat	18 %	0,8 %	5 %	1,2 %
Carbohydrates	25 %	33 %	30 %	35 %
Minerals	5 %	6,6 %	6 %	4,5 %
Fiber	5 %	2,6 %	6 %	36 %

These data however varies and what is first of all important for the tahu production is the content of proteins, since it is the protein in the beans that will be coagulated to tahu.

The protein content in total can vary extensively, and good beans contain 25% more protein than poor ones, and also their usefulness and possible yield vary extensively.

It is important to be aware of that beans are cultured and cultivated with 2 different main objectives; protein yield and fat content. Soybeans for oil extraction should of course first of all have a high fat content and the protein content is less material. Such beans should never be used for tahu production.

Small beans generally have a thinner skin and give a better yield than big ones.
The age of the beans is also of high importance for the tahu yield, and the beans should preferably not be more than a few months old. As long that one uses American beans, these are harvested in September/October and may hence become as much as one year old. Older beans than that must be avoided.

The sprouting ability of the beans also counts for the yield. Good beans have a high percentage of spounting seeds.
Some varieties of beans perform better than others. Among American beans, these considered the best types for tahu production:

1. Prize
2. Kim
3. Kanrich.

We propose the following steps to be taken:

1.1 <u>Quality norms for beans for Tahu production:</u>

A multitude of quality factors are specified above. How the combination of the different factors influence the tahu production can not be determined exactly. They can all give an idea about the usefulness of the beans. But it will be better to determine quality based on a simple laboratory test specifying norm figures for:

- Volume yield in %
- Protein recovery in %
- Flavour a long a scale, 1 - 5.

Provided exact test norms are laid down as close to normal manufacturing conditions as possible, a very satisfactory measures to determine the value of the beans will be available.
The test should involve simplified tahu manufacturing in a laboratory scale, according to a laid down procedure. The test results will be available after a couple of hours after starting the test.

Knowing as much as possible the analytical and historical data of the beans consignment, one will also in time be able to make a base for a good judgement on that background.

1.2 <u>Import of beans according to test data.</u>

Considering the extensive quantities that are consumed, it will be fair to import soybeans specifically for the use for tahu production.

The relation between the value of the beans for tahu production and the general emphirical/analytical data, as may be **derived** from the tests as specified, should be giving BULOG a good bases for negotiations, but order and price agreement should better be pending the laboratory test figures.

1.3 Cooperative purchases based on test data.

Purchases of the cooperative may also be based on the test data, ensuring the cooperative that they can purchase the right beans fit for tahu production at favourable prices.

Beans less fit for tahu production can of course be directed towards tempe production or may be left for different purchases and purposes.
Making these data of each consignment known to the **manufactures**, they will also know their situation and be able to act accordingly.

1.4 Local purchases based on historical/analytical data.

Very small local purchase quantities can not be based on test data. The correlation factors that will be drawn after repeated testing of beans between historical/analytical data for the consignments on the one side, and the test performance on the other will however enable the manufacturers to make a fairly good quality judgement of locally grown beans, and enable meaningful selections and price agreements.

1.5 Quality specifications as guidelines for the bean cultivating farmers and for Ministry of Agriculture.

As the relations between historical/analytical data and tahu performance gets known this should be made known to Ministry of Agriculture and to soy bean cultivating farmers.

They should with this information be able to direct selection of varieties, ways of cultivation and storage etc. towards better performing and better paying alternatives.

1.6 Redisposition of Sub-standard beans.

When the yield or the quality of the tahu becomes extensively substandard, this can be discovered after processing in the production of 1 or 2 10 kg batches. The rest of the consignment will by than, either only be soaked or not yet be started processing at all.

a) For what is yet to be soaked, a procedure should be worked out by the society, according to which, the unprocessed beans can be returned to the society to be used for other purposes.

b) Beans that have already been soaked can not be returned to the cooperative and the beans must be used within a couple of hours to avoid damage. In most cases such beans can be made into tempe. The change in use of soaked beans however, must remain a matter to be solved between individual tahu and tempe manufacturers.

We can only propose to encourage that the individual manufacturers make private arrangements with Tempe manufacturers or others to take over the soaked beans at a price to be agreed among themselves.
Such different manufacturers are often found within reasonable geographical distances and transport by bicycle should not create large problems.
We will generally not propose the tahu manufacturers to do alternative processing themselves.

In cases where no tempe manufacturing unit is located in the close surroundings, the further tempe processing should be sought done by the tahu manufacturing units themselves. What is required of additional equipment is a peeler and some fermentation shelves. Peeling of these limited quantities can always be done manually and if no space for packaging and for the shelves is available, that may possibly be located somewhere next door.

2. USE OF SOY BEAN FLOUR AS RAW MATERIAL.

As mentioned above, soybeans are also used as raw material for edible oil production, and soybean oil is considered one of the finest oils for food purposes.

When extracting oil, the proteins and the carbohydrates remain with the fibre and the product that remains can be used for tahu production. 35% of the tahu production in Japan is based on this product.

Oils are extracted either by mecanical pressing or by solvent extraction. The mechanical oil extraction and part of the solvent extraction is done at increased temperatures. In those cases the remainder is not well fit for tahu production. When doing solvent extraction at low temperatures however, the by-product can be used for tahu production, mixing it in with the rest of the paste before cooking.

The economy of this production is quite good, considering the lower price of the flour. (That may be available at something like 60 - 70% of the kg price for beans) and also the higher percentage of protein (as to the table on page 12 A).

Tahu contains fat. This flour does not. A product made entirely from soybean flour will hence be different from normal tahu. The consistence will be less tough, and the tahu cracks easier. We will therefore not recommend to make tahu solely from flour, but will rather recommend to add 10 - 20% of this flour in-to the production.

Indonesia has several oil extraction mills using solvent extraction, even if none of them at the present uses soybeans. If however the by-product can be fully utilised for Tahu production, we see no reason why such extraction should not be permitted and encouraged. The cooperative has earlier tried to make tahu from soybean flour but than 100% from the flour, and as explained above, one can not expect very good results from that.

We propose to let one of the oil expelling companies do a test run of one charge of soybeans. Thereafter one can use the flour as a additive in the Tahu production, test wise with 20%, and after that to draw a conclusion for possible further recommendations

8. IMPROVED STORAGE OF SOYBEANS.

The storage time of beans for the tahu producers is so short, and the quantities so small that it can hardly be viable to concentrate too much emphasis on the storage facilities for the tahu producers.
Both for the Cooperatives and for BULOG's storage of **beans**, however, the storage conditions are of the greatest importance.

The air humidity in Indonesia is especially high (about 80 - 85%) and so is temperature. Both are very important for soybeans to be used for tahu production.
When the moisture content of the beans exceeds 15%, the beans start generating heat and growing of mold is possible.

There are also experience data available showing how quickly the beans deteriorate when under moist and humid conditions:
Beans with 16,5% moisture content decreases the yield for tahu production to 50% of the normal:

in	20	weeks	if	storared	at 20°C
in	12	"	"	"	at 25°C
in	8	"	"	"	at 30°C

If soybeans are stored in bulk or in open stacking of bags, they will generally not be attacked by rodents, contrary to if stacked compactly in bags.

If heat develops, this can with compact stacking not easily be controlled, temperature will continue to increase, and the beans will easily get totally spoilt. Beans are hygroscopic products, absorbing moisture from the air according to the climatic conditions.
In the principle beans behave like wood. With a temperature of 25 - 30°C and air moisture of 80 - 85%, wood stabilized its moisture content at 17%. If this is representative also for beans, stored beans, unless taking specific precautions, are bound to deteriorate extensively only after a number of weeks even if the initial moisture content was fairly low. Hence, it makes very little sence to secure high yielding beans as proposed in para 1 above, unless also taking necessary precauntions for improved storage.

As far as we know, both the Cooperatives and BULOG store the beans under less desireable conditions as indicated above, compact stacking of bags under high temperature and high air humidity.
It is quite likely that the storage conditions is responsible for a substantial part of the quality difference between stored and fresh beans.

If the storage conditions are responsible for only [illegible] decrease in the yield, than the lost values for the Tahu production in Java amounts to over 4 billion Rp. annually.

If beans will be imported and distributed in bulk, the price of beans will go conciderably down (from USA about 40%), and additional benefits are available.
That require investment in a silo facilities, but the investments will certainly be worthwile.

We recommend the following alternatives to be investigated further:

3.1 <u>Import of beans in bulk</u>, **Storage** in silos to be established. The silos to be air conditioned and possibly slightly insulated. Distribution of beans in a tank wagon with pumping facilities. Tahu manufacturers who are conveniently located may get supplies directly from the tank wagon.

Others may collect their requirements from the cooperative, having also air conditioned silo facilities. At the warehouse of the cooperative, the manufacturers should be able to bag the beans themselves, or fetch beans as convenient for them.

3.2 <u>Temporary arrangements</u>. If one is not immediately ready for so far drastic improvements and cost reductions, the storage facilities of BULOG and the Cooperatives should at least be improved as much as possible. It is important that immediate measures include:

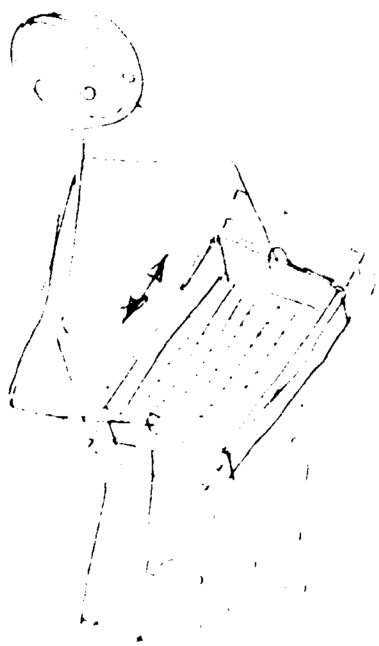
a) Air conditioning of the storage rooms, (possibly heat insulated)

b) Open stacking of bags.

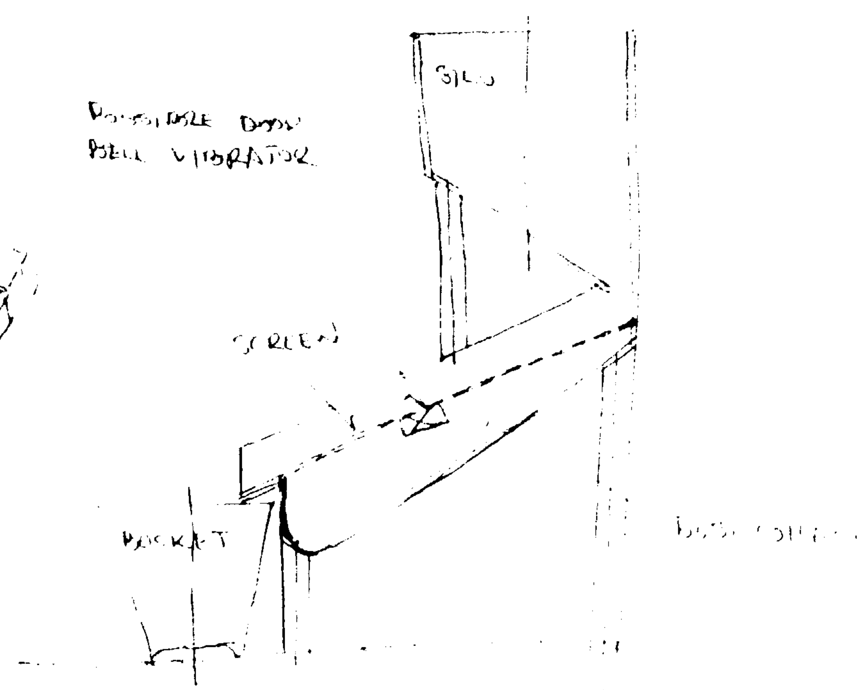
4. BEANS SCREENING.

It has been observed that the beans are very dirty and are mixed up with stones, soil lumps and husk etc. The beans are not screened before soaking. Hence the job of washing becomes extensive, the water consumption becomes unneces-sarily high, the place more **untidy, and probably also the** beans less clean.

Pre screening of the dry beans before soaking should there-fore be arranged. The job is simple and quick and the majority of the pollutions can be screened out with simple equipment.
The beans may either be shaked shortly in small portions in a hand shake tray before soaking, or they may pass over a slooping screen, with or without vibrator. The arrangement's may look as follows:



Hand shake tray alternative



SLOOPING SCREEN ALTERNATIVE

5. Soaking.

5.1 Soaking time.

Correct soaking time is of importance for yield, flavour, and shelf life of the tahu.
If the soaking time is too short, the yield will decrease.
If the soaking time is too long, the beans will start to ferment, loose flavour and substance.
Americans, Chinese and Japanese soak from 9 to 12 hours.
The water absorbtion increases by temperature. According to relation diagrams the soaking time at 30°C would be about 6 hours, whereas 3 hours soaking is practised in Jakarta. Correct soaking time can easily be checked by weight control. As soon as 120% absorbtion, or approximately the maximum possible is reached, the soaking should stop and the processing continue.
Correct soaking can also be cheched visually:

Over-soaking is characterized by:

- extensive foam on the water (CO_2 from fermentation)
- wrinkeled seed coats.

Under-soaking is characterized by:

- concave seed halves inside surfaces (when separating them)
- harder, and more concentrated colour in the middle.
- not easily breakable with the figures, rubbery consistence

We can recommend this matter to be communicated to the manufacturers, and necessary assistance be given to provide optimum soaking.
It will however still be worthwile to do some confirmation tests to show with figures the importance of correct soaking time.

5.2 Soaking temperature.

Soaking by not more than 30 °C has at present seemed to be the ideal. Several people have however indicated the possibility of an increased soaking temperature, so as to get a **quicker** soaking, limiting the use of utensils etc.

We can only warn against such thoughts since the yield is dependant on the soaking temperature. The table below shows how the recovery in the soymilk varies with the temperature. The table refer to **a long range of tests** that have been completed (1)

Table No. 5.
RECOVERY OF SOY MILK DEPENDANT ON THE SOAKING TEMPERATURE:

Soaking temperature	Gram recovery in the soymilk:		
	Total solids	Protein	Carbohydrates.
25 °C	60 gram	27 gram	16 gram
30 °C	61 gram	27 gram	[illegible] gram
35 °C	61 gram	26 gram	16 gram
40 °C	59 gram	25 gram	15 gram
45 °C	57 gram	25 gram	14 gram
50 °C	55 gram	24 gram	13 gram
55 °C	52 gram	23 gram	12 gram
60 °C	45 gram	22 gram	10 gram
65 °C	40 gram	20 gram	8 gram

5.3 Improved soaking tubs.

The soaking of 40 separate batches with tubs scattered around on the floor, some on top of each other, washing, filling and emptying of several wash water portions, splashing around on the floor, loosing some beans around; the arrangement may be **improved**. **May** we indicate an arrangement as outlined in the sketch:

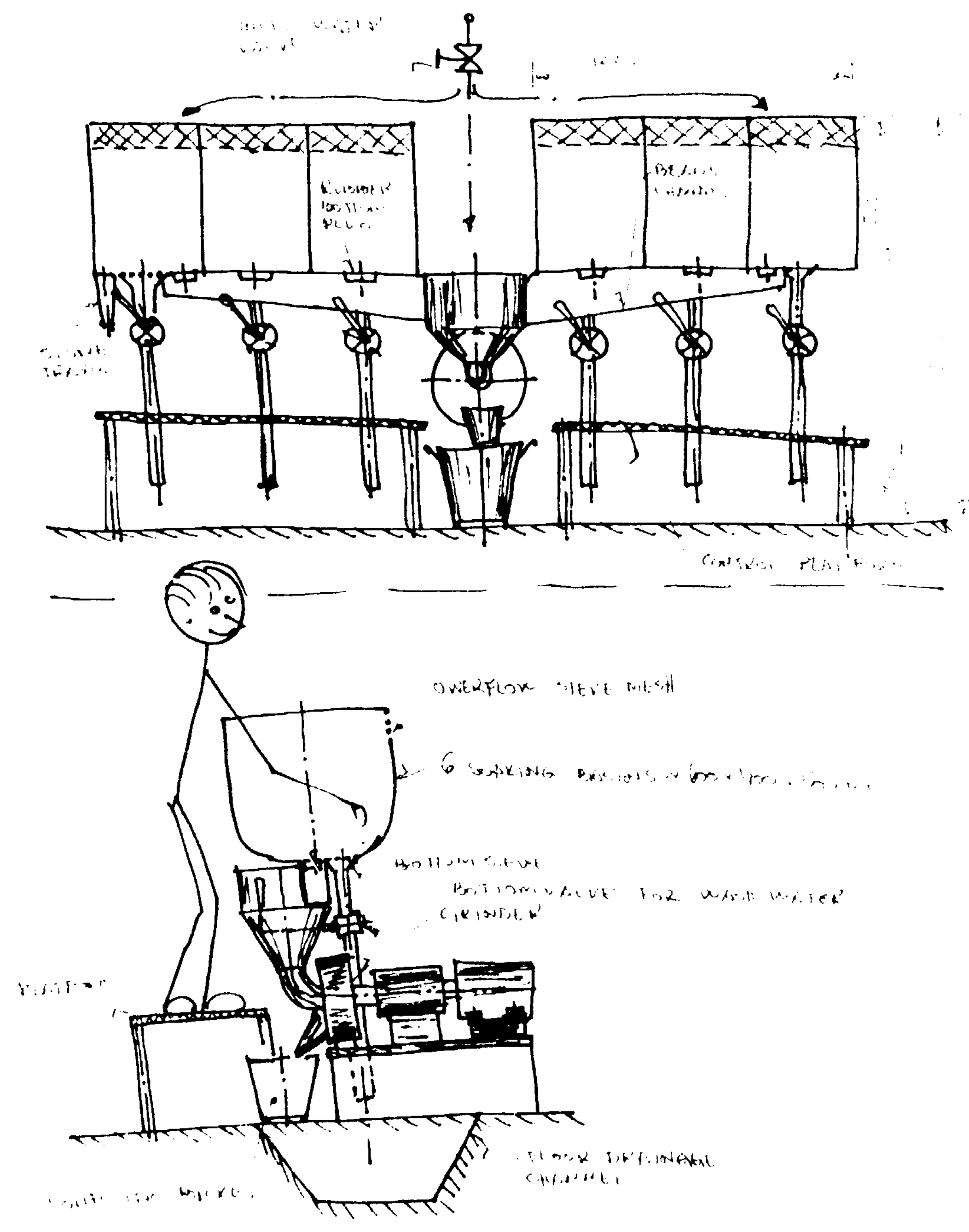


Fig 3 BEANS SOAKING ARRANGEMENT

The proposal in the sketch includes 6 soaking vessels of approximately 70 liter each, with a capacity of soaking 30 - 40 kg beans each. Alternatively could have been proposed 20 vessels of 20 liter each. We do however not easily see the benefits of operating with exactly 10kg bean changes, and will rather propose to sell tahu on quantity of product rather than on beans quantity. It will hence be less important to divide the production exactly into 10kg charges.

