5-4-4 Milling and Drying

(1) Survey Method

Losses that occur in the milling stage can be classified into those that are caused by milling machines and those that are generated by the properties and operational method of paddy before milling.

In the dry-season survey a comparative test was made on losses due to milling machine types and their combinations.

In the wet-season survey, a test was made on these combinations to determine qualitative and quantitative losses occurring due to the difference in quality of paddy which is varied with a variety of conditions of post-harvest practices before milling.

(2) Test by Combining Rice Milling Machines

1) Purpose

The purpose of this test was to make a comparative test on generation of quantitative losses by milling machine types and their combinations covering rice milling machines used in the survey area and to find improvements regarding milling machine types and their combinations that are optimal to Indonesia by analyzing and studying the data obtained in the comparative test.

2) Preparations for Milling Test

a) Scope of Survey Area

The team conducted the survey at following districts.
Aceh Province (Aceh Utara and Pidie Districts)
West Jawa Province (Karawang and Bekasi Districts)
South Sulawesi Province (Pinrang and Luwu Districts)
South Kalimantan Province (Hulu-Sungai-Tengah Districts)

b) Selection of Rice Mills

The rice mills were selected based on data considering the following items. Several candidate mills were selected, and the mills were chosen after confirming the actual conditions of the mills during the local survey.
South Kalimantan Province (H.S.T.O.)

i) In principle, Mills that were located inside the district which the survey team selected fields.

ii) Typical mills having as diverse milling machine types as possible based on machine types and combinations shown in Table 5-4-2.

iii) Mills currently in normal operation whch were runnig under conditions that were suitable for testing.

iv) Mill owners understood the purpose of the survey and would be cooperative to the test.

v) Mills conveniently located for the purpose of transporting smaple paddy and milled rice as a product.

Table 5-60 Numbers of Selected Rice Mill by Types

	Kind of Machine and Conbination	Aceh	West Jawa	S. Sulawesis		S. Kalimantans	
				Pinrang	Luwu	Banjar	H.S. Tengah
1	Engelberg	1	0	1	1		
2	Rubber Roll Husker + Engelberg	3	0			3	2
3	Rubber Roll Husker + Blowing Friction Whitener	3	(Flash Type) 1	4	4	1	1
4	Rubber Roll Husker + Screen Separator + Blowing Friction Whitener		2				
5	Rubber Roll Husker + Mechanical Separator + Blowing Friction Whitener	5	4	1		2	
6	Rubber Roll Husker + Mechanical Separator + Cone Whitener		1				
7	Rubber Roll Husker + Mechanical Separator + Abrasive Whitener		3				1
8	Rubber Roll Husker + Mechanical Separator + Abrasive Whitener + Blowing Friction Whitener		3				

c) Paddy

i) Selection of Paddy

Paddy was selected after considering the following items to meet the survey purpose:

- To select one variety among high-yielding varieties most popularly grown in the survey area.
- To secure a quantity enough for 1.5 hours of milling with the test rice mill running at full capacity.
- To select paddy that was harvested in the same district, was dried under the same conditions, and whose quality was uniform whenever possible.
- To select paddy of average quality as paddy produced in the applicable region to permit machine evaluation for the milling tests.
- In order to meet the foregoing conditions, the necessary quantities of paddy were selected from the paddy stored in the SUB-DOLOG warehouses. The quantities of paddy used in the tests are given in the following.

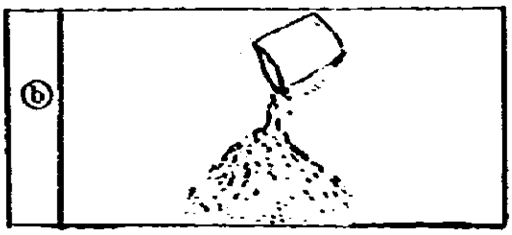
Aceh Province	Approx. 10 tons
West Jawa Province	Approx. 20 tons
South Sulawesi Province	Approx. 10 tons
South Kalimantan Province	Approx. 10 tons

ii) Mixing of Paddy

One important condition in the comparative test of rice milling machines was to use paddy of the same quality and grade in each test. In order to avoid quality defference by lot and by bag, all the bags were opened and the paddy was mixed.

ⓐ To use a concrete floor 100 m^2 in area per 10 tons of paddy as a mixing site.

ⓑ To open paddy bags (70 kg per bag) and spread the paddy on the floor.



ⓒ To heap paddy from approx. 30 bags in a conical shape.

ⓓ To equally divide paddy heaped in a conical shape into four heaps and mix while stirring paddy in diagonally opposite heaps.

ⓔ To spread the paddy on another floor in a square and in uniform thickness.

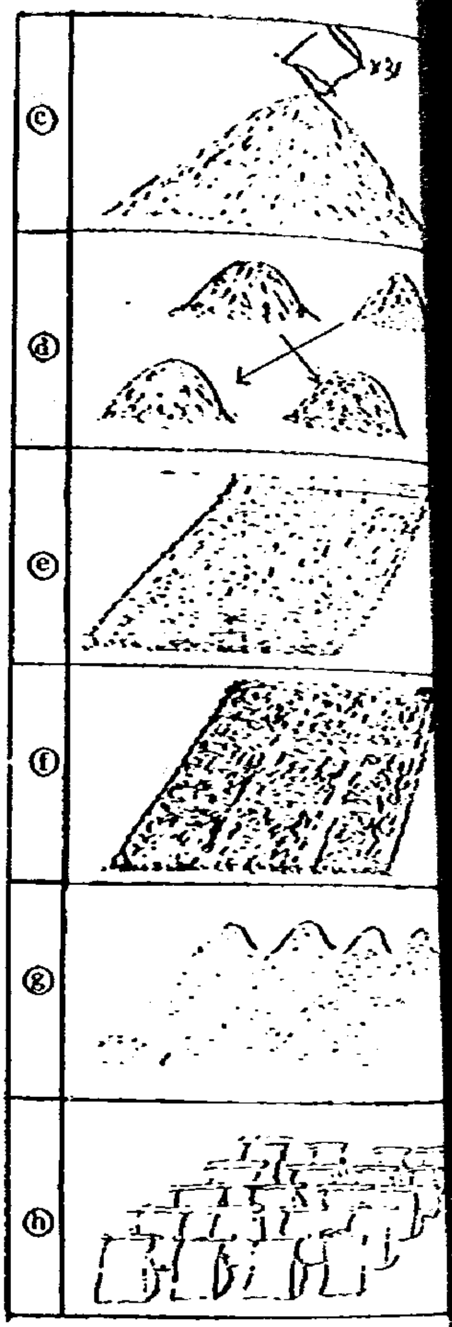
ⓕ To repeat Steps ⓑ to ⓔ and to heap all the paddy in a cube.

ⓖ To make ridges after mixing the top and bottom layers.

ⓗ To bag in about 75 kg quantities starting from the tips of the ridges.

ⓘ To sample about 5 kg from each bag for testing.

ⓙ After completing these steps, paddy contained in bags would be sent to the selected mills.



3) Milling Degrees and Milling Samples

Important factors in a comparative test of rice milling machines as mentioned earlier, were to use paddy of the same quality and to make the milling degree of milled rice uniform. Unless these two factors are met, the results cannot be compared and evaluated. It is difficult to attain the same milling degree in a comparative test of milling machines because mechanism and structure of the milling machines differ. Furthermore, the milling degree changes with a delicate adjustment. Nevertheless, efforts were made to meet these conditions by employing all the techniques that could be considered.

In the tests, the milling degree was standardized to 90% of the BULOG standard, and test samples were prepared as described below.

a In preparing samples for milling degree, test huskers (test rubber roller husker) and test cone whitener were used in the BULOG and Tambun research laboratories.

b IR36, which is grown most extensively in Indonesia, was selected as the test paddy variety. Paddy of this variety was obtained and was husked by a husker into brown rice.

c To select 1,000 sound kernels of brown rice for measurement of their weight.

d To divide the brown rice into ten 100 g samples and to mill these samples by changing the milling duration in steps.

e To measure the weight of polished rice after finishing milling and to select 1,000 sound kernels for weighing after calculating the weight yield.

f Dye polished rice with a new MG reagent, weigh the 1,000 sample kernels from which brown layers were able to be removed nearly perfectly. Calculate the yield from the weight of the 1,000 brown-rice kernels. Make the calculated yield as a 100% milling degree, take out samples with 90% milling degree relative to the 100% milling degree from polished rice samples. The milling degree of these 90% samples would be made to be the standard milling degree. When that standard is not present in the samples already milled, continue milling until samples of a 90% milling degree are obtained.

4) Milling Test

a) Outline of Test

To increase the test accuracy, husking and milling were performed separately, paddy in these two process was weighed to calcualte its yield, and the yield from paddy to milled rice was calculated.

Prior to making a full test, a preliminary test was made. In the preliminary stage, the machines were surveyed and necessary adjustments made to obtain the same degree of milling as that of the milling samples, to minimize adjustment changes during the full test.

b) Preliminary Test

i) To check and set the machines and to clean the machines and the adjacent areas to remove any remaining rice, paddy , etc.

ii) To perform a test run with a small quantity of paddy and to fill the elevators, etc. with grains in order to nearly decide the fl rate and adjustment positions.

iii) To operate for about 10 to 20 minutes to adjust to a flow rate optimal to the machines and to adjust the press board of the ric miller to adjust the milling degree of polished rice obtained in the test to the milling degree samples.
To verify the milling degree by means of a dyeing test.

iv) To prepare practical standard sample by region having a milling degree equal to that of the basic standard sample. To prepare standard sample by selecting rice mills suitable for preparing practical standard sample among rice mills selected for various regions. The rice mill thus selected would prepare practical standard sample.
After making a preliminary test, prepare a milling degree by the kernel-weight that is the same as that of the basic standard sam Make it practical standard sample and use it in the region as a sample for the milling degree.

c) Full Test

i) Operating Method

- A full test would be performed for approximately 30 minutes at least twice. Yields thus obtained would be averaged.
  The time needed between the opening of the shutter and when all the material has passed through.
- Adjust the adjustable sections in a short period of time to obtain the same degree of milling as that of practical standard rice to minimize the quantity of half-milled rice.
- Put half-milled rice in the initial stage in a separate contai When finishing the operation, feed it into the feed inlet of the rice whitener so that the entire quantity will be completely milled.

ii) Weighing and Sampling

- Weigh the total weight of paddy, brown rice, polished rice, and rice bran.
- Sample specimens of brown rice, chaff, polished rice, and rice bran on several occasions.

iii) Analysis

- Measure sound kernels, broken kernels, immature kernels, damaged kernels, and paddy from 50 g of brown rice by hand.
- Finely broken kernels (below 1.5 mm) and small broken kernels (below 1.7 mm) in 50 g of polished rice are separated by a sieve, then measure sound and broken kernels by hand. Finely broken kernels are deducted from the yield in calculations for comparison of the milling machines.
- Separate small broken kernels and broken kernels contained in 100 g of rice bran using a sieve.
- Separate rice kernels in the chaff by air separation.
- Calculate thousand-kernel-weight percentages by weighing 1,000 sound kernels in brown rice and polished rice. The percentages are to be used in calculating modified yields in comparison with the standard milling degree later.

d) Test Milling

i) Send 5 kg of paddy sampled when mixing paddy to Tambun as a test milling material.

ii) Evenly divide 5 kg to obtain 2 kg and separate dead paddy and foreign matter with an air cleaner.

iii) Pass the sample 2 - 3 times through the test husker to obtain brown rice and then weigh it.

iv) Separate broken rice, immature rice, damaged kernels, and foreign matter from 100 g of brown rice.
Weigh 1,000 sound kernels.

v) Prepare 10 samples of brown rice in 100 g quantities and mill by changing the milling time. Calculate the milled rice yield, separate with 1.5 and 1.7 mm sieves, then analyze broken kernels by hand.

vi) Weigh 1,000 sound kernels selected from the milled rice, calculate a thousand-kernel-weight yield with that for brown rice, then select the standard milled sample. For the convenience of subsequent calculations, a 91% thousand-kernel-weight percentage was regarded to be a 90% milling degree and was designated as standard sample.

e) Test Results and Analysis

The tests were made in limited regions within a short period of time at a limited number of rice mills. Evaluation of all milling machines in Indonesia cannot be made based on the results of the tests. A clearer picture is anticipated to be obtained by repeating tests of this nature in the future. However, the recent tests have shown some clear trends. By further analyzing the local situation, the current state can be analyzed precisely.

i) Engelberg-type Huller

Basically, it is not reasonable to process chaff and rice bran which have different physical properties as well, by one machine using pressure. This machine cannot mill rice without damaging the inner layer of rice.

High-yielding varieties that are grown extensively are brittle throughout Indonesia. An urgent need is to exchange Engelberg-type milling machines in order to reduce both qualitative and titative losses.

ii) Rubber Roller Husker + Engelberg-type Milling Machine

By additionally using a husker together with an Engelberg mach the milled rice yield increased compared with that when indivi machines were used separately. However, due to mechanical flaws in the Engelberg huller vis-a-vis rice and its low operability, it cannot demonstrate stable performance as a milling machine at all times.

In addition to the broken rice generated and its low yield, its poor performance in removing rice bran lowers the value of rice as a milled rice commodity.

This combination should also be promptly discontinued.

iii) Rubber Roller Husker + Jet-Air Friction Type Rice Whitener

High recovery and high quality to some extent can be obtained by a combination of these individual machines depending on how the combination is made.

Paddy is passed through the husker and milling machine twice. The charging work is performed entirely by men. Only local variety in good condition are passed through the husker and milling machine once.

If it is simply the main machines only, one could feel at ease that the fed material does not stay inside the machines, which is a requirement in custom rice milling. It does not mean that the equipment need not be improved.

That paddy is passed through a husker twice means a paddy separator is needed. Two milling machines have to be installed in tandem, or a long-length milling machine has to be installed. It then will be difficult for the charging work to be done manually. The idea that labor costs are low and that it is helping the regional society by offering employment does not benefit the development of Indonesia. Labor engaged in charging paddy should be used for purposes with higher added value such as manufacturing elevators.

iv) Rubber Roller Husker + Screen-Type Paddy/Separator + Jet-Air Friction-Type Milling Machine

This combination improves the combination described in the previous paragraph. Depending on how this combination is used, it can be considered as one of the highest practical units in terms of both yield and quality.

Actually, paddy is passed through the husker and milling machine twice partly because the screen-type separator does not perform satisfactorily with long kernel species. A paddy separator is added, and men have to lift heavy rice to the tall hopper 5 times while paddy is being processed into polished rice.

This, frankly speaking, is no longer a milling facility. Milling facilities that have gradually been improved on until now should be reexamined at present.

A solution can be found regarding the current situation in Indonesia and approaches can be determined for future milling facilities as well as improvements to be made on machines inside the facilities by undertaking further study, including the areas of development and improvement.

v) Rubber Roller-Type Husker + Mechanical Paddy Separator + Jet-Air Friction-Type Rice Whitener

Equipment all connected by elevators can be considered as being well equipped as rice milling facilities. Paddy is passed through the husker once, and only a negligible amount of paddy is mixed in brown rice that has passed through the paddy separator. However, generally there are a large number of rice mills that pass paddy through milling machines only once. The milling machine capacity is small. The pressure inside the milling machines has to be lowered when milling high-yielding varieties which are brittle and contain a large proportion of cracked rice. Some effect can be achieved by reducing the flow rate, or passing the paddy through twice. Judging from the construction of the machines in use, passing paddy through more than 3 times can be more detrimental. A study to match the internal construction of milling machines to the situation in Indonesia is a future problem. At the moment, the milling process in the machines has to be lengthened, or two milling machines in tandem should be installed.

vi) Rubber Roller Husker + Mechanical Paddy Separator + Abrasive-Type Milling Machine

Several combinations employing an abrasive type of processing as the basic construction of the milling machine could be found. These combinations had the same equipment as that described earlier for their husking and paddy separating processes. In the brittle type, rice surfaces are shaved off by an abrasive roller. Because the pressure in the milling chamber is low compared with that for the friction type, even fragile rice remains unbroken. However, rice surfaces are shaved off, and rice generally lacks luster. Furthermore, depending on how the machine is operated, the inner layers of rice are also shaved off and are discharged with rice bran, possibly lowering the polished rice yield.

As a conclusion, the abrasive type is not necessarily better than the friction type in terms of the polished rice yield. Abrasive-type milling machines are generally expensive, and a smooth supply of parts also needs to be considered.

Table 5-61 Explanation of Marks in the Table of Milling Test

		Explanation
a	Husked Rice Recovery	Weight rate of total husked rice which has passed paddy huskee (or paddy separator) as compared to the original paddy.
b	Remaining Paddy Rate	Weight rate of unhusked paddy remaining after husking (or separating) operation as compared to the original paddy.
c	Corrected Husked Rice Recovery	Weight rate of brown rice which is calculated from the husked rice recovery beeing reducted the remaining husk rate in the husked rice $C = \frac{100x(a-b)}{100-b}$ 100-C ... Weight rate of husk as compared to the original paddy $\frac{bx(100-C)}{100}$ ... Weight rate of the remaing husk as compared to the original paddy $a - \frac{b \times (100-C)}{100} =$ ... Husked rice recovery - Weight rate of the remaining husk = Pure brown rice recovery.
d	Milled Rice Recovery	Weight rate of total milled rice in comparisson to the paddy.
e	Chips Rate in Milled Rice	Weight rate of chips (fine broken rice and impurities) in milled rice as compared to the milled rice. (Screened by a sieve having openings of 1.5mm sq. and considered as unedible.)
f	Corrected Milled Rice Recovery	Recovery of edible milled rice after removing the chips in milled rice by the calculation. The purpose is to eliminate chips for the comparison of milling machines which has different size of screen openings causing different content of chips. $\frac{e \times d}{100}$ ... Chip rate in milled rice as compared to the paddy $f = d - \frac{e \times d}{100}$ ... Milled rice recovery - Chip rate
g	Weight Rate of 1,000 Grains (Assessment for milling degree)	Weight rate of milled rice to brown rice per 1,000 grains. (The grains should be sound and head kernel.)
h	Final Corrected Milled Rice Recovery	Correction of corrected milling recovery (f) by the difference of milling degree oblained by each milling test to adjust to the standard milling degree. (The standard milling degree (90%) is practically considered to be 91% as calculated by the weight of 1,000 grains.) g - 91 ... Difference between the milling rate obtained by each test and the standard milling rate (g) (Weight rate from brown rice) $\frac{(g-91)xC}{100}$ ... The difference of the milling rate as compared to the paddy $h = f - \frac{(g - 91)xC}{100}$ ... Corrected milled rice recovery (f) - The difference of the milling rate.