We propose each of the vessels to be equipped with;

- A bottom sieve with cook valve for wash water outlet
- A stone trap to prevent stones from following the beans into the production
- A mesh overflow sieve for easier separation of floating foreign bodies and dirty wash water.
- A bottom rubber plug for draining of soaked and washed beans to the grinding machine.

A common water tap with a flexible hosepipe may be arranged for fresh water supply. Adrainage grove in the floor will be needed to keep the floor dry. If a common outlet directly to the grinder will be arranged, a control platform about 40 cm high is required because of the grinders height requirement.

The soaking vessels may be made from aluminium, enamelled or stainless steel, or possibly from glassfibre reinforced plastic.

The aim of the arrangement is to get a better organized production, saving of space, improve washing possibilities, ease work and working conditions, prevent unnecessarily splashing around of water, as well as preveinting beans from following the washing water to the drain.

The direct economical savings are however limited and we will not recommend any uncritical rebuilding of already existing systems unless where the disadvantages as mentioned above are especially important.

For new installations will however the extra investments easily be outweighed by the advantages, and implementation can more easily be recommended.

6. GRINDER OPERATION.

A grinder that is operating well is a condition for a high yield. Machine grinders have been used by all the industries we have seen. A machine grinder must be considered a **necessity,** not only because of the work easening, but much more so because it is a condition for a satisfactory yield and economy of the production. Anybody still manufacturing tahu by outdated manual grinding methods, should be disrecommended to do so and given all possible assistance to invest in and install machine grinders.

The continuity of the production, and the yield, (i.e. the quantity of tahu one can produce out of 1 kg of beans), is to a large extent also dependant on the performance of the grinding machine.

It must surely be expected that there exist a clear relation between yield and degree of grinding or particle size for the ground beans; the finer grinding the higher yield.

Hence also the evenness of the grinding is of high importance. The fineness and evenness is depend on the condition and the adjustment of the mill.
Of the inspected mills, one had not adjusted the milling stones to proper distance, one had the distance adjustment out of order, one had a loose bearing creating uneven rotation of the stones, and one was new but had never been lubricated, resulting in unability to move any of its control organs.

Continious adding of correct proportions of water during the grinding is necessary. If too little water is added, the product becomes pasty and thick and does not flow well. More energy is consumed and the temperature will increase. Increase in temperature increases the risk of fermentation, decreases the yield, and the product may become overheated.

Too much water makes the product thin and gritty and the yield will drop again. Correct amount of water is experienced to be about 2,4 x the weight of the soaked beans. Hence a 10kg charge will make 53kg of ground paste. An indication of correct amount of water is it that the product forms a 2" high hip in the receiving bucket. Even addition of water is of course even more important than adding the correct amount.

The product from the grinder must be cooked immediately. A delay of 30 minutes may cause a drop in the yield of as much as 50%.

Adding of as cold water as possible is also important for the same reasons. To use heated water as has been tried by some manufacturers can only have negative effects. An other matter is it that some foreign manufacturers have had positive experience in the form of reduced cooking time and improved taste for soymilk when doing hot grinding. Any yield improvement will however not occur, and it is also necessary to maintain a temperature beyond $80^{o}C$, among other to prevent bacteria growth. That is not really possible with the equipment that is commonly used.

May we suggest the following:

- The relationship between particle size, yield and quality parameters to be tested, recorded, concluded and informed to the manufacturers.

- The cooperative to inform the members about the importance of fine and even grinding, to provide them with a simple test screen and teaching them how to control the grinding degree themselves.

- The cooperative to teach the importance of proper use and maintenance of the mills to enable even and **reliable** production and long life of the equipment.

- The manufacturers also to be informed about the importance and control of, correct water mixing ratio, low water temperature, and immediate cooking of the product.

- The more advanced manufacturers to be made aware of the usefulnes of having ready a second grinder as security against stop in production during possible breakdown or maintenance.

7. COOKING SYSTEM.

The present cooker construction and system of cooking consumes much fuel, increasing the production costs considerably. The combustion gases are released in the production room, increasing the room temperature considerably causing unnecessary fermentation and pollution. The heating of the vessel bottom is too concentrated, creating settling and burning of the product to the bottom, resulting in decreased yield. At times it also is giving a burned mistaste to the product.

The batch cooking volume is about 80 liter per charge, the 90 x 90 cm cooking vessel filled about 10cm high. The fuel consumption of 200 liter petroleum per day goes for cooking of the totally 3.200 liter soup, a fuel consumption ratio of 1 : 16. The fuel has a combustion value of 10.000 kcal/liter.
A heat utilization of 60% is a reasonable demand making available 6.500 kcal/liter petroleum. The soup may require 80 kcal/liter for heating and another 50 kcal/liter boiling = 130 kcal/liter.
Hence a fuel consumption of 1:40, 80 liter per day or 40% of the actual consumption should be possible.

The reasons for the high consumption are mainly the following:

- The cookers heating surface is small, about 0,5 m^2 and the cooling of the combustion gases are limited, the gases leave with a too high temperature.

- No possibility of controlling the amount of combustion air exist.
- The soup that settles in the bottom hinders the heat transfere.
- No useful control of the fuel flow exist
- The boiling is too intensive and the evaporation from the soup surface which is very wide, and also has no lid, is too high.

Several alternative ways may be considered to improve the cooker. We can indicate the following:

A. To use a cooking pan with smaller diameter allowing also heat from the sides, equipped with a lid, and providing the burner with simple control of air and fuel flow.

B. To use liquid filled jacketed cooking vessels with a circulating heating medium from an external liquid heater.

C. To use steam heating, injecting the steam directly into the soup from an external steam boiler.

D. To cook in an auto-clave, similarily steam heated.

3 of these 4 systems are tried illustrated in the sketches on the next page.

We can comment upon them as follows:

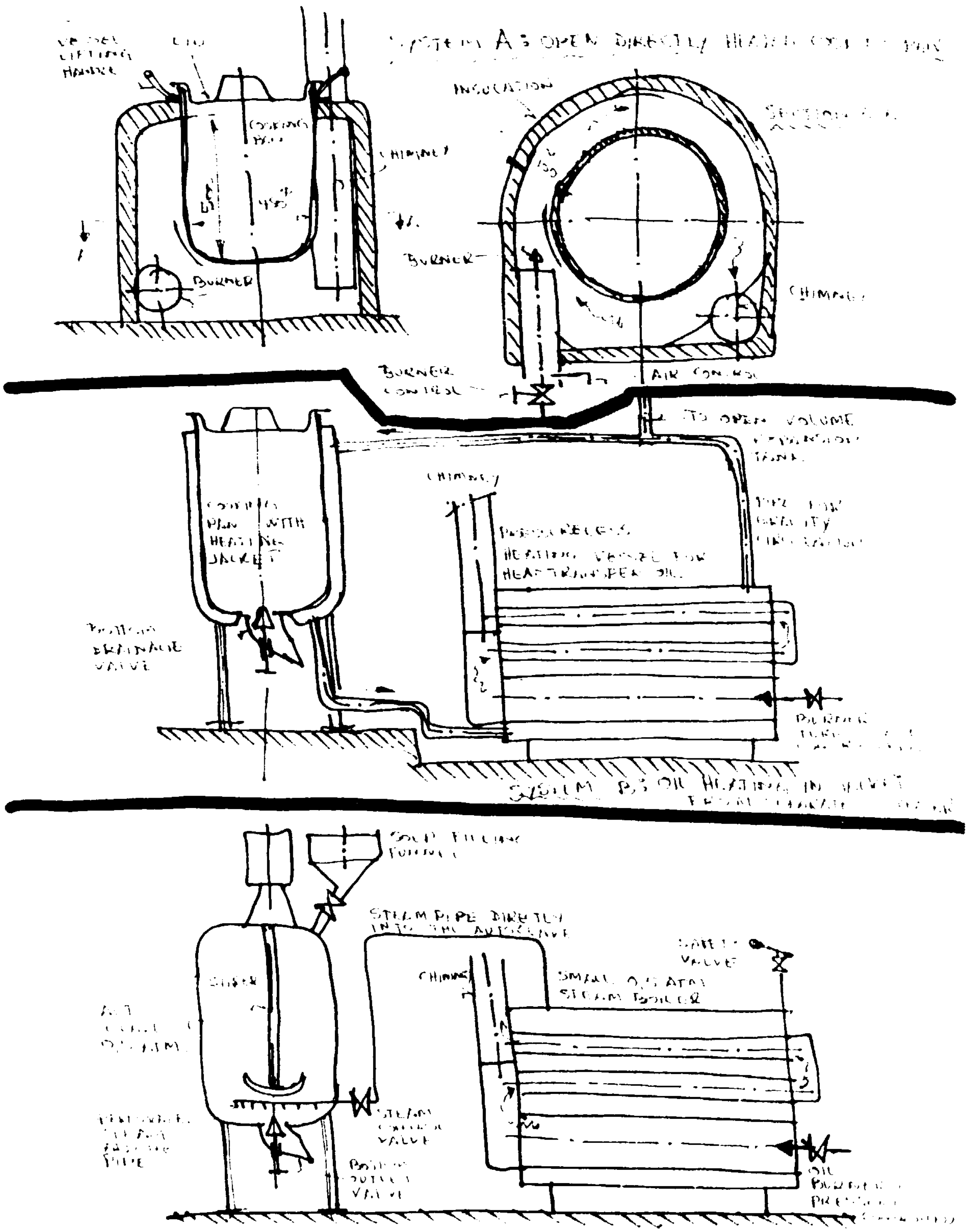


Fig 3 SYSTEM D: STEAM HEATED AUTOCLAVE

System A: Open, directly heated Cooking Pan.

This is ment as an improvement of the existing cooking method, trying to avoid the major disadvantages:

- The cooking vessel to be made all in metal, preferably **from cast iron,** tin coated steel or stainless **steel , rather than aluminium.** The vessel should be deeper and with a smaller diameter. A lid to be provided.

  With the proposed measurements the heating surface will be **about** the double of the present, and the evaporation surface will be limited to 20%. A lid will be more practical when the size will be smaller, and it will also reduce the evaporation from the surface.

- The heating chamber outside the vessel to be made circular inside, with about 70 - 100 mm clearing to the vessel's outside and the burner to be arranged tangentially in the bottom level.
  Hence the direct heat on the vessel should be limited, but circulation of the combustion gases around the vessel will be achieved due to the jet of the burner, **intensifying** and evening out the heat transfere.

- The petroleum burner which may remain the same, to be equipped with simple flow control valve to regulate the amount of heat that is added.
  (The heat requirement of the soup decreases considerably as soon as the soup starts boiling).

The fuel control mechanism should be able to control the combustion air opening as well.
To be able to maintain a good burner economy on low flame as well, also the air volume must be reduced accordingly.

Also it must be pointed out here that specially intensive boiling, as practised by many manufacturers, has no positive aim. It just wastes fuel for nothing and creates unnecessary setting and burning in the bottom of the kettle. Compared with limited boiling activity, no better or faster cooking will be achieved, only loss of liquid, a more humid, and a less pleasant working atmosphere.

- The air intake at the oil burner to be provided with a simple damper so as to regulate the ratio between fuel and combustion air. If the air is too little, soot will develop deposit on the vessel walls as an undesireable insulation, and the fuel will not be fully utilized. If too much air is added, more oil will be required to heat the extra amount of air.

  These matters are very important for the heat economy and should be closely observed. The practical control is easy: Add <u>just</u> so much air that black smoke does not occur!

- A chimney pipe is proposed from the bottom area, to secure evacuation of the coldest possible smoke. The chimney should lead out over the roof, possibly through a water heater or a dryer to make use of the rest amount of heat.

- The outer walls of the furnace may be built from light-weight, not heavily burnt brick work, preferably with hollow bricks to obtain a best possible insulation. The use of gas concrete or other more proper insulation materials would give a still better solution.

- To build the furnaces closely together , in a line (but still with a separating wall for the combustion chambers) as also presently done, is both practical and good heat economy.

- The cooking vessel is proposed with handles, possible to lift the vessels out to empty the rest content after major emptying with ladles as at present.
  The method of ladleing out the content is rough and complicated, the operators can easily burn themselves. It may therefore be much more practical to arrange a bottom outlet with e.g. a 2" pipe leading through the side wall via a ball cock valve to a bucket.

  However the heaters must than be arranged a bit elevated to give space for the bucket and it will be necessary to protect against over heating of the soup in the outlet pipe. The following 3 solutions may be considered:

  - very extensive insulation of the pipe
  - water jacketing of the pipe
  - air jacketing of the pipe
  - to fill the pipe with a plug.

It will be a matter of testing in a pilot plant to see whether any of these solutions will work satisfactory in the practise.
Probably plugging will be the best, and can be proposed as follows:

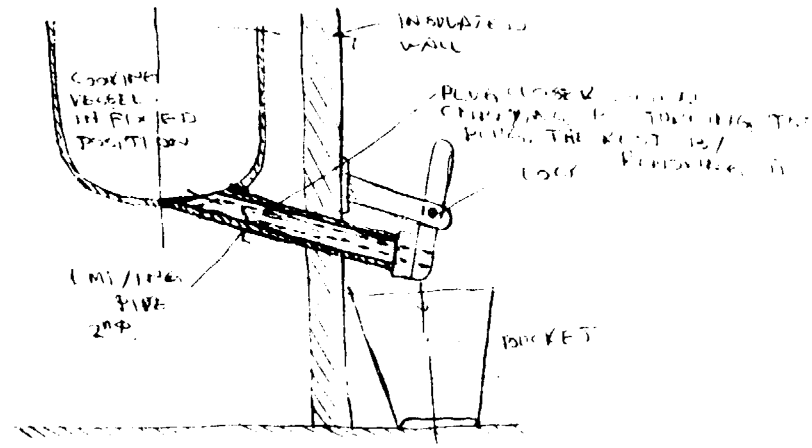


Fig 4
BOTTOM OUTLET FROM COOKING VESSEL

System B: Heating by hot liquid in a heating jacket.

It is possible to provide the cookers with a heating jacket, through which one can circulate a hot liquid, heated separately for cooking of the soup.

Using an heating oil, no pressure is required for temperatures over 100°C. An oil heating vessel can be arranged outside and if located low enough, oil circulation will be possible without any pump.
Several heat consuming units can be supplied from the same oil heater.
It will both for system B, C and D be economical to use larger and fewer cooking vessels.

With system B, C and D only very limited depositing of the soup will be possible, and no burning because of the controlled temperature of the heating medium.
Bottom drainage is also less problematic when no overheating can take place.
In the principle there will be no consumption of the heat transfere oil and there is no safety risk due to increased pressures.

One may however find the oil heater to be too expensive to provide if made new. But if a small secondand boiler or useful vessel is available, the alternative may certainly be very worthwile.

<u>System C: Steam heating of the cooking vessel.</u>

If using steam, a steam boiler capable of taking some pressure is required and a safety valve is needed.
As long as the pressure is kept under 0,5 Atm. overpressure, and the size is limited, no complicated certification and control procedures are required. Steam can more easily be transfered to several heat consumming units and in stead of the heating jacket, the steam can be injected directly into the soup. Also this alternative however, may turn-out to be a question of costing. If using steam for an autoclave or other purposes however, this will be the best way of cooking.

8. COOKING.

Correct cooking time is important for a number of factors as can be mentioned:

a) Optimation of the protein qualities for a best possible utilization in the human body.
b) Optimation of flavour
c) Killing of bacteria
d) Optimation of the tahu yield (soymilk extraction degree and coagulation factor).

These factors are partly a question about the concentration, (or the water quantity that has been added), and partly is it a question of cooking time.

8.1 Concentration.

The more dilute cooking, the better extraction and yield one will get, in terms both of Proteins and total solids recovery. A beans to water ratio of 1 : 7,8 has earlier been determined as optimum. (i.e. adding further 35 liter of water to the 10kg charge of beans, totalling now 88 liters). If increasing the water content further, the increased recovery is neglectible, while the consumption of fuel and coagulant will increase.

Use of lower water quantities can be serious, the yield will decrease drastically. The test results in the table are based on tahu production and illustrate the situation:

Table 6. TAHU YIELD DEPENDANT ON BEANS/WATER RATIO DURING THE COOKING.

Beans/water ratio	Solids recovery	Protein recovery
1 : 7, 8	79 %	48 %
1 : 5	50 %	35 %

8.2 Cooking time.

A minimum cooking time is required for the sake of bacteria killing and for the improvement of flavour and protein recovery. The recovery of solids and proteins goes drastically down if the cooking time is prolonged too much. According to earlier tests, a cooking time of 10 - 13 minutes appears to be the optimum. Tests (1) show significantly decreased yields both over and under that cooking period.
Considering a prolonged heating up period, time requirement for emptying and other variable factors, we will not recommend to base practises on these experiences, without continuously checking and controlling the yields under local practical circumstances.

8.3 Cooking Temperature.

Maximum recovery of solids and proteins in the tahu is acheived at ordinary atmospheric cooking, cooking at $100^{\circ}C$.
If manufacturing soy milk alone however, the solids recovery will be very slightly higher at a cooking temperature of 110 $^{\circ}C$.

The reason for the difference in ideal cooking temperature for soymilk versus tahu is decrease in the coagulation for higher cooking temperatures.
At temperatures over 110 °C the coagulation degree increases again, but even at 120 °C the yield remain lower than for ordinary atmospheric cooking.
Autoclave cooking also require quite expensive equipment.
In general we see no good reasons to go into that sort of processing.
Our main reason for mentioning it here is that a few people have already investmd in such equipment and others have shown interest in it. To the extent that this equipment has been tried and used in Indonesia however, only negative experiences exist, also in terms of flavour and miscolouring.

Hence we can for tahu production only disrecommend the use of autoclave for the cooking of the soup.

9. WATER HEATING.

It is not practical or economical to use one of the cooking pans for pre-heating or cooking of water. We will rather recommend to lead the combustion gases from the cookers through a separate over-head water heater before discharge.
To become efficient, the smoke pipe through the water heater must have a sufficient heating area.

Each charge require 35 liter hot water. Further water is needed for washing, cleaning etc. Hence about 2.000 - 2.500 liter hot or boiled water is required per day. The heating takes about 200.000 kcal/day. That much heat will be available from the combustion gases from the 80 liter petroleum, if the combustion heat already expected to be utilized to 60% in cooking, can be further utilized for water heating up to 82 - 85 %.

If one expect (9) an air quantity of 18 Nm^3/liter oil to be required for the combustion, and the combustion gas having a specific heat of 0,23 kcal/kg and a weight of 1,4 kg/m^3, one will get a start temperature for the combustion gas of:

$$30\ ^oC + \frac{11.000\ \text{kcal/kg oil}}{18\ Nm^3/\text{kg oil} \times 0{,}23\ \text{kcal/kg}\ ^oC \times 1{,}4\ kg/Nm^3}$$

$= 1930\ ^oC$

==========

At respectively 60 % and 85 % utilization one hence will get the following gas temperatures for the water heater:

- inlet temperature 770 °C
- outlet " 290 °C
- average " 530 °C

If the production lasts for 6 hours one will get or require:

Combustion gas: $\frac{18 \text{ Nm}^3/\text{kg} \times 80 \text{ kg}}{5 \text{ h}} \times \frac{530 + 272}{273} \, ^\circ\text{K}$

$= 850 \text{ m}^3/\text{h}$

============

Heat transfere: $\frac{200.000 \text{ kcal}}{6 \text{ h}} = 33.300 \text{ kcal/h}$

==============

We propose to install a water heater as follows under **the roof connected to the** common smoke tube from the cookers:

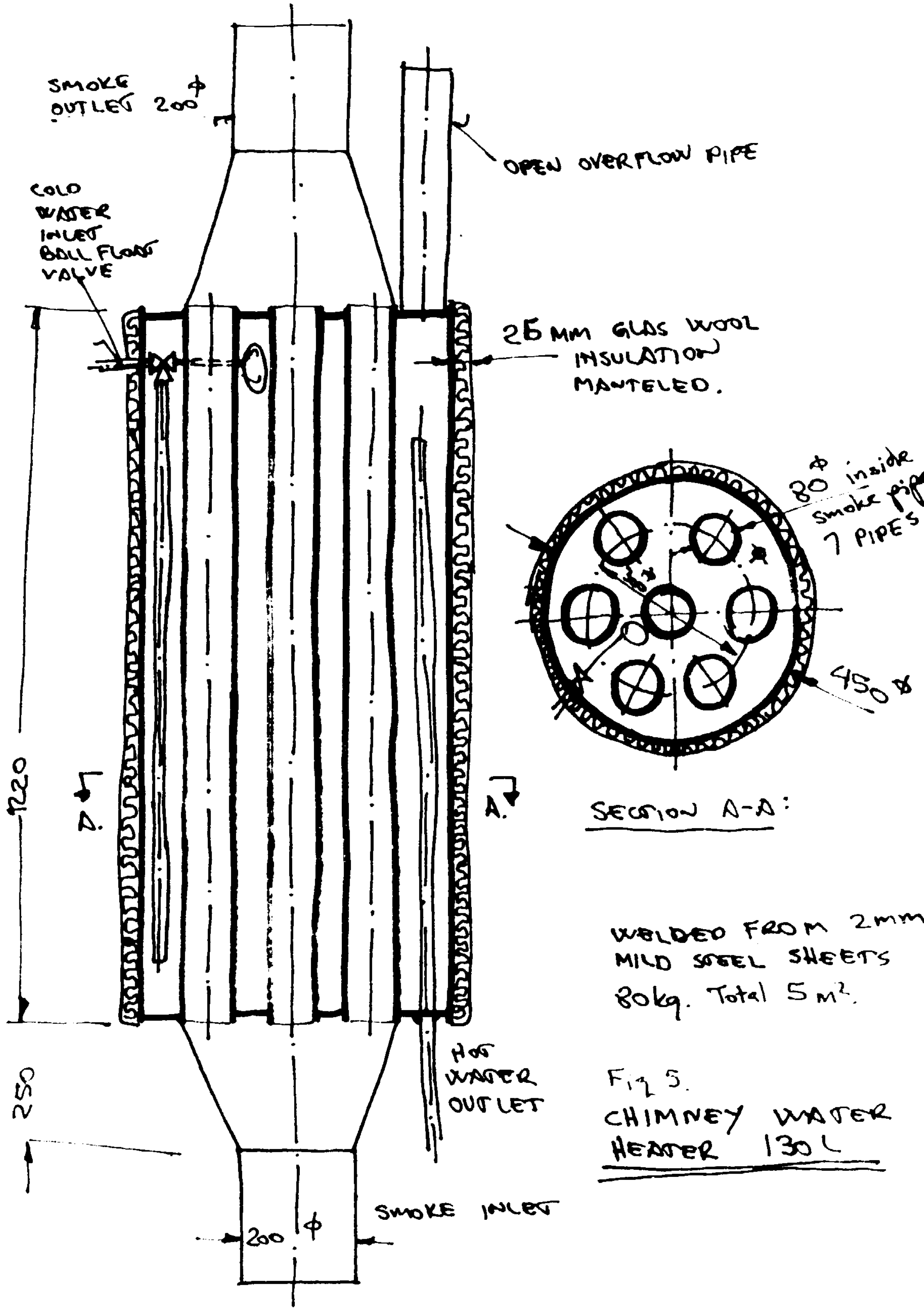


Fig 5.
CHIMNEY WATER HEATER 130 L

One will than get:

- Smoke speed; $V = \frac{850 \ m^3/h}{3.600 \ sek/h \times 7 \ pipes \times 0,005 \ m^2}$

$= 6,7 \ m/sek$

- Heating surface, $A = 7 \times 1,22 \ m \times 0,08 \times \pi + 2 \times 0,15 \ m^2$

$= 2,3 \ m^2$

- Heat transfere factor, $\alpha = (3,6 + 0,22 \frac{t}{100}) \ V^{0,75} \times \frac{1}{d^{0,25}}$

$\alpha = (3,6 + 0,22 \frac{530}{100}) \ 6,7^{0,75} \times \frac{1}{0,08^{0,25}}$

$= 38,5 \ kcal/m^2h^oC$

- Heat transfere, $Q = A.\alpha.\Delta t = 2,3 \ m^2 \times 38,5 \ kcal/m^2h^oC \times (530 - 65)^oC$

$= 41,700 \ kcal/h.$

This shows that the proposed water heater has 25% additional heat transfere capacity, allowing for some variations in the demand. The heater will take 150 liter water and have a weight of respectively 85 and 235 kg, empty and filled. The heater should be installed high under the roof and an alternative smoke pipe should be arranged.
The heater may cost Rp. 70 - 100.000 to install and will save about 5 liter petroleum/day, representing a fuel cost of Rp. 250 - 300.000 annually. It will hence be very economical.

10. SEPARATION OF SOYMILK FROM THE SOUP.

As at present, the soymilk is sieved off from the remaining okara through a sieve cloth over a sieve frame. When no more liquid comes, further water is added 2 times to wash out the remaining soymilk from the okara. The liquid that remains between the grains is hence finally becoming quite dillute and does not contain much more soymilk.

The liquid that still remains in the grains, however, still obviously has a higher milk concentration than the first milk that was sieved off. The quantities of soy milk remaining in the grains, hence are considerable. At least 3 ways exist to recover substantial portions of this:

a) Through recooking of the soup again after adding more water before renewed sieving.
b) through pressing the liquid out of the remainder
c) through a combination of recooking, resieving, and pressing after rediluting.

It appears that tahu manufacturers both in Japan and in Amerika are doing recooking once or twice, and pressing 3 times for a best possible recovery. In addition to getting an increased yield, they also avoid re-bacterization from adding fresh water with a certain content of bacteries.

How much higher yield they get is difficult to say but the total yield as they obtain are according to reports as follows:

Table 7. ADDITIONAL SOYMILK RECOVERY DEPENDANT ON RECOOKING AND REPRESSING.

Additional
Soymilk recovery in percentage of the original extraction after recooking with fresh water and repressing:

	Solids	Protein
2nd extraction	26 %	24 %
3rd extraction	7 %	6 %

The additional recovery one can obtain here, may be approximately the same, deducted what presently is washed out. However, the pressing that is practised in those countries, consist of putting the total filter bag into a simple screw press, to get out as much liquid as possible. We presume that what is possible to recover in that way is limited to the liquid that is present between the grains.

If using a roller press, or a screw press as in an mechanical oil expeller, certainly the pressure could be much higher and one could possibly get a higher recovery even without any recooking at all. One could than avoid both the extra cooking and the extra water volumes. (Presently partly used for dilution of the next batch).

To press the liquid out, rather than sieving it off, may turn out to have 2 important advantages:

a The yield may be better with less additional water added.

b The okara will occur in a fairly dry form, and require very limited extra drying for further storage, dispatchment or processing.

We will first of all now recommend some further tests to be made.
The test may involve pressing of the mainder after sieving in a simple roller or screw press, checking yield and quality of filtrate and okara, comparing the results with present practises in Indonesia and overseas as described above.

11. ADDING OF COAGULANT.

A range of different coagulants exist, including natural nigari, (natural magnesium cloride) calcium cloride, (common salt), calcium sulfate, (gypsum), magnesium sulfate (Epsom salt), Lactone, Acidic coagulants (including citrus fruit juices) enzymes (including papaya papain) etc.

Without going in detail, these coagulants give different flavours, consistences and water content of the tahu (volume yield). Suitable percentage, dilution, adding method and temperature differ from the one coagulant to the other.

Selection of suitable coagulants and procedure must be given due consideration and may differ from the one environment to the other. We will not here involve in this question but will recommend that the matter being given due consideration, being studied and recommendations to be brought up for different recommendable alternatives.

The many different qualities of tahu that is possible to make should in our opinion, also to a certain extent be possible for the consumers to have a choice of, and it may hence be recommendable for different manufacturers to use different coagulants.

Under all circumstances, it is however important that the coagulant solution will be added to the newly cooked soymilk in a bacteria free condition.

The coagulant solution should therefore be made with boiling water and kept under lid in a clean storage tank, preferably tapped through a bottom outlet.

Our recommendations hence remains as follows:

10.1 That the selection and use of coagulant be further studied an more detailed recommendation be made for their use.

10.2 That a bacteria free coagulant solution stock is kept.

12. PACKAGING, PRESERVATION SANITATION AND DISTRIBUTION.

The short shelf life of tahu is may be today's biggest problem in the tahu business.
Because the products do not last more than one day, one get the following problems:

- extra work and expenses in cooking, recooking and exchange of water on the product
- A salesforce that is 5 times higher than the number of workers in the production, because the product always must be presented fresh.
- wastage of a higher percentage of over-aged products
- limitation in consumption and sales because people are unable to keep tahu fresh in their houses and it is not always ready available when it is required.
- to high wastage among consumers.

Because of these factors, tahu, even if a reasonably costing product, becomes more expensive than necessary both for manufacturers and consumers.

The storage time or shelf life of tahu is determined by 3 factors:

1. The content of bacteria
2. The environment for bacteria growth
3. The storage temperature.

About bacteria

Generally 4 types of micro organisms can cause destruction of food. They are: Bacteria, yeasts, molds and viruses.

Virtually all problems of tahu are caused by bacteria. All bacteria in the tahu comes from outside. The bacteria can be divided into 3 main groups: those causing;

a) food poisoning
b) infection in the human body
c) food spoilage or souring only.

Luckywise it is group (c) of bacteria that mostly are spoiling the tahu. The dangers of food poisoning are much lower than e.g. for meat and mushrooms. Still, it is important to be aware of that food poisoning and infections are possible, and is dependant on which type of bacteria are allowed to enter the tahu.

Toxic bacteria dangerous for tahu are primarily staphylococcus aureus. They will generally come from people; from infected cuts, from pimples and from throats and noses of healtly people. Killing require 74°C for as much as 15 - 30 minutes. It is therefore extremely important to avoid any possible contact between the product and such organs.

Infectious bacteria include the various coli living in the sewer and in people's intestines. Proper hand washing in clean water must always be done after visiting the toilet. Infectious bacteria are killed at 78°C.

Spoiling bacteria include bacilli which are so common that they can not be avoided. They survive 7 minutes boiling and even short pressure cooking.

Some bacteria, like bacilli, form spores when they are in danger. To kill the spores, 121°C is required for 15 minutes. If such cooking is provided after sealing the tahu hermetically, the product can last at room temperature for at least 6 months.

About bacteria environment.

These ways to change the environment in the tahu to prevent bacteria growth are generally available:

a) by decreasing the pH to under 4,5
b) by decreasing the water, useable for the bacteria
c) by chemical preservatives.

a) To increase the acidity or to decrease the pH (to under 4,5) can be done by adding a food acid to the tahu. Normally the tahu is neutral (pH = 7). The acid will of course give an acidic taste to the product that not always will be appreciated. Both vinegar and citric acid may be considered. Both of them are possible to use also as a coagulant.

b) Tying up the active water can be done by adding alternatively;

   3 - 4 % agar
   1 - 2 % salt
   3 - 4 % sugar (but not less)

   Salt is the cheapest of the above (ordinary sea salt). The concentration that is needed is of course much too high for consumption, so some hours of soaking of the tahu in water is necessary before food preparation.

c) It is luckywise not normal to add chemical preservatives to tahu. and we will not recommend to do so. One will expect that they all have more or less serious side effects. Up to 1974 Tofuron was used by most tahu manufacturers in Japan, at 5 ppm. It was banned after discovery of some of its negative side effects.

About storage temperature.

It is not the presense, but the amount of bacteria that is in tahu that damages the product. The bacteria can not be killed by freezing or by lowering the temperature, but the bacteria growth can be slowed down.

Healtly tahu has been found to have a shelf life as follows, dependant on the continued storage temperature from the start:

Table 8.

TAHU SHELF LIFE DEPENDANT ON STORAGE TEMPERATURE.

Storage temperature, % C	Shelf life No of days.
30 °C	1
15 °C	1 1/2
10 °C	2
5 °C	5
4 °C	6
3 °C	8
2 °C	10
1 °C	12
0 °C	24

Obviously, tahu should be kept at a so low temperature as possible.

Practical ways to increase the shelf life.

According to the above, we can indicate the following methods for improved products and increased shelf life of tahu:

I Improved sanitation within the existing system and the existing production of the tahu factories.

II The use of natural preservatives

III Cold storage and distribution (and possibly freezing)

IV Pasteurization after sealing

V Sterilization.

We can comment further on these proposals as follows:

12.1 Improved Sanitation.

It is first of all the process and handling of the product from the cooking of the soymilk and onwards that require attention, since most bacteria are killed during the cooking. Improved sanitation in itself improves the product and its shelf life whether the product is being further protected or not. But most important is it of course when limited or no further measures are being taken. We will especially lead the attention to the following matters:

1. A bacteria free coagulant. There is no much help in boiling the soymilk, unless also boiling the coagulant that will be mixed into it. The coagulant is mixed in at a temperature very convenient for the bacteria to grow. As the practises are at the present, it can be expected to be full of bacteria.

This is especially serious because bacteria infected coagulant distributes bacteria all over, inside the tahu. These bacteria may not easily be killed even if the tahu is cooked later. That is so because the temperature takes a long time to reach from the cooking water to the middle of each large piece of tahu.

The solution of coagulant should always be cooked daily, and/or boiling water should be used for its solution. The coagulant must be kept in a clean tank under a lid. The tank may be safeguarded by the filling of the boiling water.
How the coagulant is taken from the tank is also important. If as seen, a bucket is taken up from the dirty floor and thereafter dipped into the coagulant, one can not expect the coagulant to remain bacteria free any longer. The best will be to use a tank with a bottom outlet to a tap, the lid remaining on all the time. No much bacteria will than be added.

2. <u>The filter frames and the utensils</u>. The filter frame used for scoping off the whey, the ladle that is used for transfering the tahu to the press, the soymilk tubs, the filter cloth, the pressing cloth, the press frames and the further untensils on this section, all add bacteria to the tahu. Especially the filter frames and the further utensils made from platted bambu are full of bacteria. Soy milk rests deposits in between the fibre and between the platting layers everywhere. It remains there and if rots. Fresh product is in extensive contact with these deposits, it gets mixed up, and bacteria will be well distributed not only outside the tahu pieces, but throughout the product, deep inside.

Which ever of these utensils are possible to cook, should be cooked every day after work, and hang up for drying. What can not be cooked should at least be thoroughly washed down with an effective desinfectant, chlorine or other.

As much as possible of the utensils should have an easy cleaning easy drying surface, as stainless steel or enamel. At least the platted bambu products should be exchanged, preferably with stainless or enamel ware. (It has also been noticed that some tahu is wasted because it partly goes through the rough platting of the sink-down filter frame).

3. Packaging and final heating. After cutting and packing the tahu into a 18 liter open tin, the tin presently is placed over the smoke – outlet of the cookers for heating, aiming at bacteria killing, before exchanging the water with cold fresh water and carrying the product to the market for sales.

With about 160 tins per day, 4 burners and 6 hours cooking, this reachs for maximum 9 minutes of heating. If one does not reach a temperature of at least 75°C in the interior of the tahu, this heating may do more harm than good. Heating to 50 - 60°C only makes the bacteria to speed up their growth.