Table 5-62 Comparison Chart of Ave. Milled Rice Recovery

R: AVERAGE MILLED RICE RECOVERY
D: DIFFERENCE OF THE RECOVERIES

(%)

No. (Item)	Kind of Machine, Assembly and No. of Pass	ACEH R	ACEH D	JAWA BARAT R	JAWA BARAT D	SULAWESI S. PINRANG R	SULAWESI S. PINRANG D	SULAWESI S. LUWU R	SULAWESI S. LUWU D	KALIMANTAN S. BANJAR R	KALIMANTAN S. BANJAR D	KALIMANTAN S. HULU R	KALIMANTAN S. HULU D
1	ENGELBERG 1 Pass	63.4				64.0		59.2					
2 -1	RUBBER R.+ENGELBERG 2 Pass 1 Pass	66.2											
-2	RUBBER R.+ENGELBERG 2 Pass 2-3 Pass	66.9							3.8	63.6		64.0	
3 -1	RUBBER R.+BLOWING FRICTION 1 Pass 1 Pass	67.1		64.4		66.5		62.2					1.9
-2	RUBBER R.+B.FRICTION 2 Pass 1 Pass	66.5						63.0		65.3			
-3	RUBBER R.+B.FRICTION 2 Pass 2-3 Pass	67.4	4.5		1.8		3.1				2.4	65.9	
4 -1	RUBBER R.+SCREEN SEPARATOR+B. FRICTION 2 Pass 1 Pass 1 Pass			64.3									
-2	RUBBER R.+SCREEN SEPARATOR+B. FRICTION 2 Pass 1 Pass 2 Pass			65.7									
-3	RUBBER R.+SCREEN SEPARATOR+B. FRICTION 2 Pass 1 Pass 3 Pass			66.3									
5 -1	RUBBER R.+MECHANICAL SEPARATOR+B. FRICTION 1 Pass 1 Pass 1 Pass	67.1		65.2		67.1							
-2	RUBBER R.+MECHANICAL SEPARATOR+* 2 Pass SYSTEM 1 Pass 1 Pass	67.9		66.2						65.9			
6	TEST MILL (RUBBER R. +CONE)	69.8		68.1		68.0		64.4		65.3		66.5	

Note : * Double Blowing Friction

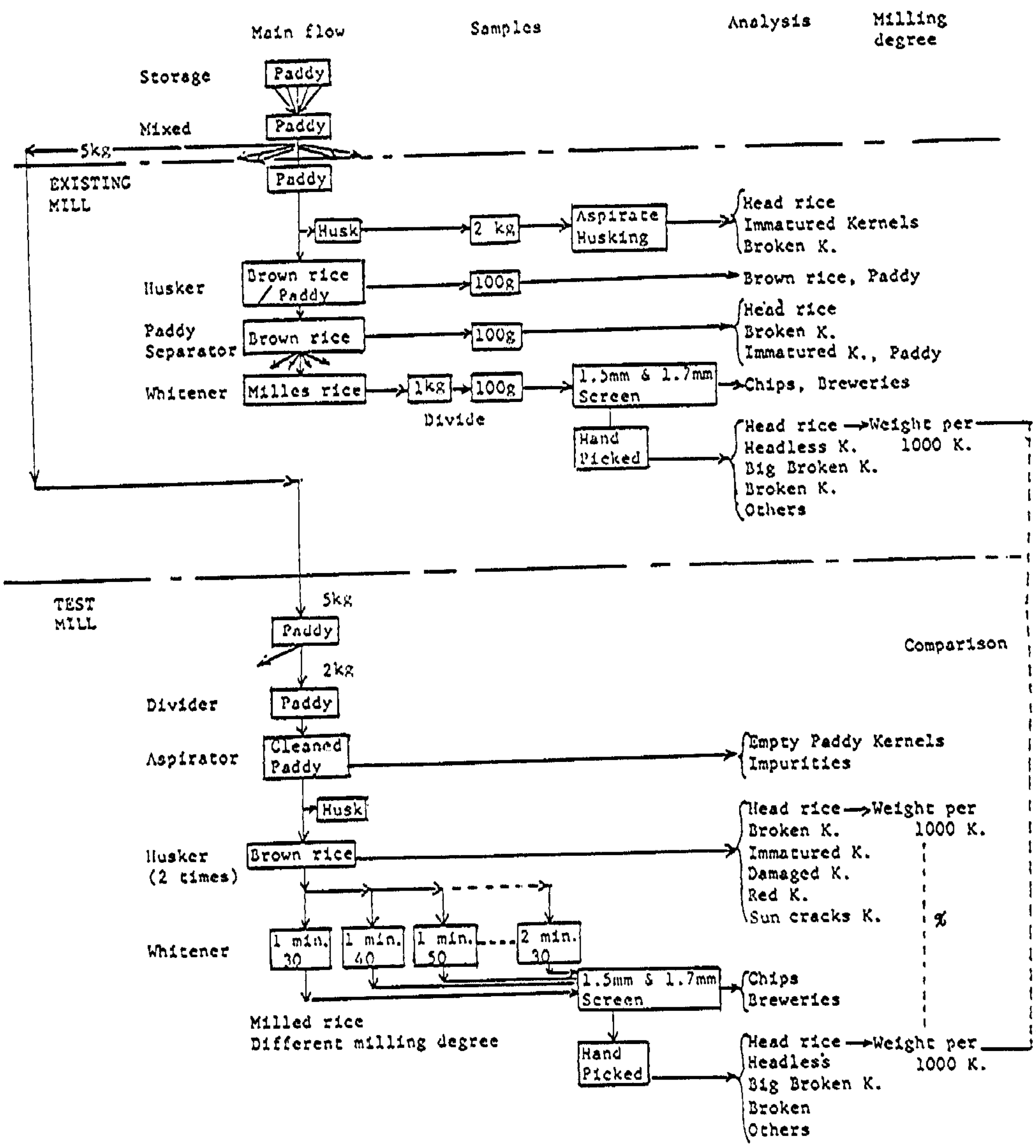


Fig. 5-43 Process of Milling Test

Table 5-63 D.I. ACEH (1)

TEST NO.	NAME OF MILL	REG. CAPACITY kg/hr.	POWER hp	COMPONENT OF MILL: CLEANER	PADDY HUSKER	PADDY SEPARATOR	WHITENER	CATEGORY OF COMBI-NATION	NUMBER OF PASS	RECOVERY % (a)	HUSKED RICE ANALYSIS: HEAD %	BROKEN %	IMMATURED %	PADDY % (b)
A-1	M.T. BUDIMAN Aceh Utara	800	62	SIFTER Local	RUBBER R. 6" Yanmer ECH 60	COMPART. 50 Local	BLOWING FRIC- TION Sanfon NL12	5 -1 -2	1	78.2	89.4	9.0	1.6	0.04
A-2	KUD TUFFAR Aceh Utara	300	18	-	ENGELBERG Grantex	-		1	1	(78.0) estimate				
A-3	MURUNIJAYA Aceh Utara	500	15	-	ONE PASS RUBBER R. 4" Satake SB10	-	+ (B. FRICTION)	3 -1	1	(79.1) estimate	92.2	5.3	2.5	7.6
A-4	KUD KUTAGLEE Aceh Utara	300	18	-	RUBBER R. 4" Gold Grain	-	B. FRICTION Gold Grain	3 -2	2	79.4	90.2	7.3	2.4	4.9
A-5	SAHABAT Acen Utara	600	40	SIFTER Local	RUBBER R. 6" China LM24-2CH	COMPART. 50 Local	B. FRICTION Nachi NL12	5 -1 -2	1	77.9	90.3	7.1	2.6	2.0
A-6	SAHABAT Acen Utara	800	27	SIFTER local	RUBBER R. 6" China LM24-2CH	COMPART. 16 Germany	B. FRICTION Satake RBS-7	5 -1 -2	1	78.1	89.4	7.6	3.0	0.7
A-7	K.P.Z.A.	800	30	SIFTER local	RUBBER R. 6" Iseki HC600	COMPART. 36 Local	B. FRICTION Satake RBS07	5 -1 -2	1	77.1	91.5	7.2	1.3	0.6
A-8	RAHAMAT Pidie	500	18	-	RUBBER R. 6" Yanmer ECH60	-	ENGELBERG Grantex	2 -1 -2	2	80.1	85.8	12.5	1.7	6.7
A-9	SWADAYA Pidie	500	18	-	RUBBER R. 6" Yanmer ECH60	-	ENGELBERG Grantex	2 -1 -2	2	77.0	90.3	7.4	2.3	2.3
A-10	KUD MERAHJAYA Pidie	800	46	SIFTER Local	RUBBER R. 6" Iseki HC600	COMPART. 36 Local	B. FRICTION Ichi NL15	5 -1 -2	1	76.8	89.8	9.0	1.2	0.08
A-11	K.P.T.B. Pidie	500	16	-	RUBBER R. 6" China LM24-2CH	-	B. FRICTION Sanfon NL12	3 -3	2	78.6	92.5	6.0	1.5	2.1
A-12	K.P.T.B. Pidie	500	16	-		-	ENGELBERG	2 -2						
A-13	TAMBUN INSTITUTE			TEST ASPIRA- TOR	TEST RUBBER R. 35mm Satake THU	-	ABRASIVE CONE MINCETTI		2	78.0	91.1	5.8	3.1	0.3

D.I. ACEH (2)

VARIETY OF PADDY: MIXTURE OF IR32, IR36

CORRECTED RECOVERY % $c=\frac{100x(a-b)}{100-b}$	TEST NO.	NUMBER OF PASS	MILLED RICE RECOVERY % (d)	ANALYSIS HEAD %	ANALYSIS BROKEN %	ANALYSIS BREWERY %	ANALYSIS CHIP % (e)	ANALYSIS PADDY Pcs/100g	CORRECTED RECOVERY % $f=d-\frac{e \times d}{100}$	MILLING DEGREE (WEIGHT % 1000KERNEL) (g)	FINAL CORRECTED RECOVERY % $h=f-\frac{(g-91) \times c}{100}$	ACTUAL CAPACITY HUSKER kg/hr PADDY	ACTUAL CAPACITY WHITENER kg/hr PADDY	TEMPERATURE PADDY °C	TEMPERATURE MILLED RICE °C	MOISTURE CONTENT PADDY %	MOISTURE CONTENT MILLED RICE %
78.2	A-1	1	67.3	53.3	43.3	3.4	1.0	0	66.6	90.5	67.0	940	540	32	47	14.6	14.3
		2	68.7	66.2	28.6	5.2	0.5	0	68.4	91.4	68.1		1100		45		14.3
(78.0) estimate	A-2	1	66.1	48.2	45.8	6.0	2.8	3	64.2	91.6	63.4	510		32	50	14.5	14.2
		1	65.2	45.3	48.7	6.0	2.3	2	63.8	90.8	63.8	480			56		14.2
(78.0) estimate	A-3	1	68.2	68.8	28.8	2.4	0.4	1	67.9	91.8	67.1	450		30	47	14.6	14.4
78.3	A-4	1	67.0	51.2	42.6	6.2	0.8	0	65.5	91.0	66.5	410	400	30	46	14.5	14.3
		2	67.8	63.3	33.5	3.2	0.6	0	67.4	92.0	66.7		400		46		14.4
77.4	A-5	1	67.7	60.5	35.8	3.6	0.5	0	67.4	91.9	66.5	410	390	30	46	14.8	14.5
		2	67.6	69.8	26.5	3.6	0.2	0	67.5	91.7	66.8		390		46		14.4
77.9	A-6	1	67.8	68.7	27.4	3.8	0.3	0	67.8	92.1	66.5	450	500	31	46	14.8	14.6
		2	68.7	68.8	28.2	3.0	0.4	0	67.7	90.6	68.7		510		46		14.4
77.0	A-7	1	67.8	70.4	25.8	3.8	0.3	0	67.6	90.8	67.8	730	490	30	46	14.8	14.4
		2	68.0	71.2	25.2	3.6	0.2	0	67.9	91.2	67.7		580		44		14.4
78.7	A-8	1	67.7	62.3	32.9	4.8	2.3	2	66.1	91.0	66.1	870	580	30	47	14.7	14.3
		2	68.0	61.4	32.6	6.0	1.8	2	66.7	92.0	65.9		640		47		14.3
76.5	A-9	1	68.5	72.4	23.8	3.8	1.0	0	67.8	93.0	66.2	660	290	30	55	14.6	14.1
		2	68.3	69.2	26.1	4.7	0.7	1	67.8	91.5	67.4		370		53		14.1
76.8	A-10	1	68.4	72.6	24.1	3.2	0.2	0	68.3	91.5	67.9	1030	630	31	48	19.8	14.4
		2	68.8	79.7	17.1	3.2	0.1	0	68.7	91.5	68.4		1020		46		14.5
78.1	A-11	2	69.0	78.1	18.3	3.6	0.2	0	68.9	91.5	68.1	840	600	31	47	14.8	14.3
		2	68.8	65.2	30.2	4.6	0.4	0	68.5	92.1	67.4		770	31	44		14.3
77.9	A-12	1	70.3	91.5	8.0	0.5	0.7	0	69.8	91.0	69.8						

Table 5-64 WEST-JAWA (I)

TEST NO.	NAME OF MILL	REG. CAPACITY kg/hr.	POWER hp	COMPONENT OF MILL: CLEANER	COMPONENT OF MILL: PADDY HUSKER	COMPONENT OF MILL: PADDY SEPARATOR	COMPONENT OF MILL: WHITENER	CATEGORY OF COMBI-NATION	NUMBER OF PASS	HUSKED RICE: RECOVERY % (a)	ANALYSIS: HEAD %	ANALYSIS: BROKEN %	ANALYSIS: IMMATURED %	ANALYSIS: PADDY % (b)
J-1	PB. TAWEBAL Karavang	4500	7x12 18x2	-	RUBBER R. 6" Iseki HC600 x12	SCREEN Local	BLOWING FRIC-TION Ichi NL-15 x4	4 -2	2	76.4	87.8	6.6	5.6	4.8
J-2	KIWAN Karavang	1500	7x3 18x1	-	RUBBER R. 6" Ichi	SCREEN Local	B. FRICTION Ichi NL-12 Satoh NL-12	4 -1 -2	2	78.2	79.3	16.4	4.3	6.3
J-3	PUSKUD UNIT II Karavang	4000		ASPIRA-TOR SIFTER Schule	RUBBER R. 10" Schule x 2	COMPART. 36 Schule x 2	ABRASIVE CONE Schule x 2	5 -2	1	75.0	94.0	1.9	4.1	0.08
J-4	PUSKUD UNIT II Karavang	2500		" SIFTER Yanmer	RUBBER R. 10" Yanmer	SHAKING Yanmer	B. FRICTION Yanmer No.4 Satoh IchiH70	5 -2	1	75.4	79.5	15.0	5.5	0.3
J-5	PUSKUD UNIT IV Karavang	2000		" SIFTER Satake	RUBBER R. 10" Satake	SHAKING Satake	ABRASIVE HORI-ZONTAL B. FRICTION Satake RB15, BS15	5 -2	1	75.9	88.0	6.6	5.4	1.6
J-6	PUSKUD UNIT XI Karavang	4000		" SIFTER Yanmer	RUBBER R. 8" Yanmer x 2	SHAKING Yanmer	ABRASIVE CONE B. FRICTION Yanmer RP10, No.4	5 -2 5 -3	1	75.6	89.2	6.9	3.9	0.3
J-7	TANJUN HARAPAN Bekasi	2000		SIFTER Local	RUBBER R. 10" Yanmer	COMPART. 36 Local	B. FRICTION Ichi x 2 NL-15	5 -2	1	75.3	89.9	5.2	4.9	1.2
J-8	TANJUN HARAPAN Bekasi	2000		"	"	"	B. FRICTION China x 2	5 -2	1	75.3	89.9	5.2	4.9	1.2
J-9	TAMBUN INSTITUTE Bekasi	1000		SIFTER Satake	RUBBER R. 6" Satake	SHAKING Satake	B. FRICTION Satake RBS7	5 -1	1	75.9	82.5	11.1	6.4	0.08
J-10	TAMBUN INSTITUTE Bekasi	1000		SIFTER Satake	RUBBER R. 6" Satake	SHAKING Satake	ABRASIVE HORI-ZONTAL B. FRICTION Satake RB-15	5 -2	1	75.9	82.5	11.1	6.4	0.08
J-11	TAMBUN INSTITUTE Bekasi	1000		-	FLASH Korea	-	B. FRICTION Satake RBS-7	3 -1	1	72.8	76.4	18.0	5.2	0.4
J-12	TAMBUN INSTITUTE Bekasi			TEST ASPIRA-TOR	TEST RUBBER R. 35mm Satake THU	-	ABRASIVE CONE MINGETTI	6	2	75.7	85.1	7.8	7.1	0.1

WEST - JAWA (2)

VARIETY OF PADDY: MIXTURE OF IR36, IR38

c = $\frac{100 \times (a-b)}{100-b}$			d				e		f = $d - \frac{e \times d}{100}$	g	h = $f - \frac{(g-91) \times c}{100}$						
CORRECTED RECOVERY %	TEST NO.	NUMBER OF PASS	MILLED RICE RECOVERY %	MILLED RICE ANALYSIS HEAD %	BROKEN %	BREWERY %	CHIP %	PADDY Pcs/100g	CORRECTED RECOVERY %	MILLING DEGREE (WEIGHT % 1000KERNEL)	FINAL CORRECTED RECOVERY %	ACTUAL CAPACITY HUSKER kg/hr PADDY	WHITENER kg/hr PADDY	TEMPERATURE PADDY °C	MILLED RICE °C	MOISTURE CONTENT PADDY %	MILLED RICE %
75.2	J-1	2	66.8	72.3	25.9	1.8	0.4	0	66.8	91.4	66.2	1270	920	33	50	13.8	13.5
		3	66.5	73.6	24.8	1.6	0.5	0	66.1	90.7	66.3		1050		45		13.5
76.7	J-2	1	63.8	67.3	31.3	1.4	0.1	0	63.7	91.4	63.4	870	1160	34	46	13.6	13.5
		2	65.3	72.3	26.6	1.1	0.1	0	65.2	91.0	65.2		750		51		13.4
75.0	J-3	2	65.9	80.9	17.6	1.5	0.4	0	65.6	91.0	65.6	4140	4400	31	43	13.7	13.5
75.2	J-4	2	66.0	66.5	29.0	4.5	1.2	0	65.3	91.1	65.2	2170	1040	33	51	13.8	13.4
75.5	J-5	3	65.5	80.4	17.2	2.4	0.4	0	65.2	89.8	66.1	1660	950	34	48	13.7	13.4
75.5	J-6	2	64.5	71.0	25.2	3.8	0.8	0	64.0	91.2	63.8	2320	1640	33	46	13.7	13.4
		3	65.6	72.6	24.5	2.9	0.3	0	65.4	89.8	66.2		1790		43		13.3
75.0	J-7	2	65.0	70.5	26.1	3.4	0.4	0	64.7	90.4	65.0	1760	1240	34	46	13.8	13.5
75.0	J-8	2	65.6	78.6	19.6	1.8	0.2	0	65.5	91.8	65.3		1260	34	48	13.7	13.3
75.9	J-9	1	65.5	77.6	19.8	2.6	0.3	0	65.3	91.2	65.1	730	580	33	46	13.6	13.2
75.9	J-10	2	65.1	79.3	18.5	2.2	0.4	0	64.8	90.5	65.2		1130	33	44	13.6	13.2
72.7	J-11	1	65.4	76.8	20.8	2.4	0.4	0	65.1	92.0	64.4	610	750	33	46	13.6	13.2
75.6	J-12	1	68.6	89.8	9.5	0.6	0.8	0	68.1	91.0	68.1						

Table 5-65 SOUTH-SULAWESI (1)

TEST NO.	NAME OF MILL	REG. CAPACITY kg/hr	POWER hp	CLEANER	PADDY HUSKER	PADDY SEPARATOR	WHITENER	CATEGORY OF COMBINATION	NUMBER OF PASS	RECOVERY % (a)	HUSKED RICE ANALYSIS HEAD %	BROKEN %	IMMATURED %	PADDY % (b)
P-1	ARIFIN Pinrang	300	6, 11	-	RUBBER R. 6" Iseki (HC600 Yanmer	-	BLOWING FRICTION Iseki JS550	3 -1	1	77.9	82.5	11.9	5.6	11.2
P-2	FARMER'S GROUP Pinrang	300	18	-	ONE PASS RUBBER R. 4" Satake SB-10	-	+ (B. FRICTION	3 -1	1	78.4	92.5	0.8	6.7	1.2
P-3	PEWEDDAI Pinrang	200	11	-	ENGELBERG	-	-	1	1	75.5	63.6	34.7	1.6	5.8
P-4	LA RUNA	300	16,5	NB18	ONE PASS RUBBER R. 4" Satake SB-10	-	+ (B. FRICTION)	3 -1	1	76.7	92.4	1.9	5.7	1.6
P-5	KUD ALITTA Pinrang	300	7, 11	-	RUBBER R. 4" Yanmer, ECH40	-	B. FRICTION Yanmer SS10	3 -1	1	80.7	87.1	6.7	6.2	28.0
P-6	BULOG PINRANG Pinrang	450	16,5	-	RUBBER R. 4" Yanmer ENH40	SHAKING Yanmer	B. FRICTION Iseki HC600	5 -1	1	74.6	88.3	4.8	6.9	1.0
P-7	TAMBUN INSTITUTE			TEST ASPIRATOR	TEST RUBBER R. 35mm Satake THU	-	TEST ABRASIVE CONE MINGETTI			75.4	88.8	3.4	7.8	0.6
L-1	LAKARIAP Luwu	500	9, 15	-	RUBBER R. 6" China LH24-2C	-	ONE PASS RUBBER 4" + B.F. Satake SB10	3 -2	2	79.0	68.0	27.6	4.4	18.9
L-2	USMAN Luwu	500	5,5, 16,5	-	RUBBER R. 6" Iseki HC600	-	B. FRICTION Satake RBS7	3 -1	1	77.0	87.6	4.9	7.5	31.2
L-3	PRIVATE SECTOR PADANG SAPPA Luwu	200	14	-	RUBBER R, Iseki	-	B. FRICTION Iseki	3 -1	1	78.9	90.3	4.3	5.4	29.2
L-4	SIMPAN Luwu	200	9	-	ENGELBERG	-	-	1	1	84.4	62.1	34.3	3.6	21.4
L-5	KUD PADANG PAPPA		5, 9	-	RUBBER R. 6" Iseki HE6B	-	B. FRICTION Iseki	3 -1	1	70.5	91.3	3.2	5.5	10.0
L-6	TAMBUN INSTITUTE			TEST ASPIRATOR	TEST RUBBER R. 35mm Satake THU	-	TEST ABRASIVE CONE MINGETTI			74.1	76.2	18.1	5.7	0.5