More than that can not be reached with the short time heating with the method that its used, and even if exchanging with cold water, the tahu will still take a long time to cool.

The smoke outlets are not well fit for the purpose and we have also proposed to reconstruct the heaters. It is also a question whether the fresh water is reasonably bacteria free. The tins are carried around open, placed on the hill and placed on top of each other. Obviously than, further large amounts of bacteria will enter again.

We will therefore recommend 3 part solutions to the above. If will work best if all of them can be implemented together, but being efficient also when implemented separately:

a) **<u>To omit the reheating of the tahu.</u>** In stead, to take precautions as listed under 2 above, and to handle the tahu with clean hands, **ensuring** also that knife, the cutting board, etc, coming in contact with the tahu is kept clean and made bacteria free every day.

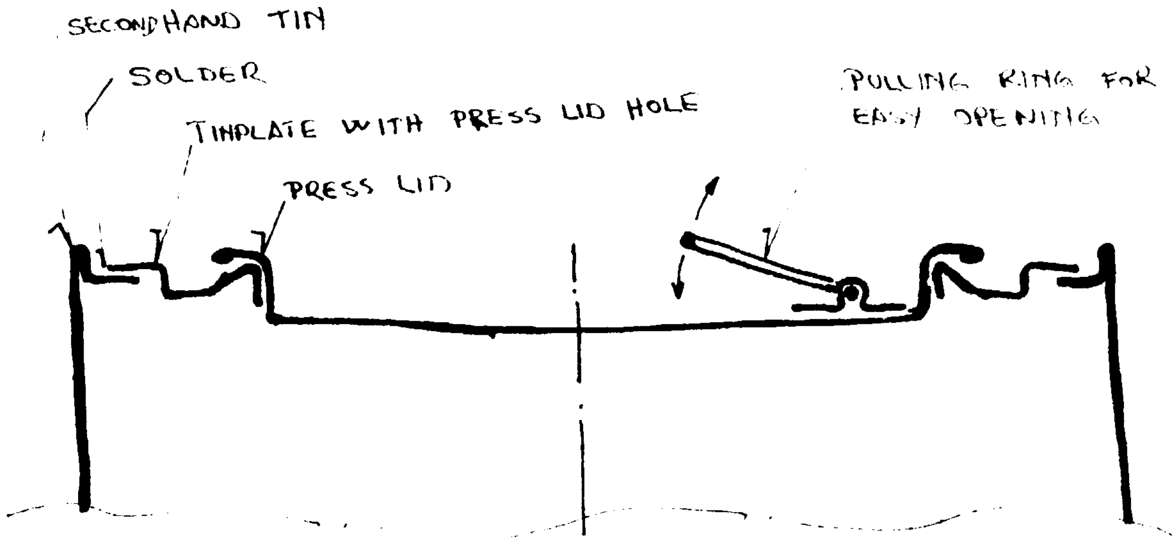
b) To make sure that <u>the cold water that is used is reasonably bacteria free</u>. It may be required to have the water analyzed bacteriologically. If the bacteria content is too much, one will need to use boiled water that afterwards is transfered to a closed cold water storage tank where it is allowed to cool as much as possible. Alternatively one may arrange water sterilization by other methods.

c) <u>To equip the secondhand tins with a press lid.</u> That can be done through soldering on to the tin top, a tin plate into which a presslid hole has been punched by the tin factory.

The factory already has available the required tools. Such solder-on lid systems may be made available through the cooperative who may order them in larger quantities.

It will also be sufficient if one can find secondhand press lids of sufficient size for this purpose.

FIG 6. LID ARRANGEMENT



One should when implementing these proposals see noticeable improvement in the shelf life of the tahu. The costs that are involved in establishing the implements are neglectible.

12.2 The use of Natural Preservatives.

As explained above, vinegar, agar, sugar, and salt may be used. The selection of additive is a question of cost, and a question of what the consumers are willing to accept.

We presume the most practical is to use salt. We also think that it at times may be beneficial for the consumers who does not have a **fridge** to buy salted tahu. Dependant on the salt concentration it may be stored in the house from a couple of days until months. Salted tahu must be soaked in water a number of hours before use.
We will recommend firstly to do some tests with salting of the remains that can not be sold the day of manufacture. On return from the market with unsold tahu, simply exchange the soaking water of the tahu with a salt brine containing not less than 2 % of salt.

One may at that concentration require about 150 gram salt per tin which may amount to less than 1 % of the sales price for the tahu. Clean sea water may also be used when available, normally containing about 3 % salt.

Left over tahu may easily be conserved this way, without any extra equipment, at reasonable costs, offering the customers an added advantage.

12.3 Cold storage and distribution.

As specified above (page 75) very ordinary tahu can be kept for up to 24 days when cooled sufficiently. That is of course dependant on a fairly quick cooling, and on that the low temperature is kept throughout.

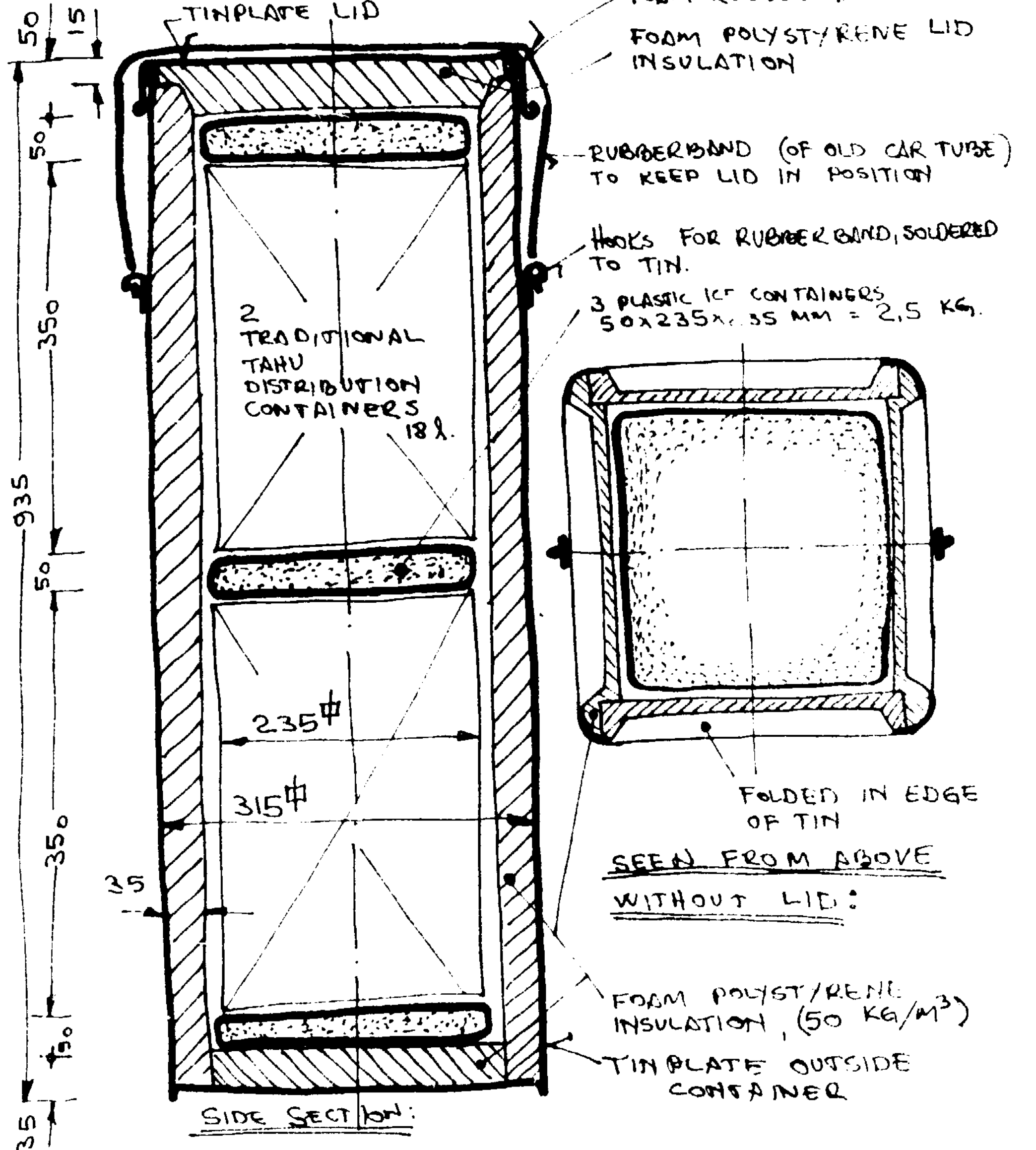
Cooled tahu may be kept in tins as at present or in plastic bags. If kept in plastic bags, the packing costs will increase, but less ice will be required because of the limited water volume. The cooling down time may be shorter and the cooling elements with ice easier to fit in between as fits best.

Also the carrying weight will be much less. Hence portion plastic bags may be prefered even if the cost of plastic bags for a bicycle load of 4 tins, about 100 pieces, may amount to around Rp. 500. Savings in weight may amount to 15 - 20 kg and in ice about 5 - 7 kg, representing arround Rp. 100 if purchased but less if frozen within the project.

The cooling can be arranged in different ways, with a cooling machine or with purchased ice, in a cold storage room, in brine, or directly into transport containers. We expect that the most rational solution will be to use insulated transport containers, where ice frozen in strong plastic bags will be placed in between the tahu containers. After melting, they may be refrozen again and again, without creating any melt moisture. They may also be filled with slightly salty water to lower the melting temperature if that would be decireable.

The proposed transport container, the cooling pack, and the freexing facilities are described in the continuation.

(a) The transport container is shown in the sketch next page. If consist of a large thin plate tin can with a tin plate press lid made for the purpose. It is lined with 35mm thick foam polystryrene giving very good heat insulation. The insulation should be of a heavy type, 50 kg/m^3. It will than be so strong that no inner lining is required, but still not too expensive or heavy. Shaped as shown on the sketch it does not need to be fastened into the container, only slid into position.



TRANSPORT & DISTRIBUTION CONTAINER, INSULATED, FOR TAHU.

INSULATION VALUE: $K = \frac{1}{1/\alpha_{inside} + 1/\alpha_{outside} + \frac{\delta}{\lambda}} = \frac{1}{1/6 + 1/12 + \frac{0.035}{0.03}} = 0,69 \frac{kcal}{m^2 \, h \, °C}$

HEATLOSS: $Q = K \cdot F \cdot \Delta t = 0,69 \times 0,95 \, m^2 \times (30-3)°C = 18 \, KCAL/h$

ICEMELTING (HEAT: From −5°C to +3°C) $I = \frac{18 \, kcal/h}{(5 \times 0,5) + 80 + 3 \, kcal/kg} = 0,21 \, KG/HOUR$

COOLINGTIME: +3°C $T = 7,5 \, KG \, ICE / 0.21 \, KG/HOUR = 36 \, HOURS$

Only the foam in the lid and the **foam rubber gasket** along the edge should be glued. A rubber strap holds the lid safely in position. The whole container will have a weight no more than 8 kg. It gives space for 2 x 18 liter tahu tins + ice packs and can easily be carried in similar, slightly longer frames, on the same bicycle.

An advantage of the container is it that it can be lent out to the tahu trader in the market or to the larger consumers where tahu can be kept at the lowest temperature for 36 hours before the **cooling** elements must be exchanged.

The tahu can remain **untouched** in the same container and be sold again the **next** day if not all is being sold the same day.
The complete container will probably cost between 12 an 15.000 Rp. each.

b) <u>The Cooling pack</u> or ice container is proposed 50 x 235 x 235 mm, made from e.g. 1,0 mm thick polyethyene foil, **welded** together all around and containing water.
Containing about 300 gram plastic it may from a small scale industry cost 5 - 800 Rp. each, **and having a cooling potential of 220 kcal per pack (for 2,5 kg from - 5°C to + 3°C).**

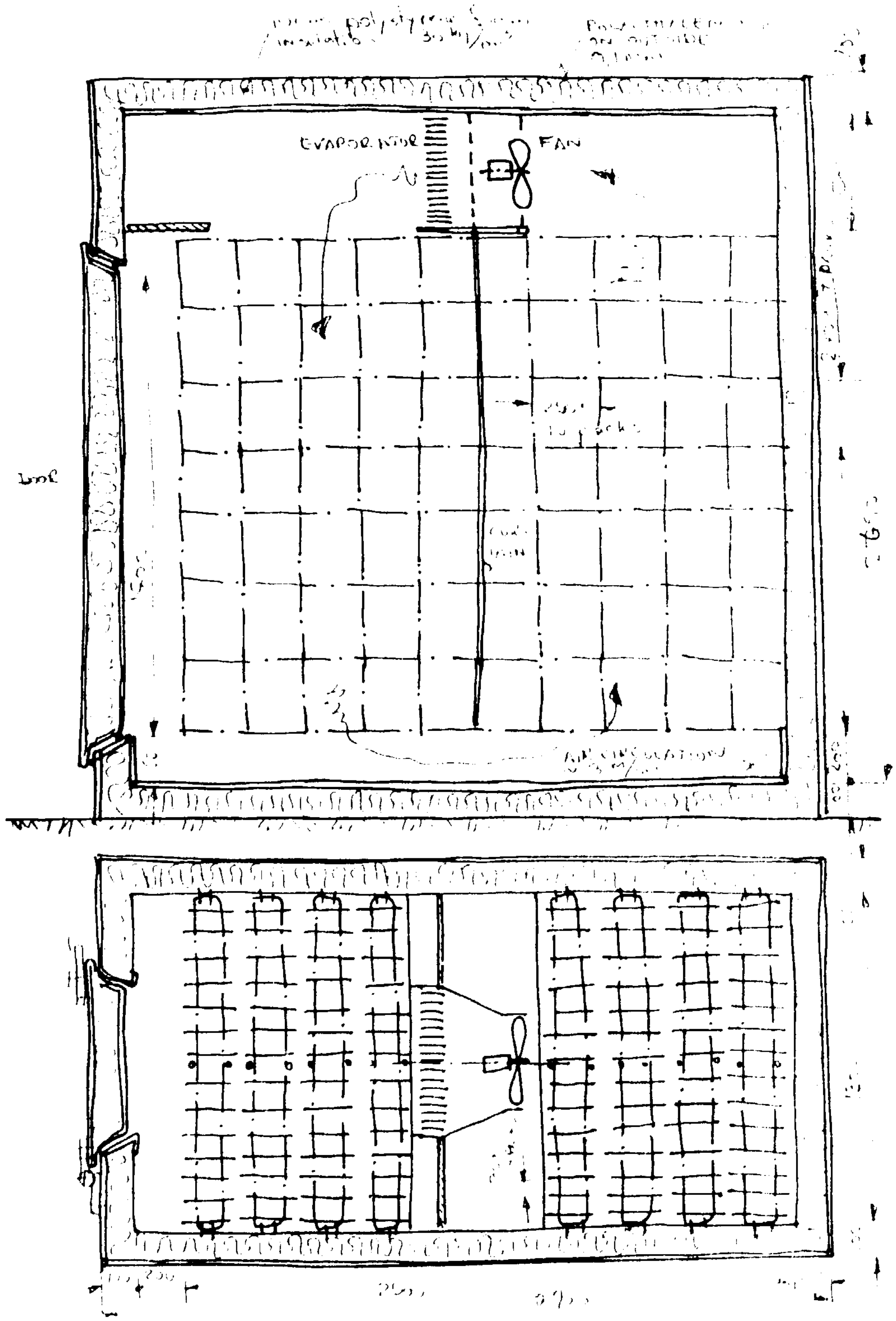
(c) The Freezing facilities for bulk ice and for the cooling ice packs are shown on the following 2 pages, while the heat and economy calculations are refered to appendix 1.

It is proposed during packaging of the tahu to cool the tin content down to about 2 °C by adding of crushed ice. When placing the tins in the transport container to use 0 - 3 ice packs as may be required dependant on the storage time that is required to enable a temperature of + 2°C to be kept for 36 hours or more.

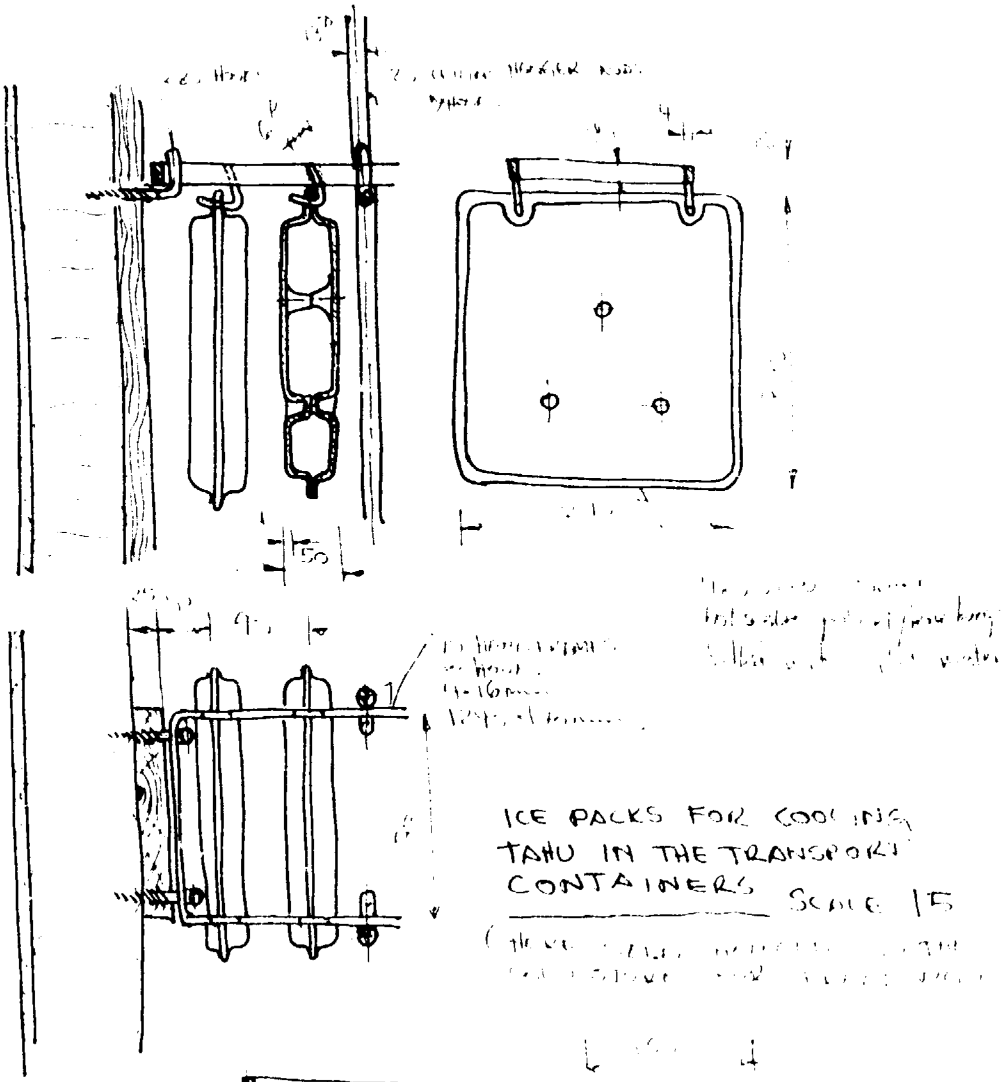
As designed, the storage room takes 1,5 m x 2,9 m space. We have designed the cold store for 480 ice packs and 288 ice containers, whereas if fully used with 3 packs in each transport container, about 240 ice packs and 150 ice blocks may be sufficient. The store room may hence be reduced accordingly.