SOUTH – SULAWESI (2)

VARIETY OF PADDY:

CORRECTED RECOVERY % ($c = \frac{100 \times (a-b)}{100-b}$)	TEST NO.	NUMBER OF PASS	MILLED RICE RECOVERY % (d)	ANALYSIS HEAD %	ANALYSIS BROKEN %	ANALYSIS BREWERY %	ANALYSIS CHIP % (e)	ANALYSIS PADDY Pcs/100g	CORRECTED RECOVERY % ($f = d - \frac{e \times d}{100}$)	MILLING DEGREE (WEIGHT % 1000KERNEL) (g)	FINAL CORRECTED RECOVERY % ($h = f - \frac{(g-91) \times c}{100}$)	ACTUAL CAPACITY HUSKER kg/hr PADDY	ACTUAL CAPACITY WHITENER kg/hr PADDY	TEMPERATURE PADDY °C	TEMPERATURE MILLED RICE °C	MOISTURE CONTENT PADDY %	MOISTURE CONTENT MILLED RICE %
75.1	P-1	1	67.4	78.8	20.8	0.4	0.4	1	67.1	91.0	67.1	260	250	33.5	49	12.7	12.2
78.1	P-2	1	66.9	79.2	20.0	0.8	0.4	2	66.7	91.1	66.6	190		30.5	55	12.4	11.6
74.0	P-3	1	69.6	73.2	26.2	0.6	0.2	0	64.5	91.7	64.0	350		33	55	11.6	11.1
76.3	P-4	1	66.5	81.2	17.8	1.0	0.3	0	66.3	91.0	66.3	500		30.5	55	12.3	12.2
73.2	P-5	1	66.7	76.1	22.7	1.2	0.5	0	66.4	91.6	66.0	300	290	31.5	47	12.6	11.9
74.4	P-6	1	67.5	73.1	25.6	1.3	0.5	1	67.5	91.3	67.1	470		31	47	12.3	12.2
75.3			68.1	89.0	8.9	2.1	0.2	0	68.0	91.0	68.0						
70.5	L-1	1	64.8	50.4	40.4	9.2	1.8	15	63.7	92.0	63.0	1120	600	31.5	51	11.7	11.2
66.8	L-2	1	64.2	55.2	38 .	6.8	1.0	13	63.6	92.1	62.9	670	730	30.5	47	13.5	14.5
70.2	L-3	1	65.1	52.4	37.6	10.0	2.9	12.	63.2	91.8	62.7	690	690	32	52	13.5	12.4
80.2	L-4	1	62.5	38.4	52.8	8.8	4.1	17	59.9	91.9	59.2	530	130	31	51	13.5	12.4
67.2	L-5	1	62.2	36.8	54.4	8.8	2.3	1	60.8	90.5	61.1	630	440	31	51	11.4	11.4
74.0			64.8	56.0	41.0	3.0	0.6	0	64.4	91.0	64.4						

Table 5-66 SOUTH - KALIMANTAN (1)

TEST NO.	NAME OF MILL	REG. CAPACITY kg/hr	POWER hp	COMPONENT OF MILL: CLEANER	PADDY HUSKER	PADDY SEPARATOR	WHITENER	CATEGORY OF COMBI- NATION	NUMBER OF PASS	RECOVERY % (a)	HUSKED RICE ANALYSIS: HEAD %	BROKEN %	IMMATURED %	PADDY % (b)
B-1	MASTUP Banjar	300	4, 17	-	RUBBER R. 6" Iseki HC6B	SHAKING Local	ENGELBERG Chinmichi	2 -3	2	77.4	83.2	7.2	9.6	3.0
B-2	HASAN SALMAN Banjar	300	10	-	RUBBER R. 6" Iseki HC6B	-	ENGELBERG Granted	2 -2	2	79.3	80.0	9.7	10.3	17.5
B-3	SEKDA Banjar	300	12, 9	-	RUBBER R. 6" Ichi HC60	SHAKING Local	B. FRICTION Echo H40C	5 -2	2	74.0	86.9	4.2	8.9	5.0
B-4	KAYUTANGI Banjar	1000	5, 14	SHIFTER Local	RUBBER R. Satoh	SHAKING Iseki	ENGELBERG	2 -3	1	76.5	67.0	22.3	10.7	3.5
B-5	P. DEWIE	1000	10	SHIFTER Local	RUBBER R. 6" China (LM24-2C) Iseki HC600	SHAKING Satake	B. FRICTION Ichi N120 China P150A	5 -2	3	77.1	71.6	24.9	2.5	1.5
B-6	KUD BINATANI Banjar	400	6, 9	-	RUBBER R. 6" Yanmer ECH60	-	B. FRICTION Echo H-20P	3 -2	1	75.8	79.2	10.7	10.1	2.0
B-7	TAMBUN INSTITUTE			TEST ASPIRA- TOR	TEST RUBBER R. 35mm Satake THU	-	TEST ABRASIVE CONE MINGETTI		2	76.9	84.2	9.8	6.0	0.3
H-1	P.P.H. DARMAWI Hulu Sungai Tengah	300	16	-	RUBBER R. 6" Kyowa KL-2	SHAKING Kyowa	ABRASIVE VER- TICAL Kyowa RP5	5 -3	1	75.1	78.6	2.5	18.9	0.5
H-2	P.P.H. DARMAWI Hulu Sungai Tengah	700	55	-	RUBBER R. 6" Iseki HC-6 Echo HP-60A	SHAKING Local	ENGELBERG Chinmichi	2 -3	1	73.0	76.1	7.1	16.8	1.0
H-3	ROSMADI Hulu Sungai Tengah	300	5, 9	-	RUBBER R. 6" China LM24-2C	-	ENGELBERG Grantex	2 -2	2	75.3	68.6	5.0	26.4	10.0
H-4	KUD	300	6, 11	-	RUBBER R. 6" Yanmer ECH60	-	B. FRICTION Yanmer SS10	3 -3	2	77.2	67.0	12.6	20.4	1.0
H-5	TAMBUN INSTITUTE			TEST ASPIRA-	TEST RUBBER R. 35mm Satake THU	-	TEST ABRASIVE CONE MINGETTI		2	75.5	80.3	8.5	11.2	0.4

SOUTH — KALIMANTAN (2)

VARIETY OF PADDY:

CORRECTED RECOVERY % $c=\frac{100\times(a-b)}{100-b}$	TEST NO.	NUMBER OF PASS	MILLED RICE RECOVERY % (d)	ANALYSIS HEAD %	ANALYSIS BROKEN %	ANALYSIS BREWERY %	ANALYSIS CHIP % (e)	ANALYSIS PADDY Pcs/100g	CORRECTED RECOVERY % $f=d-\frac{e\times d}{100}$	MILLING DEGREE (WEIGHT % 1000KERNEL) (g)	FINAL CORRECTED RECOVERY % $h=f-\frac{(g-91)\times c}{100}$	ACTUAL CAPACITY HUSKER kg/hr PADDY	ACTUAL CAPACITY WHITENER kg/hr PADDY	TEMPERATURE PADDY °C	TEMPERATURE MILLED RICE °C	MOISTURE CONTENT PADDY %	MOISTURE CONTENT MILLED RICE %
76.7	B-1	2	66.4	60.5	36.5	3.0	1.6	4	65.3	92.6	64.0	560	560	31	47	14.7	14.3
74.9	B-2	3	66.4	47.0	50.2	2.8	4.1	24	63.7	93.0	62.0	540	230	31.5	42	14.4	14.4
72.6	B-3	2	66.7	58.5	34.6	6.9	2.1	7	65.3	90.6	65.6	390	330	30.5	50	14.9	14.3
75.6	B-4	1	66.6	53.0	41.1	5.9	1.5	0	65.6	92.0	64.8	660	610	30	56	14.7	14.2
76.8	B-5	2	67.5	58.5	37.8	3.7	1.5	2	66.5	91.5	66.1	1420	810	29	44	14.6	14.1
75.3	B-6	2	66.1	64.5	28.7	6.8	1.5	15	65.1	90.7	65.3	470	460	29	48	15.1	14.4
76.8	B-7	1	68.7	83.8	16.2	2.7	0.6	0	68.3	91.0	68.3						
75.4	H-1	3	59.5	50.0	46.4	3.6	0.6	0	59.1	84.1	64.3	140	100	31	55	15.7	14.3
72.7	H-2	1	64.0	61.5	37.1	1.4	0.3	0	64.0	92.1	63.0	440		31	50	15.5	14.2
73.7	H-3	2	67.5	61.0	36.8	2.2	2.0	0	66.2	92.5	64.9	360	400	31	47	15.7	14.2
77.0	H-4	2	68.1	65.5	32.7	1.8	1.4	0	67.1	92.5	65.9	630	520	31	40	15.4	15.1
75.4	H-5	1	66.9	76.1	23.6	1.1	0.6	0	66.5	91.0	66.5						

[illegible]) Surveys Employing Mechanical Harvesting Equipment

1) Purpose

The purpose of the survey is to compare the qualitative and quantitative losses generated by traditional methods and by employing machines in the reaping, threshing, drying, and milling stages in order to find improvements.

Methods for drying and milling were combined and comparative tests were made to pursue losses in quality and quantity. Combinations had traditional sun-drying and mechanical-drying, and average existing milling equipments and improved milling equipments for the milling process.

2) Test Areas and Test Sites

West Java Province

Dryer site	Central Research Institute of Food Crop, Karawang Branch (LP3)
Improved milling equipment	Rice Processing Center in Tambun
Average existing milling equipment	Rice Processing Center in Tambun

Aceh Province (Aceh Utara and Pidie Districts

Dryer site	M.T. Budiman Rice Mill, Aceh Utara
Improved milling equipment	M.T. Budiman Rice Mill, Aceh Utara
Average existing milling equipment	Swadaya Rice Mill, Aceh Utara

3) Outline of Test

Traditional and improved methods were combined in each process, and the following tests were made.

a) Control Method

To treat all processes employing the safest method to obtain the best results from sample paddy.

b) Traditional Method

To perform all processes in accordance with local ways and practice.

c) Improved Method

To perform usual methods by combining machines.

d) Mechanical Method

To employ machines in all processes.

In milling rice, average and improved facilities were combined for all items.

Code No.	Process-ing Way	Reaping		Threshing		Drying		Milling		Test Milling	
		Qty	Method	Qty	Method	Qty	Method	Qty	Mill	Qty	Mill
A	Control	1.8 m^2	Sickle			2.0 kg	Natural Air			1.5 kg	Test Mill
G	Conven-tional	2.6 ton	Sickle	2.6 ton	Tramping	1.2 ton	Sun	0.5 ton	Average	1.5 kg	Test Mill
								0.5 ton	Improved		
H	Improved					1.2 ton	Dryer	0.5 ton	Average	1.5 kg	Test Mill
								0.5 ton	Improved		
I	Mechan-ized	1.3 ton	Power Reaper (or Sickle)	1.3 ton	Power Thresher	1.2 ton	Dryer	0.5 ton	Average	1.5 kg	Test Mill
								0.5 ton	Improved		

4) Preparations for Tests

a) Paddy Dryers

Dryers were custom-made in Japan matching the intended tes purpose and were sent to Indonesia. Each dryer, of a flat batc type, had two 2-tsubo (1.5 ton) drying boxes and an axial-flow blower with a burner, which could send air to the two boxes alternately.

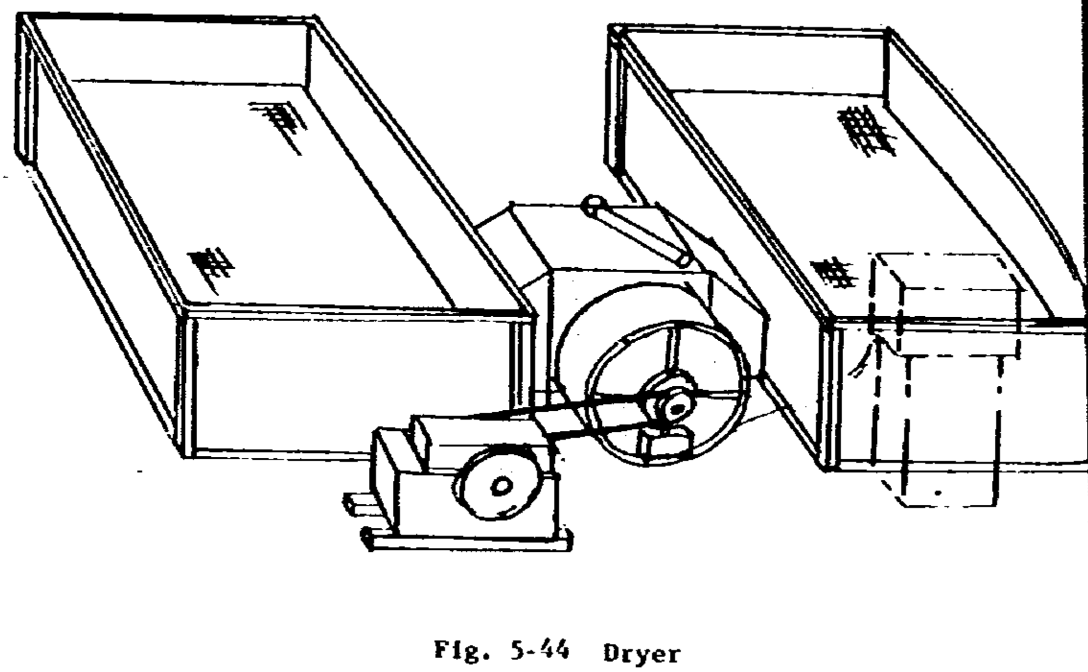


Fig. 5-44 Dryer

Table 5-68 Varieties, Weight and Moisture Contents Ratio of Paddy by Machine Utilization

West Jawa Code No.		Variety	Qty. kg	Moisture Content %	Aceh Code No.		Variety	Qty. kg	Moisture Content %
MS-1	G	Cisadane	296.9	19.8	MS-7	G	Cimandiri	1,182.6	16.8
	H		297.7	19.4		H		1,029.4	17.5
	I		101.2	24.3		I		801.2 (692.2)	20.5 (18.8)
MS-2	G	IR-Pillip.	172.8	20.5	MS-8	G	B-1	1,117.9	17.9
	H		229.6	22.7		H		1,187.9	15.9
	I		172.8	23.6		I			
MS-3	G	Cisadane	995.6	23.0	MS-9	G	IR-46		
	H		996.8	19.7		H		1,159.7	22.2
	I		1,101.2	22.2		I		1,094.2	19.5
MS-4	G	IR-36	995.4	20.3	MS-10	G	Cimandiri	1,074.5	16.1
	H		1,007.4	20.5		H		1,030.2	17.0
	I		971.6	21.8		I		319.8 (626.8)	15.9 (15.9)
MS-5	G	Sumeru	994.3	19.0	MS-11	G	GH-16	500.0	17.0
	H		996.0	21.2		H		577.9	17.0
	I		922.7	24.0		I		227.0 (843.4)	16.0 (16.2)
MS-6	G	Cisadane	899.1	20.8	MS-12	G	Cimandiri		
	H		897.7	20.2		H		639.7	15.3
	I		962.4	20.4		I		572.4 (170.0)	43.6 (22.2)

5) Test Method

a) Drying

i) Sun-Drying

In accordance with the local method, paddy was spread on a concrete floor. The paddy top and bottom layers were mixed every two hours until the moisture content lowered to the target level. Paddy was sun-dried from 8 a.m. until 4 p.m., after which it was heaped and covered with vinyl sheeting. It was left on the concrete floor until the following morning.

ii) Machine-Drying

The entire quantity was stored in dry boxes broken down by test item, and the paddy was dried by warm air (35 to 45°C). In the test, the top and bottom layers were mixed every 2 hours. A test, in which the top and bottom layers were not mixed, was also combined.

iii) Measurement and Analysis

A air temperature, fuel consumption, and drying time relative to drying conditions were measured. The moisture content of the top and bottom layers were measured every ho[illegible]

iv) Sun-Drying Sites

- West Jawa Province

  The Central Research Institute had a concrete floor made as a sun-drying test site, and this facility was used in the test.

- Aceh Province

  The concrete floor at MTB rice mill, which was utilized as a base for a milling test in the dry season, was used.

b) Milling Facilities

i) West Jawa Province

A variety of milling machines were installed in a rice processing center in Tambun belonging to BULOG. Both average and improved machine were selected and used.

Average existing milling equipment

Rubber roller husker + jet-air friction-type milling machine

Improved milling equipment

Paddy cleaner + rubber roller-type husker + tray-type paddy/separator + jet-air friction-type rice whitener (2 pass type)

ii) Aceh Province

Average existing milling equipment

Rubber roller-type husker + Engelberg-type rice whitener

Improved milling equipment

Paddy cleaner + rubber roller-type husker + compartment type paddy separator + jet-air friction-type rice whitener (2 pass type)

iii) Test Equipment

- Test husker

  A rubber roller-type husker with an aspirator was used.

- Test rice whitener

  A friction-type rice whitener that produces rice of the same quality as that of a practical machine was used.

c) Paddy

Fresh paddy reaped and threshed after the mechanization survey was sorted and weighed broken down by test item and was sent to the drying sites. An amount of 3 to 4 tons of fresh paddy from one field was used for the testing.

d) Husking and Milling

i) Distribution of Paddy

Approximately 1 ton of dried paddy for the individual test items was distributed in accordance with the capacities of the milling equipment to be used in the test. Paddy was stored in bags for tempering for about 2 days after drying and was then moved for milling.

ii) Test Using Average existing Milling Equipment

In both West Jawa and Aceh, an individual husker and rice whitener were combined. Tests and measurements were made individually for both husking and milling. Polished rice was obtained after passing paddy twice through the husker and once through rice whitener.

iii) Test on Improved Milling Equipment

The milling equipment used in West Jawa and Aceh Provinces were the so-called multistage mills whose basic combinations were the same. Species were sampled from brown rice after the husking and paddy/brown rice separation. Measurements were then made. The brown rice thus obtained was used in the milling test. Only one rice whitener was selected from this milling equipment and was set to mill from brown rice to polished rice.

For use as the most improved equipment in the tests, only the rice whiteners had two passes, and testing as well as measurements were made accordingly.

6) Test Results and Considerations

Tables 5-70 and 72 summarize the test results.

Based on the test results, a large difference depending on drying methods could be confirmed for qualitative and quantitative losses of paddy. These are caused by increases in cracked rice due to differing drying conditions and of broken rice produced during milling.

These results serve as a basis for the concrete ways and means to be recommended regarding drying of paddy in Indonesia.