The storage room is equipped with hangers for the ice packs and for the ice block moulds, and has a freezing aggregate mounted under the ceiling. A separate unit with condensor and compressor, 2,25 KW, may be placed outside for connection to the freezing aggregate.

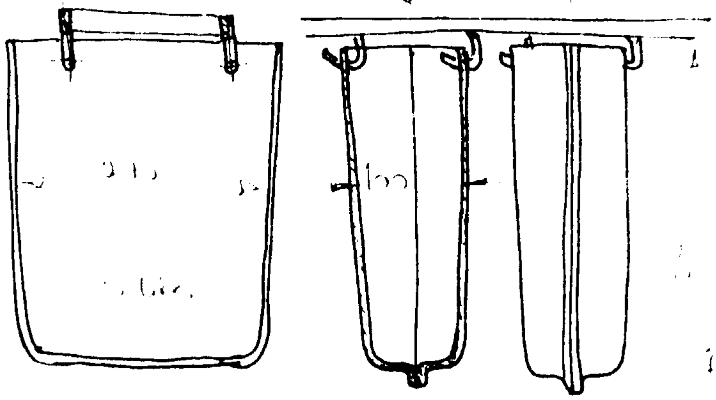
The total investment including cold store, compressor, condensor unit, transport containers, ice packs etc., is estimated at Rp. 3,45 million. The annual saving in the form of better preserved products and reduction in the sales force is estimated at Rp. 8,4 million.



FREEZING ROOM FOR COOLING PACKS SCALE 1:25



ICE PACKS FOR COOLING TAHU IN THE TRANSPORT CONTAINERS Scale 1:5



CONTAINERS FOR FREEZING OF ICE TO BE CHRUSHED AND USED FOR PACKING OF TAHU

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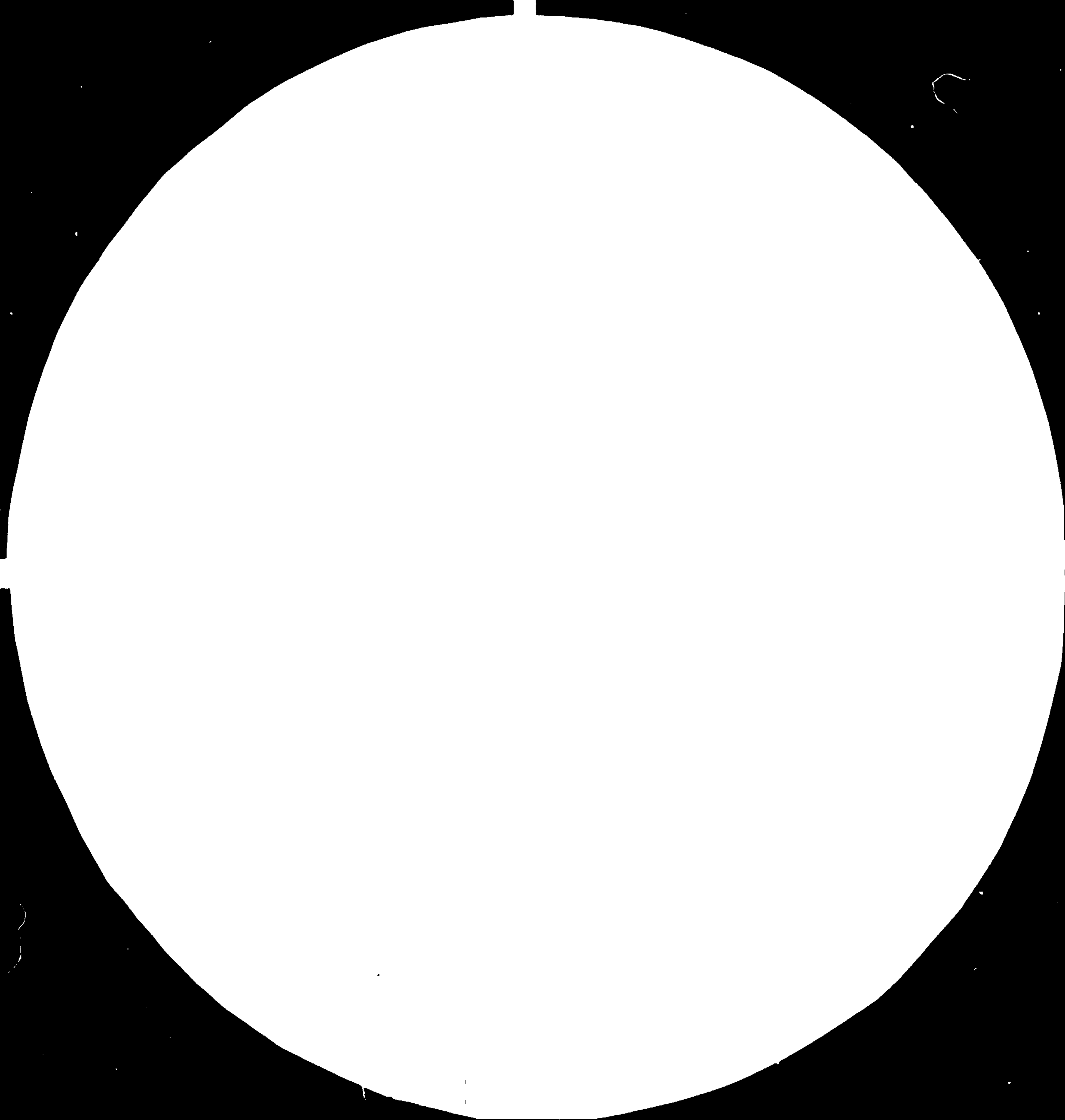
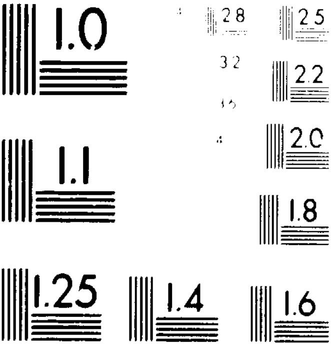




MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS

STANDARD REFERENCE MATERIAL 1010a

ANSI and ISO TEST CHART No. 2

Net annual saving deducted all costs are estimated at Rp. 5 million. Hence the annual saving are 1,5 times up the total investment. Even if the investment appear high, the economical prospects of the investment appear very prosperous. We have not here calculated with any increased price for the product or any increased activity due to serving a better product.

The savings, as it appear from appendix 1, have been calculated only in the form of a better sales price for products that would have been spoilt if cooling was not available, and in the form of reductions in the sales force.
If for instance calculating with a 5 % higher price for the product, additional annual sales of Rp. 3,75 million could occur.

However, starting a procedure of distributing chilled tahu has still wider prospects than this. When tahu in this way can get a shelf life of 1 - 2 weeks, a totally different pattern of selling and buying tahu may develop. Natural to image is distribution in larger quantities, transporting the whole day's production in 2 - 3 pick up loads to a lower number of customers, keeping the product in stock for sales over a longer time.

12.4 Chilled packaging in insulated transport containers.

If cooling the containers to 0°C only, without having any extra cooling magazine with icepacks, and packing them in the same insulated transport containers, made 15 cm lower, one will require less investment, lover costs, very limited space demand, but the temperature in the tahu will increase much faster during storage.

Still however, the alternative is quite sufficient to preserve the product based on quick sales. If the consumer has a fridge, he can still keep the product for a number of days. (It may not be necessary to add much ice to the tahu container during the packaging of tahu, most may be dissolved in the water in advance).
Based on similar calculation as above, and on the following data the temperature will increase as specified in the following table.

- Heat conductivity, K = 0,69 $kcal/m^2h^oC$
- Heating surface, A = 0,8 m^2
- Air temperature t_{air} = 30^oC
- Specific heat C = 1 kcal/kg x 18 kg = 18 $kcal/^oC$
- Time of temperature increase,

$$T = \frac{q\,(t_{after} - t_{before})}{K.A\,(t_{outside} - t_{m\ inside})}$$

When the outside temperature is 30^oC, and the start temperature for the tahu is 0^oC, packed in the insulation container, the 2 cans are full, and as long as the insulated container is not opened, the temperature will increase as follows:

Table 9.

TIME FOR TEMPERATURE INCREASE TO DIFFERENT LEVELS, PACKING TAHU AT 0°C, PLACING THE TINS IN AN INSULATED TRANSPORT CONTAINER:

Tahu temperature	Temperature reached after number of hours with 35 mm polystyrene insulation.		Time for temperature increase, based on 30°C outside temperature and 50 mm polyurethane insulation.
	At outside temperature = 30°C	At outside temperature = 45°C	
2 °C	2 h	1,5 h	3,5 h
4 °C	4 h	3 h	8 h
6 °C	7 h	4,5 h	12 h
8 °C	10 h	6 h	17 h
10 °C	13 h	8 h	23 h
12 °C	17 h	10 h	28 h
14 °C	20 h	12 h	36 h
16 °C	25 h	14 h	43 h
18 °C	30 h	16 h	51 h
20 °C	36 h	19 h	65 h
22 °C	42 h	22 h	73 h
24 °C	50 h	25 h	87 h
26 °C	61 h	28 h	105 h
28 °C	77 h	32 h	134 h
30 °C	110 h	36 h	190 h

As can be seen from this, and compared with the table on page 75 it will e.g. take 25 hours before the temperature reach 16 °C. Hence the product can be sold as very fresh the 2nd and possibly also the 3rd day without any change of water.

If the containers are not shaded **from** direct sunshine however, the temperature will easily reach 45 °C and the temperature will **rise** much faster.

Insulation of the transport containers with 50mm hard polyurethane instead of 35 m foam **polystyrene** will with a λ value of 0,22 give a K-value of 0,4 and the temperature will rise more slowly as specified in the last **coloumn** of the table. With such a transport container we expect that the tahu will be kept fresh also for the 3rd day, and the container can be kept by the shop keeper for selling very fresh tahu to the retail customers.

Making the container.

Both the outside tin plate cover and the polyurethane insulation of such containers can be made by a small scale industry, and may be made as follows; **referring to the** sketch, next page:

- Mould to be assembled with open lid and applied release agent.
- Bottom plate and outside mantle plate to be cut, shaped, applied sticking agent and fit into the mould.
- The 2 P.U foam components, 2,5 kg total, to be poured together in right proportions, mixed for maximum 1 minute and quickly filled into the mould.
- Fit the lid and wait 30 - 60 minutes for foam to rise, press and cure
- Dismantle the mould and the container is ready.

Ice for this purpose will, as calculated in appendix 1, be 640 kg/day. Based on 10% heat **losses** this amount to 30 kg/hour in 24 hours.

The ice must than during night production be collected in a insulated ice box.
One may used a flake ice machine, continuously discharging small ice flakes. About - 6°C refigerant and 3.300 kcal is required which may take a 1,25 Kw compressor.

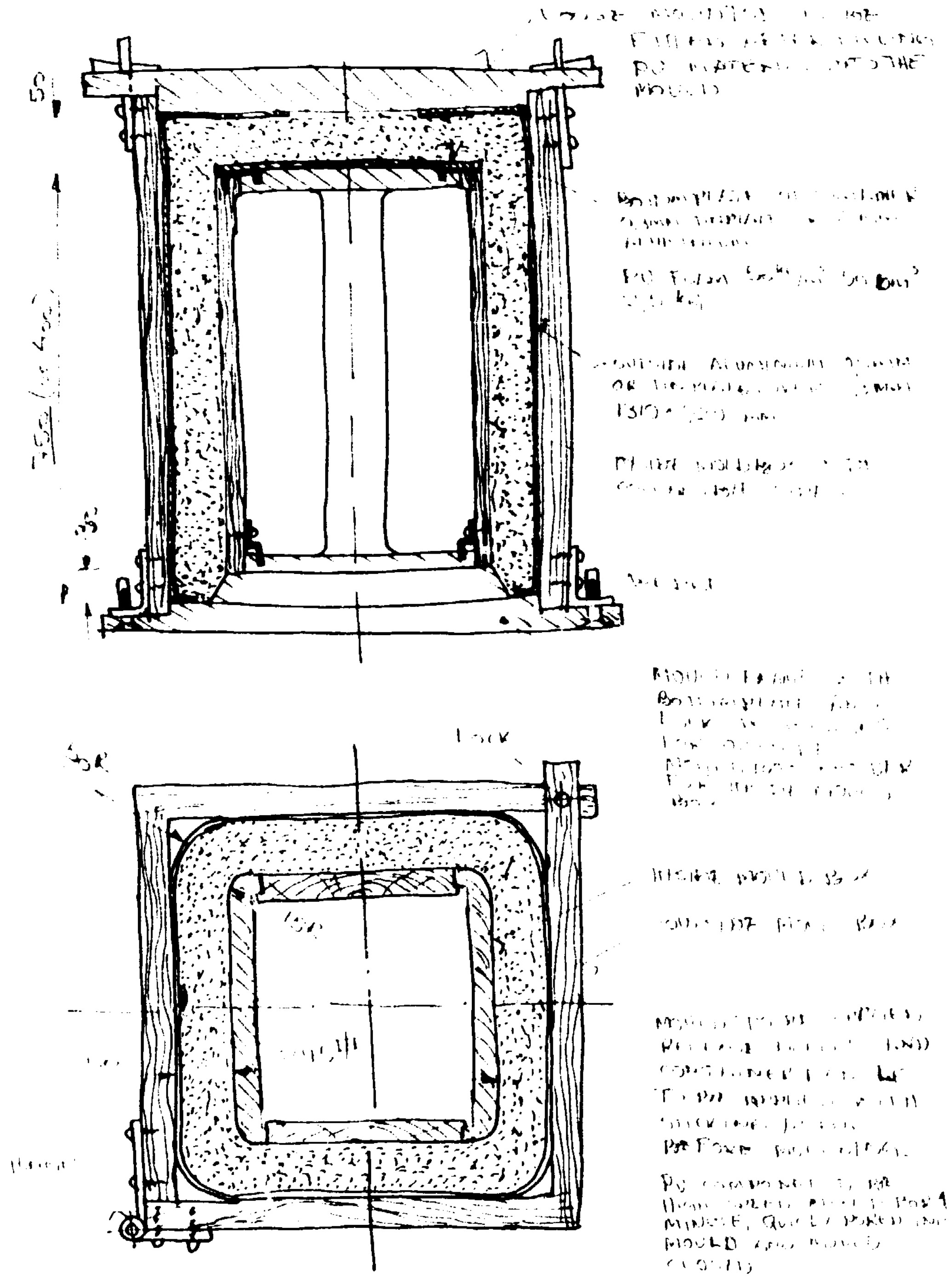
Investments:

Container:	2,5 kg aluminium sheet	Rp. 7.500
	2,5 kg P.U Components	Rp. 5.000
	Manufacturing costs	Rp. 4.500
	Total	Rp.10.000 x 80 pieces
		= Rp. 1.360.000

Ice flake machine	Rp. 600.000
Compressor 1,25 Kw	Rp. 340.000
Condensator coil	Rp. 200.000
Insulated ice container, refregerant, control, etc,	Rp. 200.000
	Rp. 2.700.000

Operational Costs.

Electricity, 1,25 Kw x 85% x 7.200 h at Rp. 120	Rp. 920.000
1/2 extra operator	Rp. 300.000
Maintenance, repair, renewals	Rp. 105.000
Interests and depreciations, 25 %	Rp. 675.000
	Rp. 2.000.000



MOULDING OF FOAM POLYURETHANE INSULATION CONTAINER FOR TAHU

Prospective savings may possible be as for the cold store alternative and hence giving very good returns on these costs and investment.

12.5 Pasteurization after sealing.

Pasteurization is an alternative to the other mentioned preservation methods, but may also be combined with the use of natural preservatives and/or cooling.
Pasteurization involves heating the product to a certain temperature for a certain time, in order to kill the most active bacteria, but still not being able to kill their spores. The higher the temperature, the shorter time is required. Earlier 7 minutes at 75 °C has been mentioned as a desirable goal. After pasteurization, bacteria will again grow, dependant on the temperature. How much the shelf life can be improved with storage at 25 - 30 °C is difficult to say, but certainly not more than 1 - 2 days extra.
Soymilk packed at 82°C after cooking may stay for 3 - 5 weeks when quick cooled, and than kept below 3 °C.
Initially some test packaging should be carried out, checking the shelf life, compared with ordinary packaging.

It is with pasteurization important to be aware of that it is not the temperature of the storage water that counts, but the temperature in the middle of the largest tahu pieces in the middle of the tin. Certainly a long time is required from heating the water. Until the temperature reaches the interior of the larger tahu pieces, the longer time. If slized to 1/2 thickness, cooking temperature might be reduced to about 1/4.

Now with 30mm thick tahu expected to have a heat conductivity probably around λ 0,5 kcal/m h°C, and a specific heat of C = 0,9 kcal/kg, when placing in water of 95 °C, the heating from 30°C to 75 °C may per dm² take something like:

$$K_m = \frac{1}{\frac{1}{\alpha} + \frac{\delta_m}{\lambda}} = \frac{1}{\frac{1}{500} + \frac{0.01}{0.5}} = \underline{45\ \text{kcal/mh}^\circ\text{C}}$$

$$Q = C \times p \times \Delta t = 0{,}9 \times 0{,}3\ \text{kg} \times 45\ ^\circ\text{C} = 12{,}2\ \text{kcal/dm}^2$$

$$\Delta t_m = 35\ ^\circ\text{C}.$$

$$T = \frac{Q}{K_m \times F \times \Delta t_m} = \frac{12{,}2}{45 \times 0.01 \times 35} = 0{,}77\ \text{h} = 45\ \text{min.}$$

It will obviously not be suitable to heat the tahu for as much as 45 minutes. That is first of all because the protein content of the tahu must be expected to be seriously reduced.

If calculating similarily with 15 and 20 mm thickness of the tahu pieces, and being surrounded by boiling water, it appears that one may need the following heating times to reach respectively 70 °C and 75 °C:

Table10.

REQUIRED HEATING TIME FOR PASTERURIZATION OF TAHU IN THE CAN IN MINUTES:

Tahu thickness	To reach 75°C		To reach 70°C	
	Water 95°C	Water cooking	Water 95°C	Water cook
3 cm	**45 min**	**37 min**	38 min	30 min
2 cm	22 min	17 min	18 min	14 min
1,5 cm	13 min	10 min	10 min	8 min

Hence, to reach a reasonable heating time for pasteurization is it necessary to split the tahu pieces, preferably to 15 mm thickness. 95^{o}C refers to heating of the tins in a cooking water bath, while cooking water in the tin require heating of the tins directly over the fire. Heating in a water bath is simpler.

If expecting that 70 ^{o}C in the interior is sufficient, according to this 10 min heating in a water bath will be sufficient. For the pasteurization to have any sense, the can must be filled up with boiling water after filling the tahu and the tins must be equipped with an air tight press lid as specified on page 80

Immediately after heating, the lids must be fixed and the cans placed in cooling water. The cans not to be opened again before removing tahu for sales. We can not say whether this cooking will reduce the content of proteins to any significant extent, or possibly affect other quality factors, but refering to todays heating of the cans, that will probably not involve any problem.

With a production intensity of 25 - 30 tins per hour, the water bath for cooking of the tins must be capable of at least 6 tins. The cooling bath having a continuous water flow, must be considerably larger, but here the cans may be completely immersed.

12.6 Complete Sterilization.

Killing of all the bacteria and the spores is possible if heating to 121 ^{o}C for 15 minutes (1). If the product packaging first has been completely sealed, the product may after sterilization be kept at room temperature for 6 months or more.

Sterilization can only be done under high pressure in an autoclave, and again the time must be long enough to allow the temperature to increase sufficiently in the interior of the product. It is an open question whether this is possible without damaging both the proteins and the consistence of the tahu.
The pressure of the autoclave must also be kept for so long that the temperature of the tahu can come down before the pressure is released. If not, both the packaging and the tahu will simply explode. Probably a procedure of filling the autoclave first with air pressure and secondly with pressure cooling water is necessary.

Sterilization of tahu in large packings does not have much sense. If sterilization should be done, it should be done for small consumer packings that the consumer is willing to pay a bit more for, and can keep in his house until heneeds it.
As far as we know, nobody are yet to do sterilized packaging of tahu in any commercial scale. That factor alone should not scare one off, because if anywhere sterilization can become a viable venture, it should be in Indonesia, where temperature is high and the bacteriological environment is difficult, and also where limited cooling facilities are available in the trade and in the households.

We will however not immediately propose any commercial realization of this alternative. Laboratory test packaging and autoclaving must first be done.

One may than aim at placing slices of tahu, may be 5 - 10 mm thick in a sealed and printed plastic bag, containing very little water and air, hot sealed and thereafter heated in autoclave.

One may do the following test; place 8mm thick wet tahu slizes aside of each other in a 0,15 mm thick plastic bag of sufficient heat resistance. Heatseal with a sufficiently wide welding strip, preferably under slight vacuum, place in a small test autoclave. Be sure the pack is located so that steam can reach the pack from all sides. Rise the steam pressure to 1,5 atm over-pressure. (Corresponding to 127 °C). Keep pressure for 9 minutes to allow **the internal temperature to reach 121 °C.** (This require a **certified autoclave)** If pressure is increased to 2 kg/cm = 132 °C, still 7 min is required which may not be a good idea, allowing a higher temperature in the outer masses of the tahu.
The internal temperature may increase about as follows:

After	2	min	80°C
"	3	"	92°C
"	4	"	102°C
"	5	"	109°C
"	6	"	113°C
"	7	"	116°C
"	8	"	119°C
"	9	"	121°C

Now decrease the temperature to 121°C, adding compressed air, and keep it for 10 min. (The packing may burst if the pressure drops). Check the internal temperature development in a control pack with a **thermo element.** Thereafter exchange the air pressure with pressure cooling water.

13. FURTHER PROCESSING OF TAHU.

Further processing of Tahu for sales has definetely its interest in general as alternative products that should be available on the market in addition to the ordinary tahu sold in a water bath.

We consider that it may become very viable ventures if somebody would like to start such manufacturing as their general line of production.

The other possibility, and the major reason to mention it here, are however the opportunities that lies in **further processing of unsold tahu before it gets too old. Further processing does not only** involve new and desirable varieties of tahu on the market. It also means increased shelf life and easier distribution.

We will mention the following alternatives:

- I Firm tahu
- II Pressed tahu
- III Smoked tahu
- IV Deep fried tahu
- V Tahu burgers
- VI Ready made tahu dishes
- VII Vitamine enriched Tahu.

We prefere to mention several alternatives since different manufacturers may choose different processing, dependant on the local circumstances.

Also some of the 2nd stage processing may be done by others, collecting tahu from different tahu manufacturers in the surroundings.

13.1 Firm Tahu.

Fresh tahu or unsold tahu may be pressed to firm tahu. Firm tahu is made by further pressing of the tahu pieces with a pressure of 0,15 - 0.25 kg/cm^2 (or about 400 kg on 45 x 45 cm area)
The pressure is not very high, but enough to compact the product considerably and to press the water content down to about 85 %.
The product is reported to have a shelf life of 4 - 10 days without any refrigeration or preservative.
Firm tahu should be wrapped in paper and sold dry.
It will be used in the cooking without any further treatment. It will than be a more concentrated product with a texture like cheddar cheese.
It is reported that 25 % of tahu sales in the USA is represented by firm tahu.

13.2 Pressed Tahu.

The only difference between firm tahu and pressed tahu is the degree and period of pressing and hence the compacting of the product.
Pressed tahu may get a pressure of about 5 kg/cm^2 or say 2,5 tons on a 22,5 x 22,5 cm press area. Press time probably 1 - 2 hours with filter cloth. The moisture content may average 60%. Again the product can be prepared into dishes as it is, and jets a texture something like ckichen mant The shelf life has been reported to reach 3 - 5 weeks.

Both firm and pressed tahu becomes of course very much more convenient to distribute and to keep, also because of the considerable decrease in volume and weight.
A simple hand screw press may be used for pressing of the products, representing very moderate investments.

13.3 Smoked Tahu.

Smoking is an excellent method of preservation and it gives a flavour which most people like.
Smoking of tahu must be based on already firm or pressed tahu. The smoking will generally again reduce the water content further with a weight reduction during the smoking of about 25%. Cold or warm smoking is possible.
In general has been recommended for tahu a smoke temperature of 50 - 60 °C for 24 - 48 hours.
A simple smoke chamber may be used, having a fire place with controlled air inlet in the bottom, and wire mesch sheves above again with a controlled limited smoke outlet on top. The tahu pieces may be laid on the wire mesh, or if pressed in larger flakes they may be hung. Use dry fire-wood and add up with sawdust for the smoke.
A temporary drum smoker may arranged outside, while permanent smoke chambers with chimery may also be arranged inside the building.

13.4 Deep fried Tahu.

Combined preservation and preparation of day-old tahu may be done through deep fat frying. The normal size normal tahu pieces first to be put under moderate pressure for 1/2 hour to drain water. Thereafter to be placed on a metal mesh frame and immersed in cooking oil 190 °C.

After 1/2 minute the tahu pieces will float and become golden brown. Turn around on the other side for another 1/2 minute before lifting out the frame and place the tahu on cooling racks before packaging for sale.

13.5 Tahu Burgers.

Tahu mesh, broken pieces and tahu with a poorer appearance may not be fit for any of the above mentioned processings. Such material, if reasonably fresh, may still be used to make tahu burgers for sale.
Tahu burgers are very popular in USA as a snack put into a bun sandwich with fresh vegetables as a vegetarian hamburger. It is difficult to say whether the product can become popular here.

Wash and press tahu pieces in a cloth until fairly dry. Mesh coarsely and add in ingredients as may be preferred for taste. In USA is preferred per 10kg of Tahu mash to add 100 gram grated carrots, 50 gram whole roasted sesam seeds, 150 gram Kambu (a sea weed) + salt and binder. As binder may be used 75 gram grated glutinous jam or possibly cassava flour.
The ingredients are mixed and formed into discs 120 mm diameter, 10 mm thick. Deep fat fry for 30 sec each side in 170°C oil, cook and wrap. The burgers may not last well until the next day unless refrigerated.

13.6 Ready made Tahu dishes.

A range of ready made tahu dishes can be prepared and distributed, fresh, chilled or frozen as the situation may be. Fresh dishes will normally not last for many hours. We will not give any prescription of such dishes, but rather refer to available cooking books (1) specifying a range of products fit for centralized preparation and distribution.

Such dishes should comply with local tastes and food habits. Examples of such products may be:

- Tahu/Egg salads
- Tahu/Fish salads
- Tahu **lemper**
- Tahu **pies**
- Tahu coconut cream Bars
- Tahu Puddings
- Sundry Baked Tahu products
- Tahu Cutlets
- Tahu Babyfood, etc. etc.

13.7 Vitamin enriched Tahu.

The possibility of adding vitamins to tahu is not a question about preservation or after-treatment, but a question about increasing the food value of tahu in general. Tahu is one of the major staple foods in Indonesia, and a product one rely on as basic source of proteins and other important **nutritients.** Tahu has a reasonable amount of Reboflavin and other B-vitamins, but is not rich in A and D vitamins, that in general are minus factors in Indonesian food. It should therefore be looked into whether A,D, and some B vitamins should be added to Tahu in general.

It is of course a major consideration, to which extent the vitamins will be preserved in the tahu and become of value to the human body. May be could the vitamins best be added into the interior layers of the tahu before pressing.

We can however not say how well the vitamins than can be distributed and how much will remain.

May be can vitamin additives more easily be used in firm or pressed tahu, but to be of widespread value, it should better be added to tahu in general. We can here hence only propose that further studies of these possibilities being undertaken.
The possibility of adding minerals may also be looked into.

14. USE OF THE OKARA.

Okara is the residue in the sieve after sieving off the soymilk further used for tahu production. 26% of the original dry matters in the bean remains in the okara. 17% of all the proteins in the beans, and it is the most useful part of the proteins, remain in the okara, and so does 29% of the solids.
On dry weight, okara contains:

24 % proteins
8 % fat
19 % fibre
49 % carbohydrates and minerals (probably respectively 34 % and 15 %).

Together with the other nutritients it compares as follows:

Table 11.

NUTRITIVE CONTENT OF OKARA COMPARED WITH OTHER FOOD.

Content	Dried Okara	Soy beans	Wheat	Rice	Maize	Dry milk	Soybean oil meal
- Proteins	22	38	13	7	9	25	44
- Fat	7	18	2	1	4	26	5
- Fibre	17	5	3	1	2	0	6
- Carbohydrates	30	24	70	80	70	40	30
- Minerals	14	5	2	1	2	6	6

Hence, it remains as a product with very high nutritive value.

The calorific value is not very high, and the content of digestible proteins is higher than for most other feed. The fat is of high quality, mostly unsaturated fatty acids, and the fibre consist in a form useful for the human digestive system. The product can be used for protein enrichment of human food and provides fibre which presently is an important ingredient for better functioning of the human digestion system. Fibre is in too limited proportions available in modern food. The minerals of the okara first of all include **Manganese, copper,** pottasium and **phosphours**, all needed by the body in limited quantities.

As okara occurs from local tahu production, it is not in any way pressed, and therefore contains huge amounts of water that slowly sieves **off.**
If pressed in an ordinary screw press, the okara my contain about 24% dry matter and 76% water. If pressed in a more mechanical way as indicated above, the water content can become very much lower.
Presently okara is mainly sold in a wet, extensively perishable condition, as cattle feed, collected by the farmers from the various tahu manufacturers at a very modest price. Some of the okara is **wasted and some very** limited quantities are used for oncom production.

We will indicate the following potential uses for the future:

I To be further pulverized to very small particles and remain in the tahu

II To get a better organized and increased use in oncom production

III To be mixed into tempe creating a special compact tempe quality.

IV To be used (by others) for production of soysages.

V To be used for manufacturing of crackers

VI To be used by bakeries as an ingredient in cakes and bread.

VII To be dried to okara flour (to be used in the house-hold and in organized production by others for sauce richening or for making products as specified above).

VIII To be dried and used as an ingredient in poultry feed.

IX To be dried and better organized in the use as a feed for cattle, pigs and other animals.

As indicated, many different uses of okara are open. The availability is also so great, say about 150.000 tons annually in Java, that different outlets will be required also in the future. What may fit for one manufacturer in one place, may not be fit elsewhere.
On the different uses we can comment as follows:

14.1 <u>Let the okara remain as an ingredient in the Tahu.</u>

It is possible to make tahu from whole beans, and the method is commercially used among others by the Pantnagar Soy Dairy in India.
The method uses 100% of the protein of the beans and also recovers 89% of the solids. The soy milk, and [illegible] the tahu becomes fully smooth and any remainder of the beans can not be traded. The method however requires a slightly different processing with somewhat higher investments. Firstly the beans must be dehulled, and we expect that it may be possible to do this after soaking in the same way as for tempe, loosening the hull with a simple roller machine, and thereafter separating the hulls.

Secondly the beans will be ground with water. The ordinary stone mill, however will not be able to grind fine enough. A Rietz disintegrator (model RP. 6-K 115, fitted with a screen with 0,023" perforations) is know to be used. The mass is being run through the grinder twice with the solids limited to 10% in water solution. After this, the mass is heated to 85°C and run through a simple homogenizer, pressurized to as much as 250 kg/cm^2 by a pump. This will presumably be sufficient as a mass treatment. The method will probably prove economically favourable compared with the existing methods and it will result in a reduced import demand for soybeans. However, increased investments are required for the more developed grinder, the pump, and the homogenizer.

The maintenance demand will increase, and further skill development is necessary. A few uncertainties exist and we can for the time being not recommend anything else than doing some further research based on the above for full clarification of product, process and economy. (The method was originally patented. Please refer to referred literature of Kuntz, Nelson, Steinberg and Wei for further details).

14.2 Improved and Increased oncom production.

Oncom from okara is already made in a limited scale in Jakarta, but the process and the product is not well known. The product is not manufactured under especially developed conditions and presentation of the product on the market is not so advanced that it gives high class consumers the necessary confidence. The product is therefore mainly consumed by the porest people.

The product is presented at a very low price. For that reason people tend to think that okara oncom is some sort of 3rd class food which at least serve the purpose of filling the stomach of starving people.
Nothing could be more wrong. Okara oncom contains probably as much proteins as tahu does and the proteins are of a **even** better composition than in tahu. The content of fat, fibre, and minerals is also much higher.

All together the nutritive value is higher and it contains elements of even higher importance for the body building. Presently the production goes as follows:

1. The wet fresh bag of okara from the Tahu manufacturer is placed between 2 board-plates in a simple mechanical press, served by a 10 ton hydraulic jack. Some water is pressed out, (about 10 liters from a 75kg bag). But presumably, the product does not become as dry as could be desireable.

2. 2 - 3% of dry cassavaflour is mixed in as a binder, whereafter the product is dry steamed for 1 1/2 hours in an open oil drum placed on an open fire, the steam passing through the okara from the bottom of the drum through a perforated dividing bottom 20 cm over the bottom. Petroleum fuel consumption is 30 liter/ day for 4 drums, = 8 bags of okara = 480 kg oncom.

3. After steaming, the mass is plastered into some wooden frames, placed over an old plastic foil on a plated bambu frame. The frame is thereafter removed and 2 "plakats", 25 x 18 x 1,8 cm, remain on the plastic. 800 pieces are made per day, 0,6 kg each.

4. As a fermentation starter, some oncom from last days production is spilled on top and the product is left to ferment in the open air. After 1 day the plakats are turned upside down. After 2 days the product is ready. It is still a fairly loose cake. It has grown in volume and is covered by a partly red, partly grey mold.

5. The product is now ready for sale. It will be sold between 3 and 8 A.M in the morning, brought around on an open bicycle frame, still remaining on the same plastic covered bambu frames. The sales price is Rp. 40 per piece, or Rp. 67 per kg. What is not sold at 8 a.m is thrown away.

The economy of the production may appear about as follows on a daily base:

Daily Inputs:

8 x 75kg bags of okara at Rp. 1.000	= Rp. 8.000
30 liter petroleum at Rp. 3.500 per 20 liter	= Rp. 5.250
2 kg cassava flour at Rp. 200	= Rp. 400
Excharge of plastic, bambu frames etc.	= Rp. 350
Rent of building, maintenance of bicycle, equipment, etc.	= Rp. 1.000
Wages to 3 family members at Rp.2.000	= Rp. 6.000
	Rp. 21.000
Product sales: 75% of 800 pieces at Rp. 40	Rp. 24.000
Profit 12,5%	Rp. 3.000

At least 30 such industries exist in Jakarta, processing may be something like 5.000 tons of okara or about 5% of the total availability. Making an improved product with an improved presentation, reasonable possibilities must be considered to exist for increased use.
May we propose the following:

1. A proper starter culture, "Neurospora" as is supposed to be, to be used with frequent intervals, not always only using old oncom for fermentation start, where obviously the bacteria culture as time goes, get mixed up with other bacteria, probably not all very desirable and healtly.
   The bacteria cultures to be laboratary tested with reasonable time intervals.