Test Results of Rice Milling by Difference in the Variety of Chaff, Moisture Content and Drying Methods

1) Purposes

This is a test conducted for the purpose of examining the influence of the difference in the variety of paddy for milling, their moisture content and the methods of drying over the results of milling from a total point of view and to clarify the profit-loss relationship.

2) Outlook of the Test

a) Difference in Variety

IR36 and Cisadane, both of which are widely grown in West Java and known as high-yielding, were chosen for the test.

b) Difference in moisture content of paddy for milling test. The target moisture content of paddy for drying as paddy for the milling test was set at 16% and 14%.

c) Difference in Drying Method

Sun drying (on a concrete floor), sun drying (on a mat) and mechanical drying with natural air were chosen as the three basic methods of drying. Also, 3 kg of original wet paddy for each type was dried in the shade with natural air to have the moisture content of 14% as the standard method (control method).

d) Combination of Each Test

Combining the above-mentioned items, a total of 14 different tests, 12 test methods and 2 standard methods were conducted.

Table 5-69 Classification of the Tests and the Amount of Dried Pa

Final M.C.	14%	14%		16%			
Method of Drying / Variety	Natural Dry	Dryer Natural Air	Sundry on Concrete Floor	Sundry on Mat	Dryer Natural Air	Sundry on Concrete Floor	Sundry on Mat
CISADANE	3	75	75	75	75	75	75
IR - 36	3	75	75	75	75	75	75

e) Test Milling

By using the testing machines and existing mills, husking a whitening tests were conducted with each drying test group.

3) Test Methods

a) Testing Materials

500 kg each of the material that immediately after harvestin threshing and that was average in quality (moisture content of a 24-25%) was picked.

The material was mixed and stirred by each different group so as average the quality and distributed according to each different item for each different test.

b) Drying Methods

- Natural Drying Method (Control Method)

3 kg of material was spread out in a bamboo basket in a 2 cm layer and dried naturally indoor.

- Mechanical Drying with Natural Air

By making use of the drying box of the flat bed type dryer, 7 kg of chaff was spread in a 30 cm-thick layer and dried with natural air.

• Sun Drying (on a Concrete Floor)

On a concrete floor specially made for drying purposes, the paddy was spread in a 4 cm-thick layer and upside-down mixing was performed every two hours. During the night time, the paddy was piled up and covered with a vinyl sheet.

• Sun Drying (on a Pandan-made Mat)

The paddy was spread in a 4 cm-thick layer on a mat spread over the ground. Every two hours, upside-down mixing was given. During the night hours, the paddy was kept in sacks.

c) Test Milling Methods

• Testing Machines

3 kg of paddy after each drying test was sent through the testing husker (rubber roll type) twice to get test milling unpolished rice. To make it as close as the existing mill, a small scale friction type whitener was used for whitening.

4) Results of the Tests and Review

a) Difference in Variety

Under various conditions, Cisadane had a 0.5% higher milling recovery rate than IR36 and about 5% more broken kernels was found in IR36 when compared with Cisadane.

b) Difference in Moisture Content

When the paddy with a moisture content of 14% and that with 16% were compared, that with a higher moisture content showed a 1% lower milling recovery rate and 5 to 10% more was found in that with a higher moisture content.

c) Difference in Drying Methods

When comparing the method of mechanical drying with natural air with the sun drying method, the sun drying method showed about a 1% lower milling recovery rate and some 15% more broken kernels.

d) Results When Combined

As for the combination of the difference in moisture content and drying methods for the chaff with a 14% moisture content dried under the mechanical drying system with natural air and those with a 16% moisture content dried under the sun drying method, the chaff with a 14% moisture content showed about a 2% higher milling recovery rate and about 20% less crushed chaff was found in that with a 14% moisture content against that with a 16% moisture content.

Note: In the tests of this time, most of the machines used were testing machines. As the tests using machines for practical use were not sufficiently conducted, we were merely able to examine certain trends. It will be necessary to repeat similar tests in order to obtain absolute figures.

(5) Milling Tests with Different Percentages of Immature Kernels

1) Purposes

In these tests, the influence of the percentage of immature kernel mixed in the chaff over milling results were checked. The immature kernels found in the original wet paddy separated by the separation method by winnower and by sieve was husked and whitened as the basic material.

2) Test Methods

a) Original Wet Paddy

To obtain the original wet paddy containing a different percentage of immature kernels, the original chaff was selected using a manually operated sieve and also a manually operated winnower. With this, the original wet paddy was brought closer to the naturally existing mixture rate. The percentage of immature kernels in the chaff as the milling material and the weight proportion will be shown in the test results table.

b) Husking and Milling

For husking, the test husker (rubber roll type) was used and for milling, the test friction milling machine was used.

3) Test Results

The Results of the milling tests are shown in Table 5-75. After the original wet paddy was sorted into a group that contained more sound paddy and that which contained less immature kernels by the cleaning using wind power and a sieve, it was found that the total milling recovery was higher when the two groups were compared and milled than when they were not separated before milling. It is expected that the original wet paddy with more amount of immature kernels will have better results when milled with an abrasive type whitener.

Table 5-70 Milling Recoveries and Broken Rice Percentage from Different Content of Immature Kernels

...No.	Method of Separation	Position of Paddy	Weight rate at the Position	Percentage of Immature Kernels	Milled Rice Recovery	Total Broken Rice	
-3.7	-	-	- %	3.7 %	70.0 %	37.1 %	
-8.9	-		-	8.9	65.4	30.2	
-11.9	-		-	11.9	60.3	38.7	
...-8.9 -a	Sieve (Manual)	Above 1.9 mm Slotted Hole	71	4.2	71.6	38	66.8
...-8.9 -b	"	Below 1.9 mm	29	26.1	55.4	51.2	
...9-a	"	Above 1.9 mm	61	6.1	69.2	39.7	60.0
...9-b	"	Below 1.9 mm	39	37.7	46.9	43.5	
...-8.9 -I	Winnower (Manual)	1st Outlet	78	7.8	70.1	42.5	66.2
...-8.9 -II	"	2nd Outlet	20	20.2	57.4	50.8	
...9-I	"	1st Outlet	73	10.5	67.0	43.7	
...9-II	"	2nd Outlet	22	24.7	42.4	55.7	

Table 5-71 Table of Milling Recovery and Broken Ratio by Machine Employing Survey

(1)

Item	Way of Process	West-Java Code No.	West-Java Average Mill	West-Java Improved Mill	West-Java Test Mill	Aceh Code No.	Aceh Average Mill	Aceh Improved Mill
Milling Recovery	Conventional	MS-1-G	67.3	70.6	68.4	MS-7-G	69.0	69.7
		2	68.3	69.1	67.8	8	68.4	68.0
	1.Sickle	3	69.0	70.6	67.9	9		
		4	66.2	65.3	62.7	10	66.4	68.5
	2.Trampling	5	67.3	69.4	65.7	11	67.7	69.3
		6	66.8	66.7	65.0	12	65.5	67.4
	3.Sun Dry	Average	67.5	68.6	66.3	Average	66.6	68.6
	Improved	MS-1-H	69.2	70.6	69.2	MS-7-H	69.4	69.8
		2	69.7	69.1	68.1	8		
	1.Sickle	3	70.1	70.7	70.5	9	65.8	65.5
		4	69.5	69.4	70.5	10	66.2	69.1
	2.Trampling	5	67.9	70.3	69.8	11	67.8	70.0
		6	68.7	69.0	68.1	12	66.7	68.9
	3.Mech-Dryer	Average	69.2	69.9	69.4	Average	67.2	69.3
	Mechanized	MS-1-I	70.2	71.1	69.4	MS-7-I	68.5	69.8
		2	69.5	69.7	69.4	8	65.9	67.0
	1.Binder	3	69.0	69.7	69.2	9	65.9	68.5
		4	70.1	69.8	70.7	10	68.4	69.9
	2.Thresher	5	68.8	70.7	68.4	11	68.7	69.6
		6	69.3	68.9	68.8	12	62.8	68.1
	3.Mech-Dryer	Average	69.5	70.0	69.3	Average	66.7	68.7
Broken Rice Percentage	Conventional	MS-1-G	34.8	29.0	48.3	MS-7-G	38.8	24.4
		2	25.8	19.0	13.4	8	52.0	43.2
	1.Sickle	3	31.0	27.6	36.6	9		
		4	79.8	44.1	48.9	10	51.6	35.6
	2.Trampling	5	47.9	46.3	41.6	11	34.4	30.6
		6	41.3	46.4	42.9	12	57.6	28.6
	3.Sun Dry	Average	42.9	35.4	38.6	Average	46.9	32.4
	Improved	MS-1-H	14.3	15.6	20.3	MS-7-H	36.0	26.8
		2	8.7	8.0	7.0	8		
	1.Sickle	3	14.5	11.2	20.1	9	41.2	24.0
		4	26.6	26.2	21.0	10	42.8	35.8
	2.Trampling	5	21.8	19.2	18.3	11	34.4	32.0
		6	21.0	18.7	24.0	12	45.6	28.8
	3.Mech-Dryer	Average	17.8	15.3	20.1	Average	40.0	29.7
	Mechazed	MS-1-I	18.6	15.0	25.1	MS-7-I	38.5	37.2
		2	7.3	7.8	7.1	8	44.0	37.6
	1.Binder	3	27.0	14.5	22.6	9	35.6	20.4
		4	16.6	23.3	24.2	10	33.2	33.6
	2.Thresher	5	26.6	26.0	34.2	11	38.8	35.6
		6	23.9	24.0	41.5	12	49.2	22.8
	3.Mech-Dryer	Average	20.0	18.4	25.7	Average	39.9	33.2

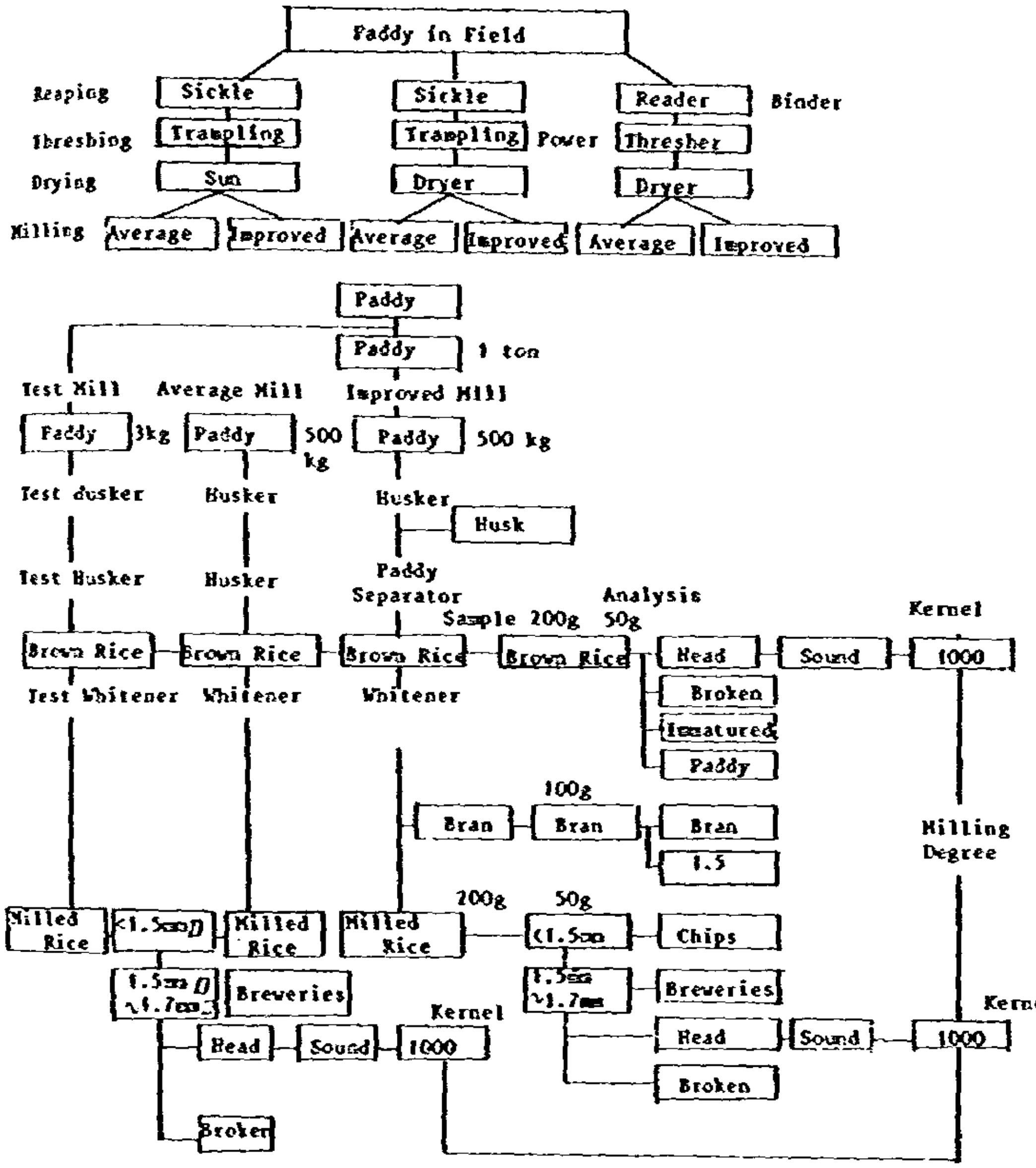


Fig. 5-45 Milling Method and Analyzing Process by Machine Utilization Survey.

Table 5-72 Results of Drying and Milling by Machine Utilization Survey (Part 1)

ID	VARIETY	REAP METHOD	THRESH METHOD	DRY METHOD	DRYING					AVERAGE EXISTING MILL (1)														IMPROVED EXISTING MILL (1)														PADDY		TEST MILL (1)													
					MOIST. CONT.		TEMP.	TIME	SPEED	BROWN RICE					CORRECTED HUSKED RICE RECOVERY	MILLED RICE							FINAL CORRECT RECOVERY	BROWN RICE					CORRECTED HUSKED RICE RECOVERY	MILLED RICE							FINAL CORRECT RECOVERY	PADDY	IMPURITY	BROWN RICE					CORRECTED HUSKED RICE RECOVERY	SUN CRACK	MILLED RICE						CORRECT RECOV.
					INITIAL %	FINAL %	°C	hr	t/hr	RECOVERY	HEAD	IMMATURED	BROKEN	PADDY		RECOVERY	HEAD	BROKEN	BREWERY	CHIP	CORRECT RECOVERY	1000G RECOVERY		RECOVERY	HEAD	IMMATURED	BROKEN	PADDY		RECOVERY	HEAD	BROKEN	BREWERY	CHIP	CORRECT RECOVERY	1000G RECOVERY				RECOVERY	HEAD	IMMATURE	BROKEN	PADDY			RECOVERY	HEAD	BROKEN	BREWERY	CHIP	COLORED	
										a				b	c	d				e	f	g	h	a				b	c	d				e	f	g	h	-	-	a				b	c		d				e		f
[illegible]	CISADANE	CONTROL	TRAP	NAT.AIR	24.3	14.6	-	20.0	0.3																															79.2	93.7	6.3	2.0	1.1	79.6	4.4	68.5	78.5	20.8	0.5	0.1	0	68.4
[illegible]	"	SICKLE	-	SUN	19.8	14.6	-	32.0	0.2	77.5	82.9	11.5	5.6	0	77.5	67.6	55.2	33.2	1.5	0.5	67.3	92.6	66.1	78.6	81.1	11.7	6.4	0	78.6	70.7	71.0	27.0	1.7	0.2	70.6	93.4	68.7			80.4	90.9	6.8	1.4	0.8	80.2	34.5	66.4	59.7	45.6	1.1	0.5	0	66.1
[illegible]	"	-	"	DRYER	19.4	14.9	45	8.0	9.6	77.1	78.2	18.5	3.3	0	77.1	69.3	55.7	13.6	0.6	0.1	69.2	92.6	69.0	77.8	75.3	21.3	3.1	0.2	77.8	70.8	84.4	14.5	0.9	0.3	70.6	92.4	69.5			81.7	90.8	6.9	1.14	1.0	81.5	22.5	69.3	73.7	19.4	0.9	0.1	0	69.2
[illegible]	"	BINDER	THRESHER	-	24.3	14.9	45	8.0	1.2	78.8	70.4	24.9	4.7	0.2	78.8	70.3	81.4	18.1	0.4	0.1	70.2	91.9	69.6	79.2	66.0	26.6	5.2	0	79.2	71.2	85.0	14.6	0.4	0.1	71.1	92.6	69.8			80.0	83.8	6.1	3.2	0.9	79.8	22.0	69.5	75.9	23.2	0.8	0.1	0	69.4
[illegible]	IR-[illegible]	CONTROL	TRAP	NAT.AIR	24.4	13.0	-	10.0	0.3																													94.0	1.5	79.7	95.1	4.8	0.1	0	79.7	5.5	70.0	97.5	23	0.1	0.1	0	69.9
[illegible]	"	SICKLE	-	SUN	20.5	14.7	27-35	22.0	0.2	78.1	86.6	11.7	1.7	0	78.1	68.6	74.2	25.2	1.2	0.4	68.3	91.9	67.6	76.4	83.6	8.7	2.6	0.1	76.4	69.2	81.0	18.0	0.9	0.1	69.1	92.5	68.0			78.5	93.0	6.1	0.9	0	78.5	26.0	67.9	86.6	12.8	0.5	0.1	0	67.8
[illegible]	"	-	"	DRYER	22.7	13.0	45	9.45	1.0	77.0	93.3	9.1	0.6	0.1	77.0	69.8	91.3	10.1	0.5	0.1	69.7	92.0	69.9	77.0	85.8	14.4	0.8	0.1	77.0	69.2	92.0	7.6	0.3	0.1	69.1	91.5	68.7			77.8	93.4	5.7	0	0	77.8	15.0	68.1	93.0	6.6	0.3	0.1	0	68.0
[illegible]	"	BINDER	THRESHER	-	23.6	14.0	45	14.35	0.7	78.2	84.5	14.5	1.0	0.3	78.1	69.6	92.7	7.0	0.2	0.1	69.5	92.4	68.4	78.0	87.5	9.8	2.1	0.2	78.0	69.7	92.2	7.5	0.3	0	69.7	92.0	69.9			79.4	84.6	14.1	0.2	1.0	79.2	13.5	69.5	92.9	6.6	0.4	0.1	0	69.4
[illegible]	CISADANE	CONTROL	TRAP	NAT.AIR	19.2	13.5	-	16.0	0.4																													84.7	1.4	79.7	91.0	7.2	0	0	79.7	5.5	70.7	93.4	6.3	0.3	0.1	0	70.6
[illegible]	"	SICKLE	-	SUN	23.0	14.0	27-35	13.2	0.7	78.4	86.8	8.7	4.5	0.1	78.4	69.1	69.0	29.5	1.2	0.2	69.0	92.2	68.1	78.4	87.2	8.4	4.1	0.2	78.4	70.7	72.4	26.9	0.6	0.1	70.6	93.0	69.0			80.2	91.1	5.9	3.0	0	80.2	29.0	68.2	63.4	34.2	2.0	0.4	0	67.9
[illegible]	"	-	-	DRYER	19.7	14.1	45	5.1	1.1	77.3	81.6	10.6	1.6	0.6	77.2	70.2	85.5	13.4	0.9	0.2	70.1	93.0	68.6	77.8	81.2	15.8	2.9	0	77.8	70.8	88.8	10.6	0.4	0.2	70.7	93.0	69.1			80.7	89.7	9.5	0.4	0.4	80.6	10.5	70.6	79.9	19.1	0.9	0.1	0	70.5
[illegible]	"	BINDER	THRESHER	-	22.2	13.9	45	8.0	1.0	77.7	85.1	11.7	3.2	0.3	77.6	69.2	73.0	25.4	1.3	0.4	69.0	92.3	65.0	77.6	82.6	14.8	3.2	0.3	77.5	69.8	85.5	14.0	0.4	0.1	69.7	92.0	68.9			80.3	75.7	23.3	0.8	0.2	80.3	6.5	69.3	77.4	21.6	0.9	0.1	0	69.2
[illegible]	IR-[illegible]	CONTROL	TRAP	NAT.AIR	22.9	14.4	-	10.0	0.2																													85.6	1.4	78.1	81.9	6.2	0.4	0	78.1	17.5	70.3	84.5	14.5	0.8	0.1	0	70.2
[illegible]	"	SICKLE	-	SUN	20.3	14.7	28-35	24.0	0.2	76.9	63.8	8.0	28.2	0.6	76.8	69.2	23.2	60.5	12.0	4.4	66.2	92.4	65.1	75.9	76.6	4.6	18.5	0.2	75.9	67.7	55.9	39.2	10.4	3.5	65.3	91.3	65.1			78.0	68.8	8.7	21.3	1.1	77.8	49.0	65.4	51.8	32.5	13.0	4.1	0	62.7
[illegible]	"	-	-	DRYER	20.5	13.7	45	6.3	1.1	76.2	86.0	7.9	6.1	0.7	76.0	69.8	73.4	24.5	1.2	0.4	69.5	92.6	65.3	77.0	84.5	9.6	5.6	0.1	77.0	69.5	73.8	24.8	1.1	0.2	69.4	92.6	68.2			79.2	85.5	10.8	2.0	0.6	79.1	22.0	70.6	79.0	19.9	3.0	0.1	0	70.5
[illegible]	"	BINDER	THRESHER	-	21.8	13.5	45	7.0	1.2	77.1	85.3	8.5	6.2	0.6	77.0	70.2	83.4	15.7	0.6	0.2	70.1	92.5	69.0	77.3	78.3	15.6	6.5	0.5	77.2	70.0	76.7	21.4	1.5	0.3	69.8	92.5	68.6			80.0	82.9	13.3	2.4	1.3	79.7	20.0	70.8	75.2	23.3	1.4	0.1	0	70.7
[illegible]	SEMERU	CONTROL	TRAP	NAT.AIR	19.6	14.5	-	24.0	0.2																													93.1	3.0	79.5	93.7	4.3	1.8	0	79.5	7.5	67.3	79.8	18.9	1.1	0.2	0	67.2
[illegible]	"	SICKLE	"	SUN	20.3	14.6	28-35	12.5	0.5	77.0	65.2	10.2	24.6	0.6	76.9	69.7	52.1	38.6	6.1	2.6	67.3	90.5	67.7	77.6	70.3	6.7	21.4	0.1	77.4	70.2	53.7	49.6	4.4	1.2	69.4	90.0	70.2			80.8	66.4	12.0	17.8	3.8	80.0	65.5	67.2	58.6	33.2	6.2	2.2	0	65.7
[illegible]	"	-	-	DRYER	21.2	13.9	40	6.3	1.2	74.5	81.4	11.9	6.7	0.9	74.3	67.7	59.2	25.1	13.5	1.2	67.9	91.0	67.9	80.9	74.9	14.2	10.5	0.2	80.9	71.1	83.8	15.8	2.3	1.3	70.3	92.5	70.7			79.2	82.0	12.9	2.1	2.9	78.6	11.5	69.9	81.7	16.1	1.9	0.2	0	69.8
[illegible]	"	BINDER	THRESHER	-	20.1	14.7	40	5.3	3.0	76.9	82.7	8.6	0.7	1.5	76.5	69.0	73.4	25.1	1.2	0.3	69.8	90.5	69.2	78.2	68.9	14.4	16.5	0	78.2	71.1	74.0	24.5	0.6	0.5	70.7	90.3	71.2			80.8	81.4	10.4	4.0	4.2	80.0	21.5	68.7	65.8	31.0	2.6	0.4	0	68.4
[illegible]	CISADANE	CONTROL	TRAP	NAT.AIR	19.9	16.7	-	32.0	0.2																													82.2	3.3	80.7	55.7	3.6	0.7	0	80.7	5.2	69.1	72.1	26.8	0.9	0.2	0	69.0
[illegible]	"	SICKLE	"	SUN	20.8	14.7	29-35	16.0	0.4	74.8	74.6	12.2	13.0	0.5	74.3	67.6	58.7	36.5	3.3	1.2	65.8	91.6	65.4	76.4	79.4	7.3	13.7	0.1	76.4	68.0	53.6	38.8	5.3	1.9	66.7	91.7	66.2			79.5	76.2	12.4	12.6	0.8	79.3	36.5	65.7	57.1	37.3	4.6	1.0	0	65.6
[illegible]	"	-	"	DRYER	20.7	14.9	35	11.0	0.5	74.7	85.0	9.2	5.0	1.4	74.3	68.9	79.0	18.7	2.0	0.3	68.7	92.2	67.7	75.3	75.8	18.1	6.1	C	75.3	69.1	81.3	17.7	0.8	0.2	69.0	92.0	68.2			79.6	86.1	12.0	1.6	0.3	79.5	26.5	68.3	66.0	32.4	1.2	0.3	0	68.1
[illegible]	"	BINDER	THRESHER	-	20.4	14.6	35	9.5	0.6	75.1	78.5	15.4	6.1	0.5	75.0	69.4	76.1	22.7	1.2	0.1	69.3	92.3	68.3	76.9	80.7	16.3	6.4	C	75.9	69.2	76.0	22.5	111	0.4	68.9	92.3	67.9			80.3	82.0	11.7	5.2	0.6	80.2	16.0	69.1	58.5	39.6	1.5	0.4	0	69.0