2. An improved binder, or increased volume of binder to be tried out. The fermentation started to be mixed into the mass after some cooling, and the mass to be better pressed into larger flakes, possibly re-pressing after fermentation, cutting it into suitable squares and individual packaging, probably in plastic or in briefing printed paper.

3. The product during packaging to be placed directly into a transport/distribution container as specified on page 91.
   Expecting to cool the product from 30°C to 3 °C, 1kg of ice is required per 3 kg of oncom. (If not distributing immediately, the ice may after 3 - 4 hours be exchanged with maximum 7,5 kg fresh cooled ice and may than last for 36 hours cooling at 3 °C.

4. If buying the ice, about 150 kg may be required per day for cooling and preserving the 480 kg oncom. At a price of Rp. 18 per kg, that amount to about Rp. 2.700 per day, or almost 1 mill Rp. annually.

That will still be economical getting increased sales of better products, and saving the spoiling may be of oncom for Rp. 7 million annually.
We will however rather recommend to buy a small freezer for the ice packs. The freezer may need space for about 250 kg or 100 x 2,5 kg ice packs.

This may possibly best be arranged with an insulated salt brine cooling tank served by a 2 HK compressor with air or water cooled condensator and evaporator in the brine tank.
Available from a small scale industry manufacture, such units may possibly cost under Rp. 500.000 and provide ice freezing at lower costs.

5. Some further oncom industries to be planned and established, better organized, and under more sanitary conditions than those already existing.

6. An information campaign for increased use of oncom to be started, informing about its nutrition values and giving recepies for good dishes.

14.3 Use the Okara for Tempe manufacturing.

In fact, several possibilities exist for making tempe from okara. We can mention the following:

- Pure okara Tempe
- Ordinary tempe added okara

- Tempe from brown rice + okara
- Tempe with wheat + okara.

The Tempe production book (6) says about the first mentioned, that okara tempe is an excellent product. They mention that for a good result it is very important to use well pressed okara, whose moisture content has been reduced to below 80%. They further say that this is an exceellent source of dietary fiber (14,8 % on dry weight basis), protein (32%), oil (20%), containing higher quality protein and higher protein efficiency ratio (per) than whole soybeans, full fat soy flour, soymilk or tahu. At least one commercial American company makes the product on a regular basis.

Rather than recommending the tahu manufacturers to make okara tempe, will we propose to arrange with tempe manufacturers to buy the okara and use it in their production.

14.4 "Soysages"

The "Tofu & Soymilk production book" describes this products developed in America, as the simplest and best way to utilize okara. They say that the product is packed with nutrition, can easily be produced in large quantities, and refer to several companies doing so. They give the following recepie for the product:

13	liter	okara
5	"	wheat germ
5	"	whole wheat flour
3,3	"	nutritional yeast
2,5	"	oil
1	"	shoyu
0,2	"	oregano

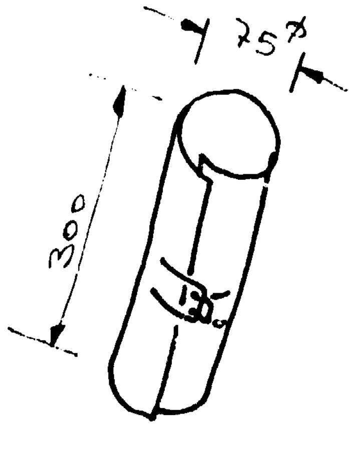
0,2	liter	prepared mustard
0,2	"	garlic
0,15	"	allsprice
0,12	"	salt
0,1	"	sage
0,015	"	cayenne

A little liquid smoke (hickory smoked water). You may add enough soy milk to give the desired consistency.

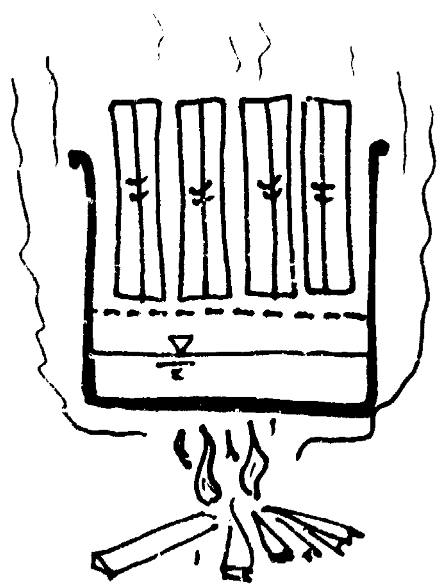
Mix the ingrediences well and fill in mould. The moulds to be 75 mm diameter, 300 mm long, open in both ends, rolled up of a stainless steel or tin plate with along-side lock (see sketch).
Place the moulds upright, ends covered with aluminium foil, on a frame above 50 - 80 mm of water in the bottom of a pan.

Steam cook at atmospheric pressure for45 - 60 minutes. Open the tubes a-long-side, slide out the soysage, cut in 200 gram discs, and close into a printed plastic bags ready for sale.

To serve they are sliced into thin rounds and fried in oil on both sides until crisp and golden brown. They may possibly be served like breakfast sausages with scrambled tahu, used in sandwishes or piza, mashed and used like a vegetable pate, or simply served with steamed rice.



SOYSAGE MOULD



SOYSAGE STEAMING

We will recommend initially to do some test manufacturing of the soysages and see how they can be liked in Indonesia.

14.5 Okara in baked goods.

Jenny Bratsford (5) says about full fat soy flour that this has been used since many years added to wheat flour in production of ordinary bread.
It bleaches the yellow pigment in wheat and makes bread whiter. It improves the texture, and helps the bread to keep longer without adding of chemicals. She recommends it as an ingredient in bisquits, soups, gravies, stews, slimming and health food.

Shurtleff & Aoyjagi (1) specifies okara used in bakeries like bran, to add natural fiber and protein, to give a crumbly texture to bread, muffins, brownies, fudge, cookies etc.
Compared with full fat soy flour okara is richer in fibre and minerals. It is not unlikely that okara may be as well, or possibly better suited for these purposes than full fat soy flour.

Initially we will recommend to discuss the matter with leading bakeries and bisquit manufacturers, and thereafter to do some tests.

14.6 Okara as ingredient in other food.

Okara burgers: To contain (1) dry cooked brown rice, okara, carrots, onions, garlic, whole wheat flour, corn oil, sesame seeds, rooled oats and salt.
Mix and pureé well and press into discs and freeze immediately. To serve, bake at 175°C for 40 minutes or deep fry in oil. Serve between halve buns with trimming as a snack.

Other possible uses include:

- Okara crackers or (baked with a binder)
- Okara & Vegetable saute
- Okara in salads
- Party mix with okara, nuts, sunflower seeds, shedded coconut, rasins etc.
- Okara granola, and okara granola candy bar
- Okara as mie or sparghetti.

Such uses can best be developed and promoted by manufacturers in the respective mentioned trades. Initially the cooperative should look at it as their task to encourage and assist the different manufacturers in the respective developments.
See the book of Tahu (8) for further information on okara food products.

14.7 Okara flour.

Products as mentioned above can most of them obviously not be made by the tahu manufacturers themselves.
Okara may be used as an ingredient by existing manufacturers or give background for new production. It is in many cases possible to use okara as it is, but in most cases it will be too cumbersome because of its short shelf-life. The okara must therefore be dried into floor. That may be done by one industry located adjacent to a cluster of tahu manufacturers, but probably as well by the tahu manufacturers themselves.
The manufacturing of okara flour involves:

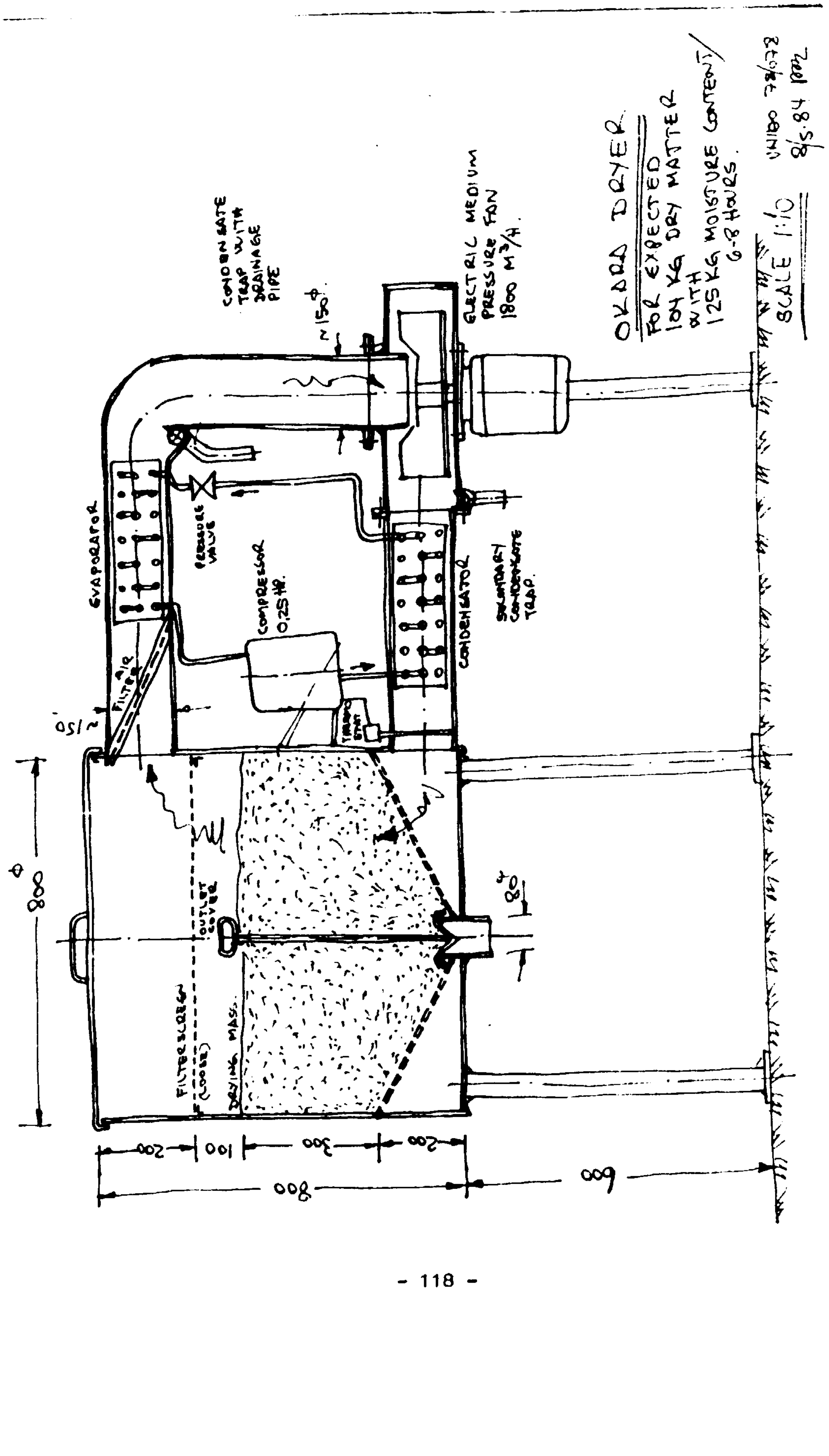
1. Pressing out the rest liquid content

2. Drying to 13% moisture content or less
3. Sifting.

As described in para 9, pressing of okara should in all cases be done to recover the soy milk for increased tahu yield.

One should not attempt to dry the okara unless it is first pressed to get the water content down at a reasonable level. The economy of the flour production is dependant on the pressing efficiency and the remaining moisture content after pressing.
We may during the drying process need to lower the water content from something like 60% to 13%. That means that for every kg of product, 1,2 kg of moisture must be evaporated. The energy required for this amounts to about 650 kcal/kg moisture. For petroleum at Rp. 175 per kg, 11.000 kcal per kg and 60% efficiency, that would cost about 17 Rp./kg dried flour.

104 kg of okara daily would hence require 12 liter petroleum per day or Rp. 650.000 annually.
We will rather recommend to use a dryer on a heat pump basis. Calculation of the dryer, as we can propose it, and a scetch of it is shown in the continuation.


OKARA DRYER
FOR EXPECTED
104 KG DRY MATTER
WITH
125 KG MOISTURE CONTENT/
6-8 HOURS.
SCALE 1:10
UNIDO 78/078
8/5.84
ELECTRIC MEDIUM PRESSURE FAN 1800 M³/H
CONDENSATE TRAP WITH DRAINAGE PIPE
EVAPORATOR
PRESSURE VALVE
COMPRESSOR 0.25 HP
CONDENSATOR
SECONDARY CONDENSATE TRAP
AIR FILTER
FILTER SCREEN (LOOSE)
DRYING MASS
OUTLET COVER
~150
~150
880
80
200
100
300
200
800
600

The dryer consist of a vertical drum with a conical screen bottom and a lid. The okara can be filled into the drum as soon as it emerges and can be drained through the bottom when dry.

Air circulates through the drum from bottom to top, and passes through a screen and a filter to protect the equipment from dust.

The air circulates over an evaporator, a circulating fan, and a condensator, before again being passed back to the okara in the drum. No exchange of air will take place.

When hot, dry air is passed through the okara, it will be moist and cool. When further passing over the evaporator, it will be further cooled and moisture will condensate and be drained. The condensation releases heat back to the system again.

Before passing back into the dryer again, the air will be reheated and hence become dry. The heat that was drained in the evaporator is led back into the system again in the condensator. The energy consumption of the system will therefore be very limited.

We expect that the annual energy consumption will be limited to about 1. Kwh and cost a small fraction compared with a dryer based on heating.

The major components of the dryer are:

- the drum with screens
- the circulation fan
- the compressor, condensator, and evaporator as in a small air conditioner.

We expect that it may be possible for a small scale industry to manufacture this unit at a total cost in the range of Rp. 500.000.

Maintenance and operation costs may all together amount to less than Rp. 500.000 p.a.
Selling about 30 tons p.a. this results in processing cost of not more than 15 Rp./kg.

Selling the product e.g. at a reasonable price of Rp. 100 per kg, an extra annual income over 2 mill Rp. will be created. A pilot plant should first be made, tested and probably modified before we will recommend the various manufacturers to install the dryer.
After completing the testing, the dryer should be made by small scale metal manufacturing projects for sale to the tahu manufacturers directly and through the various cooperatives.

Table 12.

CALCULATION DATA FOR THE PROPOSED OKARA DRYER.

The air conditions at the various stages in the dryer:

	Final Tempe-rature	Air Moistu-re %	Air Mois-ture kg/kg	Heat Content dry air kcal/kg	Heat Require ment for Evapo-ration kcal/kg	Heat from Condensation. kcal/kg
Air cooled through the evaporator	8°C	100	0,0065	1.8	-	5,1
Air heated through the condensator	50°C	10	0,0065	12	5,1	-
Air absorbed moisture in the okara	25°C	80	0,016	5,5	-	-

Drying Requirement: 104 kg okara containing 60%, or additional 125 kg moisture.

Drying time : 6 hours

Required drying capacity; $\frac{125\ kg}{6\ hours}$ = 21 kg moisture/hour

Required air circulation:

$$\frac{21 kg\ water/h}{0.0095\ kg\ water/kg\ air \times 1{,}29\ kg/m^3 \times 3.600\ sek/h}$$

= $0{,}48\ m^3/sek$.

Dryer drum dimensions: $\frac{104\ kg}{0{,}6\ kg/dm^3} = 175\ dm^3$. Diameter 0,8 m

Height 0,35 m

Air speed in dryer : $\frac{0{,}48\ m^3/\ sek}{0{,}5\ m^2}$ = 0,96 m/sek

Air speed in pipes, 150 mm Ø = 2.65 dm^2 $\frac{480\ liter/sek}{2{,}65\ dm}$

= 18 m/sek.

Calorific requirement : 12 - 1.8 + 5.1 = 15 kcal/kg x 21kg/h

= 315 kcal/h gross.

El.power requirement : $\frac{315\ kcal/h}{2.000\ kcal/hp}$ = 0,16 Hp.

A medium pressure centrifugal fan is required.
The exact required air pressure must be determined throug a test.

14.8 Am ingredient in Poultry feed.

Okara alone is not an ideal poultry feed. The proteins must be balanced up with animal proteins, probably up to 40%. Also calcium and ribovflavin must be added. Morrison (7) refers to numerous experiments and says that soybean oil meal gives excellent results when used to replace at least one half of the animal protein needed to balance rations for chicks, growing pullets or laying hens. He also says that satisfactory results are generally secured when soy bean oil meal replaces a considerably larger part of the feeds of animal origin.

If a too large proportion of soy bean oil meal is used in the starting mash for chicks, throuble from "pasting up" may be experienced. However, when great care is taken to supply proper amounts of calcium, prosphorus, and other B-complex vitamins, reasonably good egg production and growth of chicks can be secured also when soy bean oil meal replaces all the fish meal, scrap or tankage in usual rations.

Raw soy beans or even cooked whole soybeans are much less satisfactory than soybean oil-meal for poultry. Okara it already ground, it cooked, contains proteins, fat and carbohydrates as soy bean oil meal do, the content of metal is higher, and so is the fibre content.

One may expect that okara in the principle is as good in poultry feed as oil meal is. One can however not automatically draw such conclusions without first carrying out tests under scientific reliable conditions.

The proportions and the composition of the feed will under all circumstances be different because of the different proportions of proteins and minerals.

We can for a start therefore only recommend to establish tests. One may possibly also find out that the increased content of fibre is not very favourable for poultry, and that the content of okara in poultry feed therefore must be limited.

14.9 Okara as feed for other Animals.

Proper cooking and milling of soybeans increases the feed value greatly for non ruminant animals as swine and poultry, while it is less important for cows and sheep. While through cooking (7) greatly improves the soybean protein for non ruminants, too high heat or too prolonged cooking reduces the value because it destroys or make unavailable lysine or certain other amino acids.

<u>For dairy cattle</u> it is said that soy bean oil meal is one of the best protein supplements, Because of the excellent quality of proteins it can be used even as a dairy calf starter without any animal protein supplement such as e.g. skimmilk.

<u>For beef cattle</u> it is said that soy bean oil meal is one of the best protein supplements, excellent for fattening and for the breeding herd. Its limited fat content makes it more palletable than whole soy beans.

<u>For sheep</u> soy bean oil meal is equally excellent but so is for them also whole beans.

For pigs soy bean oil meal is when properly cooked (as for okara) described as the best of all common protein supplements of plant origin and gives excellent results also when used as the only protein supplement when calcium and phosphorus is added.

This can be taken as a good indication of the value of okara or dried okara, but as shown in the table on page 105 the content of okara differ somewhat from the content of soybean oil meal.
Hence correspondingly higher quantities should be expected to be required, and some feeding tests may be required to confirm the results.

It appears obvious that the okara has a higher value as animal feed than what is reflected in the todays market price for the product.

15. USE OF THE WHEY.

The liquid that remains when coagulating the tahu out of the soy milk, is called whey.
The whey normally has a volume of 8 x the bean weight. For 400 kg beans per day, hence 3.200 liter whey develop. The whey is a very dillute solution with only 1% solids.

Out of the 1%, 59% is uncoagulated proteins (1). That is about 9% of the total protein content of the beans. The proteins in the whey are of higher value than the proteins in the beans on an average, with a high portion of lecitin. Also noticeable portions of the B-vitamins goes into the whey. The further 41% of the solids in the whey consist of sugars (that may cause intestine gases), and also a major part of the coagulant itself.

Technically the following uses for the whey are possible:

- to be used as a drink
- to be used as animal feed
- to extract the proteins
- to be used as a soap, shampoo or hair conditioner
- to be fermented to fuel alcohol
- to be used as an organic fertilizer.

Further to this must be added that the whey is harmful when drained to the sewer system, first of all because of its high biological oxygen demand load (BOD).
It extracts high portions of oxygen out of the water and makes it difficult for the fish to survive.

Because of the dillution of the whey it is however difficult to utilize commercially and most of the above possibilities are only of theoritical interest.
The most realistic uses, if the tahu production is locate near to an animal farm and/or farmland are the following two:

a) to let the animals drink the whey as an alternative to water
b) to use the whey as a combination of irrigation and fertilization for gardens, vegetable cultivation, and others.

One may here consider the higher values of using natural, rather than chemical fertilizers. It is however limited how far the whey can be transported economically for these purposes.

If one let say puts a value on the solids of Rp. 300 per kg, the dilluted whey will then contain values of Rp. 3 per liter.

A farmer having let say an animal cart with a tank, may carry something like 1 ton of whey, or values for Rp. 3.000. It may still be economical for him to collect the whey if he gets it free of charge or pays it at a maximum of Rp. 1 per liter, especially if he has to do efforts for watering any-way.

Obviously, rather than to carry water for such purposes, does it pay better to carry whey, whether for own use, as a service to farmers or gardeners, or for sales in general.

16. IMPROVING THE FACTORY LAY-OUT.

Some manufacturers have fairly practical and sanitary installations with conveniently located equipment, light and tile covered walls and floors, good working light and an organized work flow. Some also manages to keep the place fairly clean and tidy without any smell. Others have none of these conditions fulfilled at all.

The poorer the building facilities are, the more important is good lay-out, carefulness, and clean habits. In the practise however, this is mostly the other way around, and one can find some badly organized, stinking places, where also the production flow is made so backward that reasonable sanitation is difficult to maintain.

Dependant on variations in final processing, in type of equipment, in building facilities, and capacity, the lay-out can not be equal. Still one must always consider to get a practical flow with simple movements and short distances from one process to the next.
The following goals are especially important to achieve, and extensively dependant on a good lay-out:

- good space utilization
- sanitary production
- limited transport and movements in the production
- high production
- limited no of workers, and reasonable labour costs.

In planning a practical lay-out one should consider the required capacities on the different steps and the flow of production. A regular flow diagram is shown in the continuation.

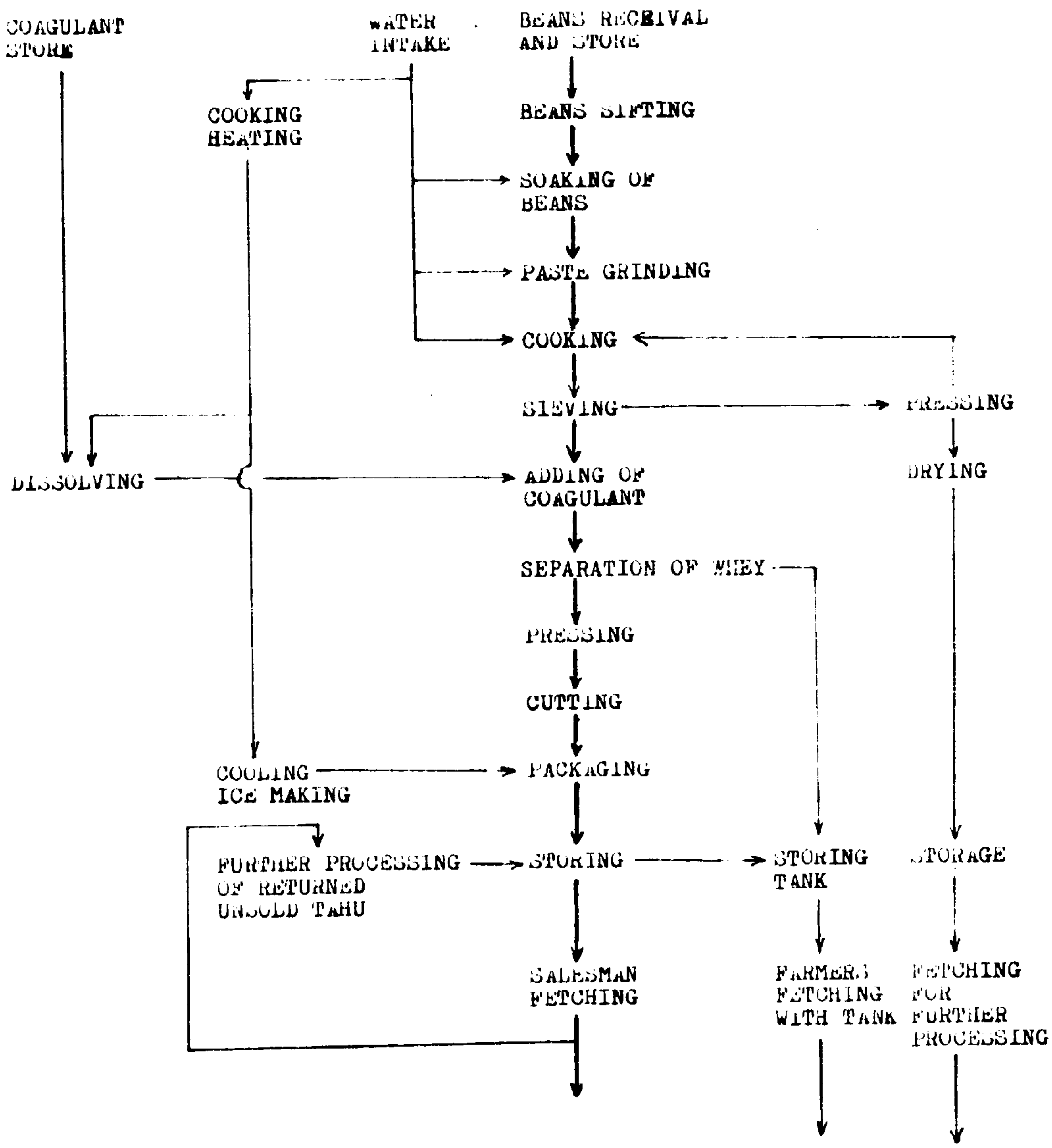
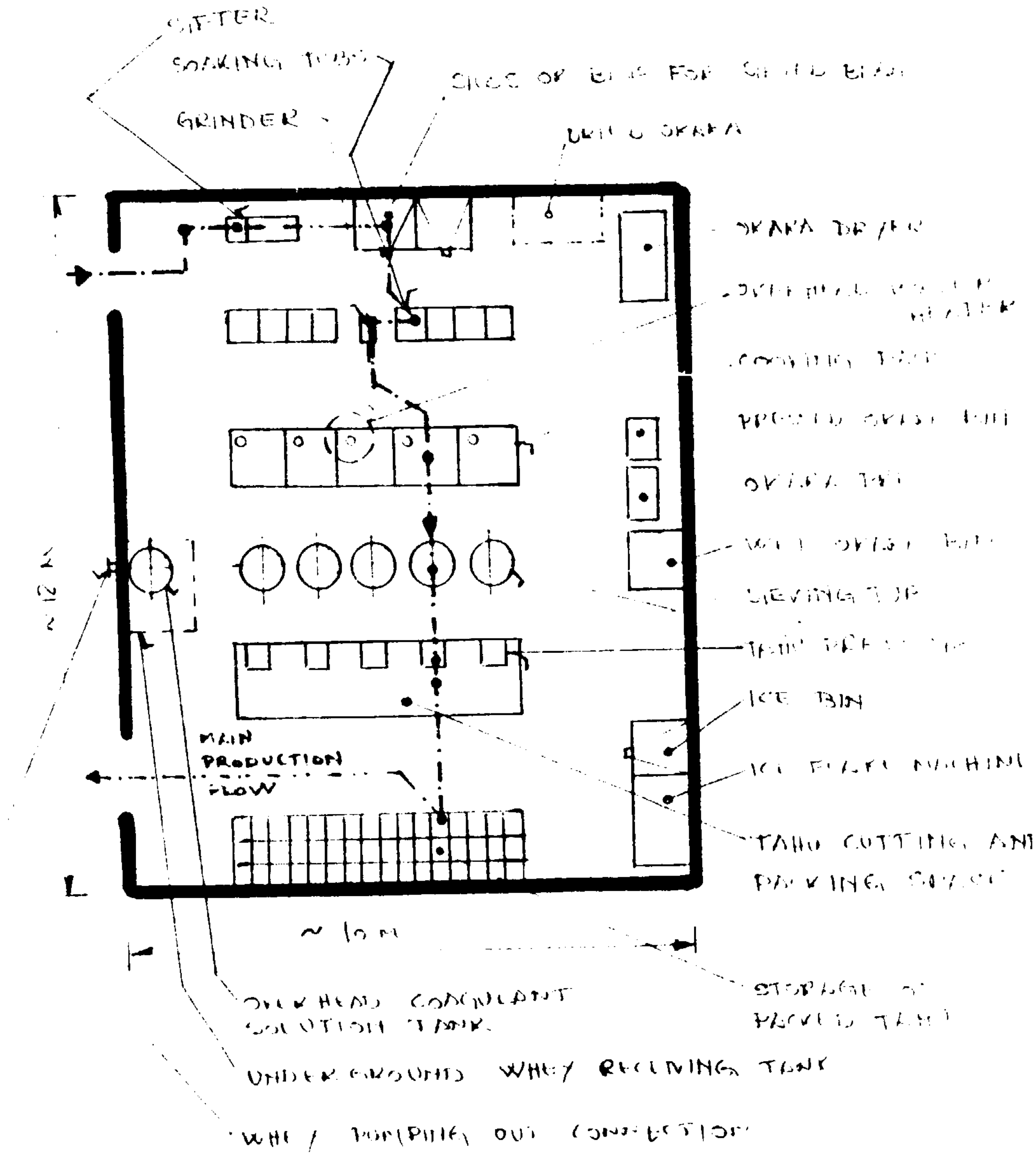


Fig. 13. Flow Chart for the Tahu Production.

Based on this, a principal lay-out basis for the processing of 400 kg of beans per day look about as shown in the continuation.

When making sketches to scale, it will for most buildings be possible to get a similarly streamlined production flow.
This must be seriously considered for all new installations. It will also often pay to do adjustments in already established production.



GENERAL LAYOUT FOR TAHU PRODUCTION

17. BICYCLE TRANSPORT.

To carry up to 100 kg on a bicycle is a very heavy load, especially when carrying from place to place with frequent stops and over many hours. Considering also what has been mentioned above, if will be beneficial if one in the future can carry larger amounts simultaniously.

Especially in Jakarta, the becaks are presently being escallated from the streets, nobody knowing really best what to do with them.

A number of these may easily and at limited costs be rebuilt to suit the transportation of Tahu.
A rebuilt becak may take a load of a maximum of 200 kg tahu and will be more convenient to operate than an ordinary bicycle.

We would suggest a protype to be rebuilt for trial proposes.

COLD STORE CALCULATIONS

Ice demand :

For cooling of tahu cans :

14 kg water + tahu at	($27^{o}C$ to $3^{o}C$ = 24 kcal/kg)	=	336 kcal
4 kg ice at	($-2^{o}C$ to + $3^{o}C$=84 kcal/kg)	=	336 kcal
18 kg total			

160 cans x 4 kg =	=	640 kg ice/day
For cooling packs :		
3 packs at 2,5 kg per 2 cans x 160 cans	=	600 kg ice/day
T o t a l		=1.240 kg ice/day

Calorific Demand

1.240 kg ice/dayfrom $27^{o}C$ to $-2^{o}C$ = 108 kcal/kg)
= 134.000 kcal/24 h=5.580 kcal/h

Heat loss through walls, etc :

10 cm foam polystyrene, K = 0,25

$$Q = K.A.\Delta t = 0{,}25 \frac{kcal}{m^2 h\ C} \times 30\ m^2 \times 37^{o}C = 280\ kcal/h$$

Total calorific requirement =5.860 kcal/h

Required air temperature in freezing room to freeze ice packs in 18 hours :

Heat requirement, Q = 2,5 kg x 108 kcal/kg (from $27^{o}C$ to $-2^{o}C$) = 270 kcal/pack.

Air speed : V = 5 m/sek

Heat transfere factor;

$$K = \frac{1}{\frac{1}{\alpha} + \frac{a}{\lambda\ poly} + \frac{b}{ice}} = \frac{1}{\frac{1}{22} + \frac{0,0001}{0.3} + \frac{0\ to\ 0,025}{2}} = \underline{18,5\ kcal/m^2h^oC}$$

Heat transfere air, $\alpha = 6,12 \times V^{0.78} = 6,12 \times 5^{0,78} = \underline{22 \quad kcal/m^2h^oC}$

$$\Delta t = \frac{Q}{K.\ A.h} = \frac{270\ kcal}{18,5\ .0,156\ m^2.18} = \underline{5^oC}$$

I.e., required air temperature in freezing room = $\underline{-7^oC}$.

ICE BLOCK FREEZING :

Aluminium moulds, Volume : 5 liters, heating surface : 22 dm^2

$K = 17\ kcal/m^2h^oC$ for ice from 0 to 50 mm thick.

Heat requirement, Q = 5 kg x 108 kcal/kg from + 27°C to - 2°C) = S 540 kcal/pack

$$\text{Freezing time} = \frac{Q}{K.A.\Delta t} = \frac{540}{17 \times 0.22 \times 5} = \underline{28\ h}.$$

Number of blocks required :

$$\frac{640\ kg\ ice/day}{5\ kg/block} \times \frac{28}{24}\ h = \underline{150\ moulds.}$$

Condensator/Compressor.

An imported together-built compressor/condensor unit complete with all control, which at an outside air temperature of 27°C, creates 6,100 kcal with - 12°C evaporator temperature giving - 7°C air temperature as specified above, 2,25 KW, condensator section 0,8 m^2, is offered at Rp. 3.000.000. A semi hermetic dismantleable compressor for the same, capable of - 40°C is charged at Rp. 1.500.000, whereas an ordinary hermetic compressor for low temperatures may cost the half.

a 1 KW compressor for 3.000 kcal/h at higher temperatures is available at Rp. 1.60.000. A together-built imported evaporator unit with controls and fan is offered at Rp. 600.000.
We expect the units to become more reasonably costing, bought separately and built together by a small scale industry.

Investments (estimate)

Compressor 2.25 KW	Rp. 400.000,-
Condensator coil	Rp. 300.000,-
Evaporator coil	Rp. 300.000,-
Refrigerant, piping, controls and housing	Rp. 300.000,-
Foam polystyrene 3 m^3	Rp. 300.000,-
Freezer house, wood, accessories and building	Rp. 200.000,-
Ice crusher	Rp. 150.000,-
240 freeze packs at 600	Rp. 150.000,-
150 aluminium ice moulds at 400	Rp. 60.000,-
40 hang frames at 1.200	Rp. 50.000,-
Further accessories, etc.	Rp. 90.000,-
80 transport containers at 15.000	Rp. 1.200.000,-
Total	Rp. 3.450.000,-

Operational Costs: (Annual)

Electricity 2.25 KW x 25% x 7.200 h at Rp. 1.20 =	Rp.1.640.000,-
One extra operator	Rp. 600.000,-
Maintenance, repair & renewals	Rp. 300.000,-
Interests and depreciation, 25%	Rp. 860.000,-
Total yearly operational costs	Rp.3.400.000,-

Annual savings:

- Products normally spoilt or sold at reduced price, now possible to sell at full price, 2% of annual sales value (300 days)	Rp.1.500.000,-
- Reduction in sales force, due to longer lasting, better product, and traders ability to keep stocks for longer time. 32 sales-men reduced to 20	Rp.6.900.000,-
Total	Rp.8.400.000,-

Net annual saving without any price increase (= 150% of investment)	Rp.5.000.000,-

ECONOMY OF BYING ICE INSTEAD OF INVESTING IN FREEZER PLANT.

Investment:

Transport containers freeze packs and ice crusher	Rp.1.500.000,-

Operational costs:

1.240 kg ice/day at Rp. 18 x 300 days	Rp.6.700.000,-
Transport of ice, 300 days at Rp. 3.000,-	Rp. 900.000,-
	Rp.7.600.000,-
Net annual saving (as above) = 53% of investments	Rp. 800.000,-

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