Table 5-72 Results of Drying and Milling by Machine Utilization (Part 2)

ITEM	VARIETY	REAP METHOD	THRESH METHOD	DRY METHOD	DRYING: MOIST CONT INITIAL %	DRYING: MOIST CONT FINAL %	DRYING: TEMP. °C	DRYING: TIME hr	DRYING: SPEED %/hr
WS 65-7-A	[illegible]	CONTROL	TRAMP	SAT.AIR					
C	"	SICKLE	"	SUN	16.8	14.3	30-33	8	0.3
B	"	"	"	DRYER	17.5	15.0	44-45	7.5	0.3
E	"	BINDER	THRESHER	"	20.5	14.6	34-46	11	0.5
65-8-A	[illegible]	CONTROL	TRAMP	SAT.AIR					
C	"	SICKLE	"	SUN	17.9	14.8	28-34	7.5	0.4
B	-	-	-	DRYER					
E	"	BINDER	THRESHER	"	15.9	15.0	43	1	0.9
65-9-A	[illegible]	CONTROL	TRAMP	SAT.AIR					
C	"	SICKLE	"	SUN					
B	"	"	"	DRYER	22.2	14.5	24-45	15	0.5
E	"	BINDER	THRESHER	"	19.5	14.1	33-45	19	0.5
65-10-A	[illegible]	CONTROL	TRAMP	SAT.AIR					
C	"	SICKLE	"	SUN	15.9	14.5	29-35	24	0.05
B	"	-	-	DRYER	17.0	14.2	45	4	0.7
E	"	BINDER	THRESHER	-	15.9	15.1	36	2.5	0.3
65-11-A	[illegible]	CONTROL	TRAMP	SAT.AIR					
C	-	SICKLE	"	SUN	17.0	14.5	28-35	47	0.04
B	-	-	"	DRYER	17.0	14.9	39-42	3.5	0.6
E	-	BINDER	THRESHER	"	16.0	14.8	44-45	2.5	0.8
65-12-A	[illegible]	CONTROL	TRAMP	SAT.AIR					
C	"	SICKLE	"	SUN	-	-	-	-	-
B	"	"	"	DRYER	15.3	14.9	32	1.5	0.3
E	"	BINDER	THRESHER	"	18.0	15.2	35-43	4.5	0.6

AVERAGE EXISTING MILL (%)

ITEM	BROWN RICE: RECOVERY a	BROWN RICE: HEAD	BROWN RICE: IMMATURED	BROWN RICE: BROKEN	BROWN RICE: PADDY b	MILLED RICE: RECOVERY d	MILLED RICE: HEAD	MILLED RICE: BROKEN	MILLED RICE: BREWERS	MILLED RICE: CHIP e	CORRECT RECOVERY f	1000G RECOVERY g	FINAL CORRECT RECOVERY h
WS 65-7-A													
C	82.1	94.4	-	5.6	13.1	70.0	61.2	38.0	2.0	1.4	69.0	-	-
B	80.3	92.0	-	8.0	14.2	70.3	64.0	30.4	1.5	1.3	69.4	-	-
E	81.4	92.8	-	7.2	19.0	69.5	61.5	45.0	2.7	1.4	68.5	-	-
65-8-A													
C	80.9	91.6	-	8.4	24.4	65.5	45.0	51.6	4.3	3.8	64.4	-	-
B													
E	87.6	89.2	-	10.8	23.0	67.5	56.0	43.2	3.0	2.4	65.9	-	-
65-9-A													
C													
B	78.6	55.2	-	6.8	16.3	67.3	58.8	40.8	2.7	2.3	65.8	-	-
E	79.3	55.6	-	4.4	17.0	67.2	64.4	35.2	2.8	2.0	65.9	-	-
65-10-A													
C	77.2	84.0	-	6.0	16.2	68.5	59.4	45.0	3.8	3.0	66.4	-	-
B	55.7	55.0	-	4.0	19.0	63.8	57.2	35.2	3.8	3.8	65.2	-	-
E	78.6	90.0	-	10.0	29.4	59.7	66.8	32.8	2.7	1.8	68.4	-	-
65-11-A													
C	80.1	85.2	-	14.8	26.0	69.6	65.6	33.2	3.3	2.8	67.7	-	-
B	79.3	97.6	-	2.4	9.8	69.5	65.6	33.6	3.2	2.4	57.8	-	-
E	77.3	86.4	-	13.5	35.2	70.5	61.2	35.6	3.3	2.6	69.7	-	-
65-12-A													
C	63.7	97.9	-	2.0	27.8	67.7	42.6	56.6	3.4	3.2	65.5	-	-
B	81.6	94.0	-	6.0	25.4	68.2	54.4	45.2	2.8	1.2	66.7	-	-
E	80.2	97.6	-	2.4	25.2	67.6	50.8	49.0	3.2	1.6	65.7	-	-

IMPROVED EXISTING MILL (%)

ITEM	BROWN RICE: RECOVERY a	BROWN RICE: HEAD	BROWN RICE: IMMATURED	BROWN RICE: BROKEN	BROWN RICE: PADDY b	MILLED RICE: RECOVERY d	MILLED RICE: HEAD	MILLED RICE: BROKEN	MILLED RICE: BREWERS	MILLED RICE: CHIP e	CORRECT RECOVERY f	1000G RECOVERY g	FINAL CORRECT RECOVERY h
WS 65-7-A													
C	77.9	95.2	-	6.8	0.3	79.0	75.6	24.0	1.2	0.5	69.7	-	-
B	76.8	93.6	-	6.6	[illegible]	70.1	73.2	26.4	0.9	0.4	69.8	-	-
E	77.6	95.2	-	6.8	1.8	69.4	62.0	36.8	1.7	0.8	68.8	-	-
65-8-A													
C	78.1	91.2	-	8.8	8	67.5	56.8	32.6	2.5	0.8	68.0	-	-
B													
E	78.0	90.8	-	9.2	1.8	67.6	62.4	36.4	2.0	0.9	67.0	-	-
65-9-A													
C													
B	74.9	89.2	-	10.8	0.3	69.0	76.0	23.6	1.7	0.7	68.5	-	-
E	75.3	81.6	-	18.4	0	69.9	79.6	20.0	1.7	0.6	69.5	-	-
65-10-A													
C	76.8	94.8	-	5.2	0.4	69.3	64.4	30.8	2.1	1.1	65.5	-	-
B	76.9	94.4	-	5.4	0.2	73.4	73.2	24.8	3.2	1.8	69.1	-	-
E	76.7	84.8	-	15.2	0	70.5	65.4	31.2	1.9	0.9	69.9	-	-
65-11-A													
C	76.1	89.2	-	10.8	0	70.0	69.6	29.6	2.1	1.9	59.3	-	-
B	79.1	96.8	-	3.2	4.3	70.7	65.0	31.2	2.0	2.0	70.0	-	-
E	78.7	88.8	-	11.2	0	70.2	64.4	31.6	1.8	2.9	69.6	-	~
65-12-A													
C	74.1	90.8	-	9.2	2.4	67.7	61.6	35.6	1.3	0.4	67.4	-	-
B	75.9	87.6	-	12.4	1.0	69.4	73.2	26.8	1.5	0.7	68.9	-	-
E	74.3	92.0	-	8.0	5.0	68.6	77.2	18.0	2.4	0.7	65.1	-	-

TEST MILL (%)

ITEM	PADDY: PADDY	PADDY: IMPURITY	BROWN RICE: RECOVERY a	BROWN RICE: HEAD	BROWN RICE: IMMATURE	BROWN RICE: BROKEN	BROWN RICE: PADDY b	BROWN RICE: SUN CRACK	MILLED RICE: RECOVERY d	MILLED RICE: HEAD	MILLED RICE: BROKEN	MILLED RICE: BREWERS	MILLED RICE: CHIP e	MILLED RICE: CORRECT RECOV. f
WS 65-7-A	-	-	79.6	95.2	-	4.8	6.7	6	68.1	59.6	39.6	1.2	0.4	67.0
C			79.6	96.2	-	3.8	4.2	6	68.0	64.4	35.2	1.2	0.3	67.8
B			79.4	92.8	-	7.2	6.6	7	68.4	65.5	34.0	1.3	0.4	68.1
E			55.6	92.0	-	8.0	5.9	3	65.4	66.8	32.4	1.0	0.2	65.3
65-8-A	-	-	79.8	96.0	-	4.0	7.1	6	68.5	60.0	39.6	0.4	0.1	69.4
C			77.8	93.0	-	10.0	4.5	10	65.9	53.2	42.9	2.0	0.6	56.5
B														
E			79.9	78.2	-	12.4	6.4	64.1	67.1	54.0	45.6	1.6	0.4	56.8
65-9-A	-	-	74.6	90.9	-	10.0	8.2	11	66.0	60.8	39.2	1.3	0.3	66.7
C														66.1
B			76.6	92.0	-	8.8	5.4	4	67.0	68.4	31.6	1.9	0.5	
E			76.2	87.2	-	12.8	7.4	5	66.5	65.6	34.0	2.1	0.6	
65-10-A	-	-	78.2	89.2	-	10.8	5.7	9	66.4	64.8	35.2	1.2	0.3	66.2
C			77.1	90.4	-	9.6	2.8	10	64.1	50.4	43.6	2.0	0.5	63.7
B			78.5	89.2	-	10.8	6.7	5	67.6	57.5	38.8	2.5	1.2	65.8
E			79.0	88.8	-	11.2	5.8	7	65.7	59.6	40.4	1.6	1.8	66.2
65-11-A	-	-	77.3	92.4	-	7.6	5.4	6	67.6	53.8	58.4	1.3	0.4	67.3
C			77.2	92.0	-	8.0	5.3	4	65.4	51.2	48.4	2.1	0.8	64.9
B			77.1	92.4	-	3.6	4.7	4	65.2	62.8	36.0	2.4	0.8	65.7
E			79.9	87.6	-	12.4	6.8	6	65.1	50.0	40.4	2.6	0.8	65.6
65-12-A	-	-	76.8	86.8	-	13.2	6.9	11	65.8	54.0	45.6	2.0	0.8	65.3
C			77.3	90.4	-	9.6	5.3	7	65.9	55.1	43.8	1.5	0.6	65.5
B			77.5	91.2	-	8.8	5.2	9	65.4	59.1	39.4	1.8	0.7	64.9
E			77.4	84.0	-	16.0	6.4	5	65.0	60.4	39.2	1.3	0.7	65.5

Table 5-73 Results of Milling Using Different Drying Method of Paddy

Final moisture (%)	Time hr.	Speed %/hr.	Existing Mill: Brown Rice: Recovery	Head	Immatured	Broken	Paddy b/a	Recovery	Head	Broken	Brewery	Chip	Discolored	Milling degree	Test Mill: Brown Rice: Recovery	Head	Immatured	Broken	Paddy b/a	Milled Rice: Recovery	Head	Broken	Brewery	Chip	Discolored	Milling degree	Condition of Drying Method: Drying Method	Thickness of layer	Upside-down mixing
12.8	12	0.4	76.3	80.8	9.3	9.9	0.0	64.5	55.3	40.4	4.6	1.1	0.0	91.8	75.6	73.8	9.3	9.9	6.7	64.7	55.9	41.6	2.1	0.5	0.0	92.2	Sundry on the fertilizer bag	4 cm	Non
14.1	12	0.3	74.7	80.6	11.0	7.8	0.3	65.3	44.3	49.6	4.2	1.9	0.0	92.6	75.6	75.8	7.1	11.2	5.3	65.0	59.7	35.7	2.2	0.4	0.0	92.6	-	-	Every 2 hrs.
13.7	12	0.4	76.0	83.4	5.8	10.6	0.2	64.7	52.7	41.3	4.1	1.9	0.0	92.2	75.6	74.9	10.0	11.4	2.4	64.8	49.4	45.2	4.7	0.3	0.0	91.6	Sundry on the concrete floor	-	Non
13.8	12	0.4	75.0	83.7	10.0	6.1	0.2	64.5	61.0	35.0	2.5	1.4	0.0	90.3	76.9	76.9	10.7	9.8	2.0	64.5	62.8	35.2	1.7	0.3	0.0	91.4	-	-	Every 1/2 hrs.
14.9	12	0.4	74.8	87.7	7.3	4.8	0.3	64.9	49.2	44.7	4.7	1.4	0.0	92.6	75.6	79.4	10.8	4.0	4.3	64.3	52.6	40.5	5.6	1.3	0.0	91.0	-	-	Every 2 hrs.
14.6	20	0.2	76.8	84.7	7.7	7.0	0.5	65.6	57.3	39.4	2.2	1.0	0.0	90.6	76.9	81.7	6.4	8.4	3.1	63.4	52.8	44.8	5.9	1.5	0.0	91.0	-	10 cm	Non
14.5	22	0.3	76.7	86.6	9.3	4.1	0.1	66.7	73.7	22.4	3.0	0.7	0.0	93.0	78.2	85.9	6.2	1.9	5.5	64.5	75.6	22.3	1.8	0.3	0.0	93.0	-	-	Every 1/2 hrs.
15.2	22	0.2	76.2	87.0	5.8	6.6	0.6	65.6	65.1	30.2	4.2	0.5	0.0	91.1	75.6	79.7	8.3	5.3	1.1	64.5	62.1	34.7	2.6	0.6	0.0	92.2	-	-	Every 2 hrs.
14.4	16	0.2	76.3	83.8	9.3	6.6	0.3	65.4	71.0	25.9	2.3	0.8	0.0	92.2	76.9	82.4	7.1	4.2	4.3	64.6	69.9	28.6	1.1	0.3	0.0	92.6	Dryer (Natural Air)		Non
14.5	12	0.3	76.3	87.1	4.7	7.1	0.0	66.4	74.9	23.0	1.6	0.4	0.0	93.0	78.2	83.1	7.4	4.9	4.2	65.2	68.7	28.7	2.2	0.4	0.0	90.2	-		Every 2 hrs.
14.5	6	0.6	77.0	87.9	4.3	7.3	0.5	67.1	72.4	25.4	2.0	0.3	0.0	89.8	79.6	80.3	8.8	5.3	5.1	67.2	78.3	24.1	1.3	0.3	0.0	90.2	Dryer (40°C)		Non
14.5	4	0.9	77.0	87.8	6.0	5.7	0.5	65.4	79.0	18.5	2.3	0.2	0.0	90.3	76.9	86.5	6.3	6.6	0.6	65.0	74.8	24.1	0.9	0.2	0.0	89.8	-		Every 2 hrs.
13.6	6	0.8	77.0	89.3	6.3	6.3	0.1	67.8	71.7	26.4	1.4	0.3	0.0	91.4	78.2	74.6	11.7	6.3	6.7	67.6	69.8	29.1	0.9	0.2	0.0	89.8	Dryer (45°C)		Non
13.5	6	0.9	77.0	86.3	6.4	7.0	0.2	67.1	69.8	28.1	1.8	0.4	0.0	91.0	78.2	80.0	10.4	6.6	2.7	67.1	74.2	24.5	1.2	0.1	0.0	92.6	-		Every 2 hrs.
15.2	16	0.2													78.5	68.6	1.6	5.8	2.8	67.1	66.9	31.0	1.9	0.2	0.0	92.6	Natural dry (in door)		Non
14.7	21	0.3	76.3	85.3	6.4	8.3	0.0	64.8	57.6	38.7	2.5	0.9	0.0	91.3	78.2	77.2	4.0	10.4	3.4		51.7	41.3	5.6	1.3	0.0	89.4	Sundry on the fertilizer bag	4 cm	Non
14.4	13	0.5	75.7	89.2	-5.8	4.6	0.2	64.2	59.4	35.9	3.2	1.1	0.0	91.7	74.2	82.0	9.2	5.5	2.8		56.2	35.9	6.1	1.5	0.0	91.0	-	-	Every 2 hrs.
14.6	21	0.3	75.5	87.0	6.2	6.2	0.3	64.6	58.5	33.3	6.1	2.1	0.0	91.3	78.2	81.0	7.5	6.4	4.1		55.1	38.9	4.9	1.0	0.0	89.0	Sundry on the concrete floor	-	Non
13.9	17	0.6	75.7	88.1	8.1	3.4	0.2	64.2	71.6	24.6	2.8	1.0	0.0	91.3	75.6	77.0	10.7	9.8	2.1		54.1	40.9	4.2	0.8	0.0	92.9	-	-	Every 1/2 hrs.
14.2	21	0.3	75.7	89.1	5.7	4.9	0.1	64.2	54.4	38.9	3.4	3.3	0.0	89.6	75.6	81.5	8.6	6.5	2.9		57.5	37.5	3.9	1.0	0.0	90.2	-	-	Every 2 hrs.
15.2	27	0.2	75.0	89.9	5.5	4.3	0.1	64.2	63.5	31.8	3.5	1.1	0.0	93.3	75.6	81.9	11.5	3.8	2.1		50.1	42.4	5.2	1.7	0.0	92.2	-	10 cm	Non
14.7	21	0.3	75.2	87.4	10.7	1.7	0.1	64.1	82.3	16.4	1.0	0.4	0.0	92.1	75.6	87.2	9.6	0.7	2.1		72.3	24.7	1.0	0.2	0.0	91.7	-	-	Every 1/2 hrs.
14.3	22	0.3	74.8	88.6	7.7	3.3	0.4	64.3	59.4	34.5	4.5	1.5	0.0	92.9	78.2	83.4	4.2	4.7	3.5		56.6	39.0	3.2	0.6	0.0	90.6	-	-	Every 2 hrs.
14.7	13	0.3	75.7	89.2	7.1	3.2	0.5	65.1	78.3	18.7	1.7	0.9	0.0	90.6	75.6	88.2	5.3	1.5	4.2		77.8	21.7	0.4	0.1	0.0	92.5	Dryer (Natural Air)		Non
14.7	13	0.4	76.2	88.1	7.8	2.9	0.8	66.2	88.1	9.9	0.6	0.5	0.0	92.1	79.6	85.6	7.3	0.3	5.6	64.6	82.9	16.9	0.2	0.0	0.0	92.5	-		Every 2 hrs.
14.5	8	0.6	77.0	79.9	13.3	6.0	0.3	67.1	83.1	16.0	0.6	0.2	0.0	91.2	80.9	79.2	9.8	1.3	5.5	66.7	76.3	22.7	0.9	0.1	0.0	92.9	Dryer (40°C)		Non
14.2	13	0.6	74.1	85.5	10.9	3.1	0.3	65.6	85.1	13.8	0.8	0.3	0.0	90.2	72.9	84.4	10.5	1.0	3.5	62.4	84.9	14.7	0.4	0.0	0.0	91.7	-		Every 2 hrs.
14.5	5	0.8	75.7	87.2	7.7	4.6	0.5	67.1	78.1	20.1	1.1	0.7	0.0	89.5	78.2	85.7	7.9	2.3	4.0	65.5	77.9	21.4	0.6	0.1	0.0	91.4	Dryer (45°C)		Non
13.7	8	1.0	75.2	89.4	4.6	5.3	0.5	66.0	71.7	26.5	1.3	0.6	0.0	90.9	75.6	85.1	9.6	1.5	3.0	65.5	83.2	16.2	0.5	0.1	0.0	91.4	-		Every 2 hrs.
14.3	23	0.2													78.2	72.7	2.8	0.7	3.2	65.8	87.4	17.0	0.5	0.1	0.0	93.0	Natural dry (in door)		Non

Table 5-74 Results of Milling Using Different Moisture Contents and Varieties of Paddy

EXISTING MILL (%)

	BROWN RICE					MILLED RICE						
	RECOVERY	HEAD	IMMA-TURED	BROKEN	PADDY	RECOVERY	HEAD	BROKEN	BRE-WERY	CHIP	DIS-COLORED	MILLING DEGREE
C-Control	–	–	–	–	–	–	–	–	–	–	–	–
C-14-A	75.1	84.4	3.9	4.2	1.3	66.1	83.5	13.8	2.6	0.1	0.0	91.5
C-16-A	76.5	86.9	3.8	3.4	0.5	64.7	79.5	18.0	2.4	0.2	0.0	91.6
C-14-C	76.5	83.9	4.0	6.5	0.6	65.8	66.9	29.3	4.6	0.7	0.0	91.8
C-16-C	73.4	83.5	4.1	6.2	0.9	62.8	62.0	32.8	3.4	0.3	0.0	92.3
C-14-M	76.8	81.4	4.8	7.8	1.3	65.1	68.6	28.8	3.6	0.4	0.0	91.5
C-16-M	75.4	88.9	2.7	3.4	1.4	62.8	66.6	31.4	2.5	0.1	0.0	91.6
IR-Control	–	–	–	–	–	–	–	–	–	–	–	90.9
IR-14-A	75.2	79.6	8.2	6.5	0.4	64.0	62.4	29.8	7.3	0.5	0.0	91.5
IR-16-A	76.8	76.2	6.5	8.1	0.6	63.0	67.1	26.5	5.6	0.6	0.0	92.7
IR-14-C	74.9	70.9	7.7	11.8	0.4	64.0	60.4	33.6	5.6	0.4	0.0	91.3
IR-16-C	78.4	69.3	4.9	21.4	1.2	65.1	56.3	38.6	5.7	0.5	0.0	92.3
IR-14-M	76.1	80.9	7.3	9.8	0.1	65.5	64.7	29.7	5.1	0.4	0.0	92.2
IR-16-M	76.4	70.2	5.8	14.5	0.7	63.7	59.4	34.7	5.7	0.2	0.0	91.0

TEST MILL (%)

	BROWN RICE					MILLED RICE						
	RECOVERY	HEAD	IMMA-TURED	BROKEN	PADDY	RECOVERY	HEAD	BROKEN	BREWERY	CHIP	DIS-COLORED	MILLING DEGREE
C-Control	76.0	88.0	4.9	1.9	0.0	67.4	83.6	21.1	0.2	0.1	0.0	91.9
C-14-A	78.1	87.5	9.0	0.8	1.2	65.4	77.5	21.8	0.5	0.1	0.0	91.6
C-16-A	77.0	85.9	8.9	0.7	0.4	62.5	66.9	32.3	0.7	0.3	0.0	91.1
C-14-C	75.7	85.2	8.5	12.2	0.2	65.2	59.8	37.1	2.6	0.6	0.0	90.8
C-16-C	77.5	84.3		1.8	0.4	57.9	49.0	46.4	2.9	1.2	0.0	90.4
C-14-M	75.5	82.2	14.1	3.5	0.0	63.7	59.3	37.2	3.0	0.7	0.0	91.8
C-16-M	76.3	83.7	12.9	2.0	1.1	59.6	48.9	46.7	3.1	1.3	0.0	91.0
IR-Control	76.2	85.9	9.9	3.6	0.4	68.6	78.0	20.5	1.2	0.2	0.0	91.3
IR-14-A	75.3	86.5	9.6	2.4	1.0	63.0	66.1	31.9	1.6	0.3	0.0	90.5
IR-16-A	76.5		8.0	8.0	0.8	62.3	51.6	45.8	3.1	0.5	0.0	90.2
IR-14-C	76.4	85.6	11.7	5.6	0.0	64.6	63.9	35.8	1.9	0.4	0.0	91.2
IR-16-C	76.5	82.3	8.1	8.4	1.2	63.5	47.8	47.1	3.6	0.9	0.0	90.8
IR-14-M	76.4	80.2	13.3	5.5	0.2	64.8	58.4	39.1	2.6	0.5	0.0	91.3
IR-16-M	77.5	76.2	8.9	8.2	2.2	60.9	47.7	49.2	2.6	0.5	0.0	91.3

Note : C ..... CISADANE
IR IR-36
14 ..... Final moisture content 14%
16 ..... " 16%
A ..... Dryer with natural air
C ..... Sundry on concrete floor
M ..... Sundry on mat
Control ..... Natural dry indoor

Table 5-75 Results of Milling Using Different Cleaning Method and Mixed Ratio of Immatured Kernels

	METHOD OF SEPARATION	SIZE AND POSITION	MIXED RATIO OF IMMATURED KERNELS (%)	EXISTING MILL (%) BROWN RICE RECOVERY	HEAD	IMMA-TURED	BROKEN	PADDY	EXISTING MILL (%) MILLED RICE RECOVERY	HEAD	BROKEN	BREWERY	CHIP	TEST MILL (%) BROWN RICE RECOVERY	HEAD	IMMA-TURED	BROKEN	PADDY	TEST MILL (%) MILLED RICE RECOVERY	HEAD	BROKEN	BEWERY	CHIP	DIS-COLORED
IG-3.7	NON	NON	3.7	79.8	81.1	3.7	13.2	1.7	70.3	63.6	30.5	5.0	0.6	78.6	83.1	3.7	12.9	0.3	70.0	62.9	33.6	2.6	0.7	0.2
IG-8.9	"	"	8.9	76.1	77.9	8.9	12.3	0.9	65.7	61.3	31.4	6.0	1.1	74.4	76.0	8.9	13.9	0.1	65.4	69.8	32.6	6.8	0.6	0.2
IG-11.9	"	"	11.9	71.7	69.5	11.9	12.2	0.6	60.6	61.3	26.3	8.4	0.9	73.1	81.2	11.9	5.2	1.0	60.3	61.3	26.3	8.4	0.9	0.0
A-IG-8.9-U	FLAT SIEVE (MANUAL)	1.9mm SLOTTED HOLE ABOVE	8.9											79.6	81.2	4.2	13.7	0.2	71.6	62.0	45.1	1.9	0.4	0.0
A-IG-8.9-B	"	" BELOW	8.9											69.3	59.3	26.1	14.0	0.4	55.4	48.8	40.6	9.0	1.6	0.0
A-IG-11.9-U	"	" ABOVE	11.9											76.9	78.8	5.1	14.6	0.2	69.2	60.3	37.6	1.8	0.2	0.0
A-IG-11.9-B	"	" BELOW	11.9											60.5	43.5	37.7	18.0	0.3	46.9	56.5	36.7	5.8	0.9	0.0
W-IG-8.9-I	WINNOWER (MANUAL OPERATION)	1st OUTLET	8.9											78.1	83.7	7.8	9.2	0.7	70.1	57.5	38.8	3.3	0.4	0.0
W-IG-8.9-II	"	2nd OUTLET	8.9											71.8	56.3	20.2	13.6	0.1	57.4	49.2	38.1	10.4	2.4	0.0
W-IG-11.9-I	"	1st OUTLET	11.9											74.5	77.8	10.5	11.1	0.4	67.0	56.3	38.8	4.4	0.5	0.0
W-IG-11.9-II	"	2nd OUTLET	11.9											60.5	51.5	24.7	23.0	0.3	42.4	44.3	37.8	13.9	4.0	0.0

Test for Paddy Drying

Purpose of Test

To measure losses during the drying process of paddy, tests made as described in the following.

Test Method

1) Assuming the use of both primary and secondary drying, tests were made for two groups - one for initial paddy moisture content of approx. 24%, and the other for approx. 19%.

2) Two paddy varieties were selected - Cisandane and IR-36.

3) In sun-drying, tests were made for drying floors (concrete, coconut fiber and vinyl mattresses), paddy thickness (4 and 10 cm), mixing of paddy layers (not performed, performed every 30 minutes and performed every 2 hours). In machine drying, tests were made for natural air drying and
control, samples dried in the shade indoors were also used.

4) The target for moisture content after finishing drying was 15%.

5) Measurements of moisture content, temperature, humidity, and weather were made every 2 hours. Sunlight duration was recorded by an automatic recorder throughout the test period. Cracked kernels were measured when paddy moisture content was 18%.

6) In principle, sun-drying was performed from 8 a.m. until 5 p.m. Paddy was contained in bags and stored indoors at night and during rainfalls.

7) After drying, the sample paddy was husked and milled by the test rice whitener and at rice mills, after which milling yield and milling quality were measured and evaluated.

(3) Test Results

1) Rate of Drying

a) The rate of drying was high in the order of: dryer 45°C, dryer 40°C, sun-drying concrete floor, vinyl bag mattress, natural air drying using a dryer.

b) Naturally, the rate of drying was higher with a high initi[al] moisture content than with a low initial moisture content.

c) The mean drying rate was higher when the paddy top and bottom layers were mixed than when the layers were not mixed. There was no prominent difference in mixing time interval between every 30 minutes and every 2 hours.

2) Results of Milling Tests

a) In both sun- and machine-drying, the ratio for generation of broken kernels rapidly increased when mean drying rate exceeded 1%/hr.

b) The difference in sun-drying methods did not effect generation of broken kernels and paddy husking

c)

(I[illegible]

Method / Item	Machine-Drying	Sun-Drying	A-B
Average Milling	66.4	64.8	1.6
Average Broken Kernels	23.1	39.7	-16.6

The price discount due to increases in broken kernels is 10 Rp. per 10%. Assuming the average milled rice price to be 220 Rp/kg, an 16.6% broken kernel difference is 7.5%. When a 1.6% yield difference is added, the total will be 9.1%.

The drying cost for sun- and machine-drying is only $\frac{12 - 4\ Rp}{220} \times 100 = 3.6\%$. Conversely, if machine drying is possible, a 5.5% loss is caused by sun-drying during the drying stage in the current drying mode.

CHAPTER VI FACTORS RELATED TO THE OCCURRENCE AND INCREASE OF LOSSES IN THE POSTHARVEST HANDLING STAGE

PTER VI FACTORS RELATED TO THE OCCURRENCE AND INCREASE OF LOSSES IN THE POSTHARVEST HANDLING STAGE

Factors in the Harvest Stage

-1 Increase of Amount of Production

Amount of paddy produced and yield per hectare are shown in Table 6-1 w. These items have steadily increased since the independence of nesia and brought a considerable amount of rice production to this ion.

Table 6-1 Average Area Harvested, Production and Yield in Indonesia for Selected Periods 1954/55-1977/78

Year	Paddy Cultivating Area (Million ha)	Yield (ton/ha)	Production (Million ton/Milled rice)
1954/55	6.59	1.71	7.68
1960/61	7.07	1.77	8.52
1968/69	8.02	2.18	11.96
1977/78	8.58	2.86	16.69

Source: CBS

The increase in production is attributable to irrigation, fertiliza-n, protective measures against the pest and disease and newly developed e cultivating technology, but more than anything else, the introduction HYV should be highly regarded.

Actually, in the areas wherein intensification programs are applied, the new variety of HYV are introduced, it is not seldom that the farmer obtain a 5-7 ton yield/ha of rice production, which is considered to be e than the national average.

A typical example is observed in South Sulawesi wherein the Lappo Ase ject of OPSUS was implemented in 1981 as shown below:

Table 6-2 The Results of Lappo Ase Project, 1981

Lappo Ase Project			Yield (ton/ha)		Production (ton)	
District	Project Area (ha)	Number of Farmers	1980	1981	1980	1981
Bone	50,700	56,244	2.24	5.64	114,565	288,096
Sinjai	9,200	15,346	1.95	5.11	17,208	52,515
Bulukumba	16,200	19,374	2.61	5.70	34,382	75,835
Total	76,100	91,014	2.27	5.69	166,156	416,447

Source: Department of Agriculture, South Sulawesi

As shown above in the project area, an approximate 2.5 fold incre production has been achieved, and upon completion of the project, abou threefold increase in production is expected. Moreover, in the distri Sinjai the following analysis has been made on the farmer's level of a

Farmer's average cultivated land: 1.67 ha

Rate of production increase/ha : 303%

Farmer's average production : 1980 Approx. 3.3 ton

1981 Approx. 10 ton

Harvesting is usually done by a sickle, cutting paddy at the low portion whereas the threshing is done by beating the paddy in the fiel 2 or 3 days after the harvesting.

Some 10 - 15 of the harvestors join in the harvesting, and each w harvests some 80 - 100 kg of paddy out of which 1/8 of the portion sh retained by the farmer.

Before the Lappo Ase Project, the following number of days were re for the farmer to complete each work of one hectare concerned.

Harvesting	:	2 days
Threshing	:	1.5 days
Total	:	3.5 days

However, after the Project implementation, 6 days for harvesting, 5 days for threshing, a total of 11 days is required.

In spite of the above situation, the number of workers is limited, and the workers have to work at sugar cane cutting while doing their pa harvesting. Therefore, as a result, threefold labor work is necessary t complete their task. In fact, after the Lappo Ase implementation, 5 - 8 workers have to complete their work within 15 - 20 days.

The following is a summary of the farmers' activities and number of days required for the work concerned before the project was implemented.

3.3 ton → Harvesting (2 days) 10 - 15 harvestors Threshing (1.5 days) → Transportation (6 man/day) → Drying → Farmer's storage / Market

However, after the Project it was changed as follows:

10 ton → Harvesting (12 days) 5 - 10 harvestors Threshing (8 days) → Transportation (4 man/ 4 days) → Drying → Farmer's storage / Market (Directly to commercial sector without drying and cleaning)

Now, the losses incurred during the above procedures are as follows:

Before Lappo Ase → Harvesting Temporary storage Threshing (2.5%) → Transportation (Trace) → Drying (0.1%) — Total 2.6%

After Lappo Ase → Harvesting Temporary storage Threshing (3.8%) → Transportation (0.1%)

(Quantitative losses)
Subtotal 3.9%

Wherein the following qualitative losses are found:

a. Qualitative losses during the temporary storage in the field due to delay of transportation.
b. Qualitative losses during the storage at the farmer's premises.

(Qualitative losses)
Subtotal 2 - 5%

Grand Total 6 - 9%

From the above results, increase in the losses concerned are summ[illegible] as follows:

① Due to rough handling, quantitative losses increase.

② Magnitude of the field work and the increased number of days in wh[illegible] the paddy which has an excessive amount of moisture content, deteri[illegible] during the storage, resulting in qualitative losses.

After the implementation of the project, particularly, the huge a[illegible] of qualitative losses have increased.

6-1-2 Shortening of Harvesting Duration

A harvesting method applied customarily in this country was the a[illegible] method in which paddy panicles were selectively cut off due to irregula[illegible] of their ripeness. This required two or three harvesting operations in[illegible] of a single operation where all the panicles were harvested. Accordingly, it usually took almost a month long period to complete the harvesting under the above condition.

However, the recent introduction of H.Y.V. which has ripeness unif[illegible] and its shattering habit forces the ani-ani method to change the sickle method. Ultimately, the time of harvesting has been minimized to two or three days, sometimes a week, before and after optimum time of harvestin[illegible]

The above situation has been clarified through experimental tests conducted by IRRI and the results of the same is self-explanatory as sho[illegible] in the following Table.

Table 6-3 Test Result of Shattering Kernels against Optimum Time

Time of Harvesting	Shattering of Kernels (%)
One week before optimum	0.77
Optimum	3.35
One week after optimum	5.63
Two weeks after optimum	9.64
Three weeks after optimum	40.70
Four weeks after optimum	60.46

Source: IRRI

However, this drastic change of harvesting method has been creating tremendous labor problems particularly in the outer Jawa where a shortage of labor force is prevalent. Namely, in spite of the above situation, while the farmers are forced to handle twice or three times the amount of paddy than that of former days within a week at least, no proper measure has unfortunately been introduced for improving the labor force and to increase the effectiveness of the harvesting work.

Meanwhile, in Jawa island, the population density and the recent tremendous increase in the labor force, in the form of "agricultural labor force" Burutani, actually it has not been causing a direct impact on labor problems. However, some impacts are obviously noted in the occasion of harvesting in the rainy season.

Generally, the following procedure of harvesting is practiced by the farmers at present.

Harvesting

Threshing

Transport from paddy field to the farmer's yard

Drying

Cleaning

Out of the above categories, both harvesting and threshing work are mainly conducted by Bawon i.e., traditional way by the village inhabitants which has been prevalent in Indonesia.
Meanwhile other works such as transportation, drying and cleaning are being done by each farmer's household mostly because the family can not afford extra labor. Ultimately, the paddy harvested, either in wet paddy or dirty form, shall be sold to a village merchant or KUDs directly.

The above handling work reflects the present situation of general Indonesian farmers who can harvest considerably more amounts of paddy than in former days within a short term of harvesting, in which, apart from the harvesting, drying and cleaning, are considered to be the main issue for securing the labor force.

This is to say, the farmer can only secure a minimum labor force by himself enough to handle the paddy required for his family's consumption, leaving considerable amounts of excessive paddy untreated. At this stage, a phenomenal loss arises in wet paddy basis without cleaning or insufficient drying, and the farmers have to keep the paddy as it is until the village merchant or KUDs arrive for procurement.

In this course of time, a tremendous amount of qualitative loss may occur at the farmer's level concerned.

For example, the paddy harvested with 22% of moisture content, can be retained for two or three days at the farmer's yard or in the field and during this period heating evolves due to respiration of the paddy itself as well as fermentation.

Of the paddy packed in a polyethlene bag, it might be exposed to di[illegible] sunshine, and will accelerate this phenomenon of decomposition and incre[illegible] qualitative losses.

In case the selling of paddy is delayed for some reason, this qualitative loss will be increased more and more, and the phenomenon mig[illegible] be accelerated especially for paddy having excessive amounts of moisture content during the rainy season.

6-1-3 Farming Implements

The introduction of the IR type of new varieties brought a revoluti[illegible] transfer of new technology of rice cultivation to the Indonesian farmers. However, out of the harvesting tools used by the farmers, only Ani-ani, a[illegible] the method of threshing have been changed into the sickle method, and the use of a threshing board respectively.

In practice, handling of stalk-paddy prepared by Ani-ani, and sickle harvesting and its threshing in the paddy field - (though after harvesting those panicles are directly packed in bags and brought to the farmer's household in some districts) - have been changed slightly. After all change in the harvesting practice necessitates a minimum amount of adequa[illegible] tools.

The following chart shows the tools required for the handling of paddy concerned.

a. Harvesting done by Ani-ani → Stalk-Paddy → Transportation → Drying → Storage

No particular tools are required for harvesting and drying. A ceiling space is used at the farmer's household for storage

b. Sickle Harvesting
- Lower portion cutting - Beating
- Middle portion cutting / Higher portion cutting → Trampling by feet / Striking by stick → Gabah → Trans-portation → [illegible]

(Threshing tool) (Bag) [illegible]

In spite of the above conditions and even after 10 years since the introduction of IR type of new varieties, no adequate tools such as bag, mattress, carrying basket and harvesting tools have been used by the farmers, and actually the following harvesting operations are observed in the relevant states:

(1) Harvesting Work

(a) Harvesting Done by Ani-ani

In the objective eight provinces, some 20% of the total cultivated area is harvested by this method at present. Those "Stalk-padi" thus harvested, are brought to the farmer's household, duly dried and stowed in the farmer's storage as such.

Most of the local varieties are naturally harvested by ani-ani method, and also in South Kalimantan where swamp areas exist and where paddy field drainage systems are found to be still insufficient, ani-ani harvesting is still popular among the farmers.

(b) Harvesting Done by Sickle

a. Lower portion cutting: Lower cutting is applied in paddy fields where the drainage system is adequate.

b. Middle portion and higher portion cutting:
Where the drainage system is inadequate, these methods are in practice. In general, in West Java where carrying of the paddy is done by a carrying pole, cutting paddy at the middle portion is conducted, whereas in other areas where panicles are bagged, higher portion cutting is required.

(2) Threshing Work

(a) Beating Method

Where the drainage system is adequate, paddy cut off at the lower section, is beaten on the threshing board.

(b) Striking Method

The paddy is hit by either the stem of a coconut leaf or any kind of stick, and threshing is done.

(c) Trampling Method

Like the above mentioned beating method, this is also one of the typical types of threshing method usually observed in Indonesia. As the drainage system is inadequate, threshing can not be done in the field. Eventually, threshing is usually done either in a dry area near the paddy field or at the farmer's yard.

(d) Pedal Thresher

Recently, the introduction of the pedal thresher is getting started in Central Java. A simple mechanism is used consisting of second parts of a bicycle, and on the rotating drum there are many nails about 15 cm in length set up for paddy threshing when the drum rotates. These pedal threshers are easily manufactured in village workshops.

(3) Transportation

Paddy thus threshed, is usually packed in used and repaired polyethylene bags. Content of the paddy weights about 70 kg usually. The method of carrying depends on local features, but in general, manpower, animals and bicycles are employed.

In the area where Ani-ani and sickle harvesting is employed, paddy is carried by the farmers themselves with carrying baskets, while in the area where the drainage system is inadequate, paddy cut at the mid section of the stalk is carried by carrying pole.

(4) Drying Work

When Ani-ani is used in harvesting, losses involved in threshing are usually less in amount because local varieties are cultivated in these areas. Accordingly, the "Stalk-padi" can be piled up and dried as it is on the road side adjacent to their houses. However, in the case of "Gabah" (paddy), the farmers are now required to prepare many mattresses to dry it, but number of the mattresses are quite few at farmers level, and usually the farmer lacks drying yards.

(5) Cleaning Work

In general the paddy could be cleaned by natural wind with simple tools. However, at the area where rice production has increased, the paddy is handled without cleaning. Meanwhile, in South Kalimantan a typical type of winnower is used widely among the farmers, and foreign material, empty paddy and part of the immature paddy are separated by it.

(6) Barn (Room for Works)

In the old pattern of postharvest handling work, farmers did not need specific room and conducted their works in the open yard. After the introduction of IR-variety, the above way of handling is still the same even in the rainy season.

(7) Storage

Lumbung is a typical type of storage system prevailing in Indonesia even though its shape, dimension and storage capacity vary depending on the local features. It can be observed at farmers' houses located in remote areas from the market place even at present.

However, at present it is out of use, because use of tracks makes transportation convenient, and present marketing system does not require storage at the farmer's side.

Originally, the Lumbung was facilitated to store "Stalk-padi" mainly but not for "Gabah" storage.

Formerly, "Stalk-padi" used to be stored in the ceiling space of each farmer's household or in the Lumbung having 2 - 3 tons in storage capacity. The Lumbung is made of either coconut leaves or bamboo mattresses. At present most of the farmers can store ample amounts of paddy to be consumed by their family only, while excessive amounts of paddy is sold to the market nearby as soon as the harvesting is completed. Paddy prepared for the family's consumption is packed in either bag or basket and placed in the farmer's household.

Due to the change of the working practice, in the process of post-harvest i.e., after the harvesting, the following types of losses usually occur at the farmer level:

1) Harvesting:

(a) Shattering: When the harvesting is done later than the optimum time.

(b) Leftover: Considerable amount of panicles remain in the field when panicle cutting is done roughly.

2) Threshing:

(a) Scattering: Scattering due to beating paddy.

(b) Spillage: When a smaller sized mattress is used.

(c) Incomplete threshing: Paddy remains in the stalk of the paddy due to incomplete threshing.

(d) Shattering during temporary stocking:
Due to stacking of paddy at field and when the paddy is removed, thereby resulting in shattering

3) Transportation:

(a) Spillage: Due to torn bags.

(b) Shattering: During the carrying of the paddy.

(c) Deterioration of quality due to rain:
Stack of paddy deteriorates due to heating and rain. This includes damage occuring during transportation in the rain.

4) Drying:

(a) Spillage and loss by birds:
Due to rough handling in drying and caused by birds etc.

(b) Deterioration of quality in drying due to rain:
Causing an increase in broken rice at the time of milling.

5) Cleaning:

(a) Winnowing: Rough handling in winnowing.

6) Storage of Wet Paddy at Farmer's Level

(a) Deterioration of quality:

Deterioration of quality due to heat evolves in storage. Especially, when paddy packed in bags and kept for longer periods waiting to be sold at field or farmers household.

(b) Wet damage during storage:

Due to scarcity of storing space, paddy gets wet when it rains, and may sometimes cause germination.

7) Storage of Dried Paddy at Farmer's Level

(a) Damages due to birds, rodents and insects:

Losses occur during storage.

(b) Deterioration of quality:

Insufficient drying and inadequate storage cause such deterioration.

-1-4 Harvesting in the Rainy Season

Ever since the introduction of IR varieties the harvesting period has been reduced by 1 - 2 months from that previously made for the local varieties. At the same time, in parts of Karawang in West Java, the irrigation system forces farmers to cultivate and harvest even in the rainy season of January, February and March respectively.

Formally, Indonesia has been abundant in remarkable natural environmental features, and agriculture & cultivation mainly depended on its rainy season when various types of local varieties were cultivated by the farmers throughout the year in the entire territories. However, it does not mean that the harvesting has been done in the heavy rains.

Its geographical features are somewhat complicated and the central mountain range runs through Java Island making a difference in the rain fall amount between the northern and southern part of the district.

Accordingly, harvesting done in January, February and March can only be observed in the plain situated in the districts of the Island where comparatively less amounts of rain fall are recorded.

However, due to the regional irrigation and rice cultivating c double cropping is getting popular, and harvesting is done by many f rather unwillingly in the rainy season.

The above situation is clarified in Table 6-4 below.

Table 6-4 Seasonal Difference of Rice Harvested Areas in Java, 1955 and 1977 (%)

Month	1955	1977
January	2.4	2.2
February	3.0	5.7
March	7.8	13.4
April	16.9	21.3
May	26.4	16.6
June	16.2	8.9
July	5.3	7.2
August	4.9	8.6
September	6.7	7.2
October	4.3	4.2
November	3.4	2.7
December	2.6	1.9
Total	100.0	100.0

Sources: 1955 Agricultural Extension Service
1977 CBS

In detail, the amount of production in the month of December, January, February and March is as follows:

Month	1955	1977
Dec. - Mar.	15.8%	23.2%

In 1977, a total amount of 9.33 million tons of rice (milled rice basis) was harvested,

9.33 million tons x 23.2% = 2.16 million tons

Accordingly, more than 2.16 million tons of paddy were harvested in the heavy rain season.

Assuming that 50% of the production is done by introduction of IR varieties in this rainy season, approximately 1 million tons of rice would be harvested in the season of heavy rain fall.

Moreover, in the case of West Java, a similar analysis will be as follows:

That, in this district, the rain fall which will influence the harvesting, affect in January and February, and the six districts are spread out in the northern districts from Bekasi to Indramayu.

Detail is given in the Table below:

Table 6-5 Monthly Production of Paddy in Six Provinces (Bekasi, Karawang, Subang, Indramayu, Cirebon and Majalenka) located in the Northern Part of West Java (1980)

Month	Harvested Area (ha)	Production (ton)	Rate of Cultivation (%)
January	3,881	21,694	0.9
February	67,341	367,019	15.0
March	198,769	1,076,554	43.8
April	116,237	605,882	24.7
May	43,713	221,017	9.0
June	35,813	101,488	6.6
Total	465,756	2,453,654	100.0

In summary, about 0.39 million ton ≑ 0.4 million ton of paddy is harvested in the months of January and February in the districts concerned, and a huge amount of paddy is exposed to rain at the time of harvesting. Insufficient drying will cause heating and ultimate fermentation resulting in quantitative and qualitative losses at the farmer's level.

At Karawang during the rainy season of 1978/82, the averaged a... of damage due to inadequate drying and deterioration of quality, and averaged rate of devaluation of paddy is estimated by business concerns in the district as follows;

0.4 million ton x $\frac{1}{4}$ = 0.1 million ton ..... 10% less (Slightly)

0.4 million ton x $\frac{1}{8}$ = 0.05 million ton .... 20% less (Heavily)

0.4 million ton x $\frac{1}{16}$ = 0.025 million ton .. 40% less (Feed)

That is to say, during this period nearly half of the total prod... i.e., some 0.175 million ton of paddy is subject to devaluation at the... of selling due to wet damage.

One year is divided into the rainy and dry seasons in Indonesia b... monsoons. This dual season system is accepted as a part of life. Fo... from the standpoint of crop growing, this dual season system is not s...

Rainfall during the rainy season in Indonesia, which lies in the ... tropical zone, is different from those in Burma, Thailand and Bangla... which belong to the continental subtropical zone.

Palawija are mostly grown in dry fields in Indonesia. In the gr... of palawija, taking full precautions against rainfall in particular is more important than in rice farming.

Therefore, one year is divided into 4 seasons, namely:

Rainy season or musim hujan
First middle season or musim labuhan
Dry season or musim kemarau
Second middle season or musim malengau

The individual seasons differ slightly from one region to another a... from one year to another. In Java, a year is divided as follows:

Rainy season	December, January, and February
First middle season	March, April, May , and June
Dry season	July and August
Second middle season	September and October

This means that sun-drying immediately after harvesting in the rainy-season crop presents a serious problem in Jawa for about three months between the second half of December and early March.

Rain in the rainy season falls like a squall in Indonesia instead of falling all day long as in the continental subtropical zones. Rain falls only for a short period of time, and sun-drying is possible even during the rainy season by sheltering the crop before the rain falls. Nevertheless, rain sometimes falls for considerably long period of time during the day. Machine drying may become necessary when a large amount of paddy has to be harvested.

4-1-5 System of Payment for Harvester

"Harvest" referred to here means paddy reaping and threshing. The situation in which harvesters are placed, payers of harvester wages, and the harvester wage payment method (paid with paddy or in cash, on a pro-rata basis or fixed percentage basis), and harvest work scope differ depending on the region. The situation of these factors affecting increases in losses generated in the harvesting process is given in the following.

(1) Bawon System

This is the system in which a farm has some farm workers engage in harvesting and pays them part of the harvest harvested by the workers at a fixed rate as compensation.

1) Reaping and threshing are performed in combination, or reaping and threshing are performed separately, for which labor compensation is paid separately. The former is common practice. In the latter case, wages are paid separately for two different jobs when local varieties are mainly cultivated and farms store paddy without theshing it immediately after harvesting, or when reaping and threshing cannot be performed at the same time as in Pidie in Aceh.

2) Threshing is performed in the field, or in the farm yard, wh threshing paddy after reaping. In the latter cases, harvested paddy is carried from the fields to farm yards by workers, and wages for carrying is included in the labor wages.

3) Individual Work and Group Work

In the bawon system, workers perform work individually, or in groups. In the latter instances, the work is divided a group members. Farms pay labor wages to the groups based on r decided in advance. Individual workers in groups are paid dif- ferently depending on whether workers are leaders, the work t (reaping only, carrying in the fields, and threshing), and s

4) When repeated on several occasions, the second reaping is cal gampungan, and the third reaping, ngasak. Generally speaking, a fixed ratio in accordance with the practice in the particula region, which is normally 1:6, is paid as labor wages for the first reaping. Normally, 1/2 of the harvest is paid for gam Workers who perform the reaping can acquire the entire harvest after ngasak. In some regions, ngasak reaping cannot be perf without obtaining approval of the farms, and in other regions, approval by the farms is not required.

5) The number of burutani who can participate in reaping depends the availability of labor in the particular region. In some a 100 to 150 burutani work per hectare in force, while in other areas, 24 to 25 burutani reap and 6 to 7 burutani spend four days. There is no difference in the payment method, etc. as far as the system is concerned. However, there is an extreme large difference in the postharvest losses.

(2) Ceblock System

This system does not differ from bawon in that farms employ buruta for harvesting of paddy. The difference is that ceblok includes planti fertilizing, weeding, and spraying of agricultural chemicals, in additi to harvesting. In this instance, each farm contracts with a group of

20 burutani for every season. Approximately 600 kg of paddy is paid per hectare, and burutani contract with 4 to 5 farms for ceblok contracts.

(3) Tebasan System

In this system, farms sell paddy to buyers as it stands. Buyers employ burutani to harvest the rice. This system is prevalent in Central and East Java. In many instances, yield is estimated as approximately 5 to 10% lower than the actual harvest. When buyers employ burutani for harvesting, harvests are given to burutani at a rate of 1:20. This numerator ratio is one half of the numerator ratio of 1:10 which farms pay. However, burutani can be employed because they are assured of bus transportation to and from the field and because they can work two times a day.

(4) Goton Royong System

This system is utilized when a large number of workers are needed at one time as in rice planting and harvesting. Relatives and neighbors work for themselves and for others under this system. The system originally started in the spirit of mutual assistance, and no labor compensation was paid. Because of work locations, workers are treated for tea, cakes, and lunch, and work based on mutual assistance without paying compensation in a strict sense can hardly be seen.

(5) Bujon System

In this system, bujon are semi-permanently hired to do farming work including harvesting when farms, or masters of farms, having a farming size above a certain level have a fixed job (sub-district offices, farmers' cooperatives, etc.) and cannot perform farming. Bujon are paid 400 to 500 kg of dry paddy for each season.

(6) Farms Work by Themselves (Sendiri)

This is the system when small farms perform farming work by themselves, or farms reap lodged spots or spots extensively damaged by diseases, insects, and frost. This system is limited in number.

(7) Actual Situation in Payment to Harvesters

As mentioned, payments to harvesters are varied depending on indiv systems. Payment amounts differ depending on regions and on the availa of labor. The numerator system for labor compensation in various regio under the bawon system is given in the following:

Table 6-6

Province	Works	Man/Day	Compensation of Work
Aceh (Pidie)	Reaping Threshing (Trampling) Winnowing	12♂ x 2 days 3♂ x 5 days 3♀ x 4 days	400 kg/ha 400 kg/ha 150 kg/ha
Lampung (Metro) South Sumatra	Reaping Threshing (Beating) Carrying Winnowing by wind power	25♂ x 1 day 3♀♂ x 4 days 3♀♂ x 4 days 2♀ x 6 days	(4,500 kg) 1:6 (4,000 kg) 1,000 Rp/day
South Sulawesi (Pinrang)	Reaping Threshing	48♂♀ x 0.5 day 48♂♀ x 0.5 day	1:6 1:9 /(4,500 kg
South Kalimantan (Hulu-Sungai-Tengah)	Reaping Threshing	30♀ x 2 days ♂ x 3 x 4 days	1,000 Rp/day (3,000 kg) 500 Rp/100 kg
West Jawa (Karawang)	Reaping Threshing Carrying	80 - 150♀ x 0.5 day 80 - 150♀ x 0.5 day	1:6 (5,500 kg)
Central Jawa	Reaping Threshing	24♀♂ x 1 day 24♀♂ x 1 day	1:10 (5,000 kg)
East Jawa (Banyuwangi)	Reaping Threshing	24♀ x 1 day 24♀♂ x 1 day	1:10 (5,000 kg)

1) Bawon's Historical Changes and Difference by Region

The ratios and level of compensation have naturally been esta for individual regions based on the level of the paddy price at the time of harvest in the particular production areas, availability of labor (and wage level), rice yield, and social practices peculiar to the individual regions. They are not necessarily fixed, and cha as time passes. The bawon ratio in East Jawa approximately 10 years ago was, for example, 1:6. The ratio has become 1:10 as yield has increased. Supposing the yield 10 years ago to be 2 tons/ha and th at present, 5 tons/ha, the wage paid to a worker 10 years ago was 285 kg/ha, compared with 500 kg/ha paid at present. The paddy price and price level 10 years ago differ from those at present. Assuming the paddy price to be 100 Rp/kg and 25 workers participated in harvesting, the income of a worker per day was equivalent to 585 Rp 10 years ago, compared with 1,000 Rp at present.

2) Regional Difference of Bawon

The numerator ratio in West Jawa 10 years ago was 1:5 and is still 1:6 at present (between 1.5 and 1.8 depending on the distance from the field to the farm and field position, but averages 1:6). Comparing wages paid workers 10 years ago and at present by the same calculation method $\frac{2,000 \text{ kg} \times 100 \text{ Rp}}{6 \times 25 \times 2} \times \frac{5,000 \text{ kg} \times 100 \text{ Rp}}{7 \times 25 \times 2} = 665 \text{ Rp}:2,850 \text{ Rp}$, West Java is more advantageous for harvesters. This can be explained by the location of West Jawa, particularly, the Karawan District, which is close to Jakarta and thus causes prices and wages to be high. Taking an outer province, particularly Aceh Province, in which labor is reputed to be extremely short, as an example, the earning by a harvester per day 10 years ago and at present is as follows supposing the paddy price to be 100 Rp. which is today's average price.

10 years ago $\frac{2,000 \text{ kg} \times 100 \text{ Rp.}}{7 \times 25 \text{ persons} \times 2 \text{ days}} = 571 \text{ Rp.}$

At present $\frac{5,000 \text{ kg} \times 100 \text{ Rp.}}{11 \times 25 \text{ persons} \times 2 \text{ days}} = 909 \text{ Rp.}$

The calculations are based on yield per ha 10 years ago as 2 tons and that at present as 5 tons.

Therefore, a simple increase ratio is 159%.

Analyzing changes in West Java (karawang), bawon changed from 1:5 to 1:6 (differed between 1:5 and 1:8 depending on the distance from the field to farm and on whether the field is near a city, but on an average, 1:6). This is the area in which harvesters rush to fields, and 50 to 150 harvesters work in 1 ha. Let us consider the number of harvesters to be 80 per day to simplify calculations. Normally, harvesters work in one or two fields a day. Assuming the number of fields harvested to be 105, a harvester's earnings per day are as calculated in the following.

$$10 \text{ years ago } \frac{2{,}000 \text{ kg} \times 100 \text{ Rp.} \times 1.5 \text{ fields}}{6 \times 80 \text{ persons}} = 625 \text{ Rp.}$$

$$\text{At present } \frac{5{,}000 \text{ kg} \times 100 \text{ Rp.} \times 1.5 \text{ fields}}{7 \times 80 \text{ persons}} = 1{,}339 \text{ Rp.}$$

Therefore, the simple increase ratio is 214%. Compared with Banjuwangi in East Java, the absolute value and increase ratio of labor wages are high.

This can be explained by Karawan being located near Jakarta in which prices and wages are high.

When the same comparison is made for Aceh Province, in which labor is reported to be extremely short, the following can be obt[ained]

$$10 \text{ years ago } \frac{600 \text{ kg} \times 100 \text{ Rp.}}{24 \text{ persons} + 15 \text{ persons}} = 1{,}538 \text{ Rp.}$$

$$\text{At present } \frac{800 \text{ kg} \times 100 \text{ Rp.}}{24 \text{ persons} + 15 \text{ persons}} = 2{,}051 \text{ Rp.}$$

Therefore, the simple increase ratio is 133%. The wage level is the highest, but the increase ratio is the lowest.

This can be explained by the fact that the payment made by fa[rms] for harvesting work is fast approaching very close to its limit [...] from the proportion of payments made by farms in their productio[n] cost, even though the wage level is high due to the shortage of la[bor].

3) Relationship Between Payment System for Harvesters and Harvest Losses

The labor system of harvesters vis-a-vis the harvest (reaping and threshing) and their approach to it have a relationship with the payment system for harvesters.

A close comparison and test could not be performed as harvesti[ng] locations and time differed. The following could be observed based on very little measured values obtained and from the standpoint of the side making the observation and study.

(a) Tebasan

Reaping and threshing losses under this system were the largest. Unreaped rice stalks, field losses due to rough reap[ing] and unthreshed paddy were prominent.

(b) Bawon

Losses under this system differed depending on the number of harvesters. Losses increased in proportion to the number of harvesters. The example in Kurawang was a typical example. The example in Aceh Province had small losses.

Losses were smaller in group work than in individual work if nearly the same number of harvesters were to work.

(c) Ceblok

Under this system, work is performed relatively carefully as the same families make contracts with nearly the same farms every year or every season and as other farming work is performed in the same field. Field and threshing losses are small.

(d) Goton Royong

Losses are smallest as relatives and neighboring farms join in harvesting.

(e) Harvesting by bujon and by farms themselves in considered to produce the smallest losses. However, no measured values could be obtained.

6-1-6 Labor Force in Harvesting

Farming work in the postharvest period has to be completed in a short period of time, in reaping, threshing, drying, and cleaning, because of weather, the characteristics of undried paddy, and for economical reasons relevant to the farms. Reaping and threshing in particular have to be finished in a short period of time. The necessity of finishing work in a short time has further increased in areas that have introduced HYV varieties. Because work has to be finished in a short time, one prerequisite to correctly perform postharvest treatment work is to secure the required labor force.

Nevertheless, the labor force is not evenly distributed. In areas where labor is short or is extremely excessive, quantitative and qualitative losses generated after postharvest treatment tend to be large.

Therefore, an excessive or insufficient labor force can be considered as factor for the increase in losses generated during postharvest treatment, and a study of the relationship between the availability and quality of labor on one hand and losses on the other will be necessary.

In Indonesia, the farming labor force engaged in postharvest handling consists of brutani who do not own land and by a labor force on small farms.

(1) Number of Burutani

According to the 1980 census, the number of burutani throughout Indonesia is as follows:

Indonesia	7,230,741
Sumatra Island	705,283
Jawa "	6,023,079
Nusatenggara Island	235,106
Kalimantan "	116,350
Sulawesi "	135,821
Maluku-Irian "	15,102
Subjects Province of Survey	
D.I. Aceh	54,472
South Sumatra	60,012
Lampung	128,379
West Jawa	2,095,146
Central Jawa	1,736,629
East Jawa	2,064,918
South Kalimantan	50,961
South Sulawesi	36,845

The above table shows that burutani are concentrated on Jawa and that burutani account for approximately 83% of burutani in all Indonesia. Therefore, there are excessive burutani on Jawa, while other Jawa lack burutani.

2) Labor Force of Small Farms

It is nearly impossible to practically determine to what extent small farms work for other farms in postharvest work as part of the labor force. Aggregate numbers of workers will be as follows assuming that all farms with a cultivating area of less than 0.25 ha send an average 2 persons and tenant farms among farms with a cultivating area between 0.25 and 0.5 ha send an average 1 person to other farms as part of the labor force.

Area	<0.25 ha	0.25 - 0.50 ha (tenant farmer)	Burutani	Total
Indonesia	5,964,354 11,928,708	948,354	7,230,741	20,093,807
Sumatra	837,891 1,675,782	227,263	705,283	2,608,328
Jawa	4,433,057 8,866,114	513,321	6,023,079	15,402,514
Nusatenggara	232,506 465,012	72,471	235,106	772,589
Kalimantan	128,724 257,448	41,544	116,350	415,342
Sulawesi	247,837 495,674	72,093	135,821	703,588
Maluku-Irian	84,339 168,678	7,666	15,102	191,446
Objects Province of Survey				
D.I. Aceh	102,343 204,686	28,866	54,472	288,024
South Sumatra	67,673 135,346	29,347	60,012	224,705
Lampung	91,599 183,198	48,025	128,379	359,602
West Java	1,603,354 3,206,708	173,936	2,095,146	5,475,790
Central Java	1,254,190 2,508,392	178,118	1,736,629	4.423,139
East Java	1,353,854 2,707,708	151,748	2,064,918	4,924,374
South Kalimantan	77,736 155,452	19,974	50,961	226,387
South Sulawesi	145,950 291,900	44,207	36,845	372,952

(3) Labor Force Required for Postharvest Handling

Depending on the region, 25 workers are needed to reap 1 ha in a day (approx. 6 hours) and 13 workers to thresh 1 ha in a day. There is a dif in efficiency between threshing by tramping and by beating on a platform, and normally, 3 to 4 workers spend 3 to 4 days.

A separate study is needed for the labor force for cleaning and dry. In many areas, neither cleaning nor drying is performed. Even if clean and drying are performed, a family labor force is used.

(4) Excessive or Sufficient

The work load per unit harvesting area is described in Paragraph 3. Harvesting in a certain area (farming group, village, sub-district, distr or province) has to be performed within a limited period of time, and the is a limit even if the labor force can move outside the region, causing excesses and shortages in a regional labor force. Nevertheless, it is true that harvesting is somehow performed at present. It is also true that the strain of excesses and shortages in the labor force is increasing losses during postharvest treatment.

The situation in the Aceh Special Province and West Jawa Province is given in the following.

In the Aceh Special Province, the labor force in the Pidie and Aceh Utara Districts, which are two largest rice producing areas, is given in the following. The estimate is based on an assumption that farms below 0.25 ha in farming size would send 2 harvesters each and farms above 0.25 in farming size, 1 harvester each, to do harvesting work.

1. Aceh Special Province

Kabupaten	Number of Burutani	Number of Agricultural Workers	Total
Pidie	11,019	62,922	73,941
Aceh Utara	11,861	125,217	137,078

Normally, harvesters in Aceh work inside sub-districts, and harvesters joining in harvesting from neighboring sub-districts are approximately 10% of the total. For this reason, the situation in Samalanga Sub-district which borders the Pidie District situated on the northernmost tip of the Aceh Utara District, will be used as an example.

Harvesting area   Average yield   Harvesting yield
3,142 ha   x   4.5 tons/ha =   14,140 ton

Harvesting area   Average harvesters per ha   Required average harvesters
3,142 ha   x   25 harvesters   =   78,550 men/day

Harvesting yield   Average harvesters per ton   Required harvesters
14,140 ton   x   16 harvesters   =   226,240

Total harvesters needed for harvesting and threshing in the Samalanga Sub-district
78,550   +   226,240   = 304,790

Number of farms below 0.25 ha   x   2 harvesters = 3,434
Number of farms above 0.25 ha   x   1 harvester   = 2,662
Burutani   851
Total   6,947
304,790 harvesters ÷ 6,947 harvesters = 43.9 days

In reality, in the Samalanga Sub-district, nearly a month is needed between the start and end of reaping and another 2 weeks for threshing. Therefore, the labor force mentioned above is close to the actual situation. However, the peak reaping time is 2 weeks in the total reaping time of one month, and the labor force is insufficient, particularly for threshing. For this reason, harvesters flow in from outside the sub-district. The number of outside harvesters is estimated at approximately 10%. Female workers also work in cleaning, and they total about 28,278, which nearly corresponds with the number of workers is the required minimum for harvesting.

West Java Province

Kabupaten	No. of Farmer's <0.25 ha	⇒ x 2 persons	No. of Farmer's >0.25 ha	Burutani	Total
Cirebon	25,387	50,774	60,958	157,210	268,942
Majalengka	71,398	142,795	67,500	115,136	325,431
Indramayu	39,315	78,630	90,136	181,081	349,847
Subang	64,015	128,030	81,681	126,350	336,061
Karawang	28,395	56,790	90,252	138,161	285,203
Bekasi	43,636	87,272	55,944	65,889	209,105

Grand total 1,774,589

Kabupaten	Harvested Area (ha)	Yield (kg/ha)	No. of Harvester	Available No. of worker
Cirebon	82,512	4,140	341,594	1,129,556
Majalengka	74,999	4,763	357,228	1,366,810
Indramayu	200,281	3,666	734,148	1,469,357
Subang	145,710	4,199	611,884	1,411,456
Karawang	186,993	4,046	756,491	1,197,853
Bekasi	91,719	3,557	326,268	878,241

The harvesting difference in February, March, and April corresponds to 82.7% compared with the harvesting method for the rainy season crop in 1981/1982.

Harvesters normally finish reaping and threshing for a unit in one half day per harvester. They normally harvest 2 units a day. (The time needed for finishing is determined by the harvesting area per unit and by the number of harvesters.) Assuming a harvester reaps and threshes 70 kg a day and that he or she works 60 days during the peak harvesting time of 3 months, there is a labor force approximately 2 to 3 times that of the harvest of the rainy season crop in each district.

3. Thus viewed, there are regions that abound in a harvesting labor force and those that suffer from an extreme shortage of it. As is the case with Aceh, the optimum harvesting season cannot be missed, and harvesters are somehow employed to do the reaping. However, the labor force is not enough to thresh as well, and tumpukan must wait until threshing workers can be employed. During this time, the paddy ferments or deteriorates in quality, causing large qualitative losses.

In the six districts in the northern plains of the West Java Province there are more harvesters than is optimally required. An excessive number of harvesters work in fields causing shattering losses in fields during reaping. A large quantity of rice stalks are left unreaped or are trampled on. During threshing, mattress is often not used, and there is more paddy that is scattered around or is not threshed than in areas where the labor force is fewer.

6-2 Factors in the Drying Stage

The drying process mostly affects the storage of rice especially in wet tropical countries like Indonesia. It also easily causes great loss of rice in milling and other postharvest practices. Therefore it is essential to look at the paddy drying process from various angles.

6-2-1 Farm Level

Paddy drying by farm families at the time when Ani-anis (finger knives) were used for cutting panicles was done by exposing to the sun the "stalk-padi" which was put directly on the ground. As the harvest then was not carried out in rainy weather, the drying process was performed in the sun.

In those days, farmers used to store paddy in an amount sufficient enough to make a living for their families for a few years. This was because the annual rice crop changed suddenly from year to year and most of the mills were of cone type which could not be run unless the paddy had been adequately dried. Under these conditions, farmers used to take more than 2 days for drying paddy fully.

A particular method of drying was seen in some regions in central Java. It was to hang stalk-paid on paddy-sheaf-racks for drying. (At present it is seen only to the local variety on the south coast of Western Java.)

Farmers used to store dried stalk-padi in an attic or a warehouse called a Lumbung.

As H.Y.V. have recently spread wide and the handling changed in gabah (paddy) after harvesting and threshing, farmers had to change their practicies so as to meet the new drying process.

(a) Paddy should be dried in an amount of two times greater than before because their production has increased so much, and the harvest must be done in the short period.
(b) More tools, appliances, mattresses and bags are required for drying.
(c) A wider place is necessary for drying.
(d) The amount of work has increased for more frequent replacement of surface paddy with subsurface paddy and tempering in the process of drying.
(e) Paddy harvested in the rainy season are more threatened with rain when they are dried.

Rice kept by farmers is not so completely dried as done in the form of paddy. It is usually dried to 15 to 16%, then stored and dried again in the sun for about half a day before bringing to a custom miller. These steps have been taken on account of the following factors: since the introduction of the IR varieties, double cropping has become popular at the dry and rainy seasons; the storage period has been shortened to only 6 months.

Farmers no longer dry their rice by themselves and the situation around them has become adverse as follows:

(a) Farmers have to sell their product at low prices;

(b) As purchase of rice by KUDs is delayed, the quality of paddy deteriorates soon;

(c) Paddy harvested in the rainy season tend to get wet and to become heated and deteriorated and also germinate.

As mentioned above, farmers sell their paddy without drying them well, and the rice marketing and processing system is very inefficient in this country. As a result, paddy of high quality are hardly available here.

6-2-2 Commercial Rice Mill Level

Big amounts of paddy are disposed by private mills in Indonesia, which have wide drying floor made of cement. Many employees engage in drying paddy in the sun, which have been collected from the farmers in the neighborhood.

The following constitutes an instance of such mills:

Drying floor	:	600 m^2 (20m x 30m cemented floor)
Drying capacity	:	8 - 10 tons a day
Number of employees	:	6

Order of work:

First day:	09:00	Bags each containing 70 kg of paddy are arranged in a line.
	10:00	When the platform is warmed with the solar heat to a certain degree, the contents of the bags are spread out about 5 cm thick over the floor.

	11:00	Surface paddy are replaced with subsurface ones (Turning of paddy) every 30 minutes and short tempering is also performed sometimes.
	16:00	Several narrow ridges about 30 cm high are made of paddy and covered by vinyl sheets.
	17:00	They are kept overnight
Second day:	11:00	The ridges are leveled and all the paddy are spread again over the floor and the surface replaced with the subsurface (turning of paddy) every 30 minutes and the tempering performed once in a while.
	14:00	A mound is made of paddy about 70 kg in weight. Then the paddy are put in bags again to be
	16:00	stored in warehouses.

The time required for each process is of course more or less different. ... several matters basically common among respective mills could be pointed ...t as follows:

(a) The cemented floor for drying is a little slanted for draining water well, and new ones have mostly rows of ridges about 1.5 cm wide.

(b) Replacement of surface paddy with surface ones (turning of paddy) is performed with an interval of 30 to 60 minutes.

(c) Paddy are dried for 2 days until their moisture reduces to about 14.0%.

(d) Some mounds are often made for tempering in the drying process.

(e) The wage of an employee is paid at the rate of Rp 2 per kg of dried paddy.

...-3 KUD Level

The drying process in KUDs is almost the same as that in private ...lls. According to an observation made by the team, replacement of sur...e paddy with the subsurface (turning of paddy) and tempering were not generally performed by KUDs so carefully as by private mills.

Some KUDs which handle a large amount of paddy, usually own the Lister dryers with a capacity of 5, 10 or 15 tons. But many of them are idle because of some trouble with the machinery. Even those in operation run only 10 to 15 days a year.

Most of the rice released on the makers in Indonesia has been dried in private mills or KUDs and important losses incurred in this level are mostly induced by the following factors:

(1) cracked kernels

(2) rice wet with rain

The latter case happens very often in the rainy season. If the rice once wet with rain is dried again, it causes to have many minute cracks. Should the handling be worse, it would be broken or cracked soon.

In this country, however, many of those engaging in drying are likely to handling such wet rice not very seriously because no remarkable defects can be seen on the rice on sale at markets. But private millers usually place the paddy wet with rain in a separate lot after drying. However, such paddy usually contain moisture of over 30% and should be dried with utmost care so as to they are to be uniformly dried and free from colored grains.

6-3 Factors in the Milling Stage

The milling work is the final stage in the postharvest handling of rice. The value of rice as a commodity may be determined during this stage.

In this process, not only the results caused by the difference in the milling method and machines, but also all the properties of the paddy and the results caused by the differences in the postharvest handling methods in individual stages before milling clearly show up in the stage.

In a study of losses in the milling stage, it is desired that factors shall be determined, problems related to such factors be taken up and analyzed, then final improvement plans be formulated.

(1) Types of Milling Machines and Their Combination

In the milling stage, paddy is physically processed into brown rice and milled rice entirely by machines and instruments while being affected very little by natural phenomena. To obtain the highest milling recovery and quality, husk should ideally be removed and only rice bran cleaned effectively from the paddy that has been sent after passing through whatever course it has taken. In Indonesia, the values that are considerably low can be obtained with the machines presently used. The performance of machines can be easily evaluated even if there are a variety of machines. In reality, however, the results are not always the same even when the same types of machines are used. The results may change even when a different adjusting method is used. So far, no accurate comparative data has been obtained about the actual situation.

The truth is that there are no equipment models that have ideal performance. This subject needs be studied in the future.

It is also true that the degree of loss changes depending on the various milling machines and how they are combined. One of the main points for the study of losses in the milling stage was to find this out.

Quantitative losses in milling are evaluated by the quantity of milled rice with a certain whiteness obtained from paddy. This is shown by a percentage of milled rice relative to the quantity of paddy.

An important requirement when comparing milling machines is that the paddy must be able to be mixed and homogenized of the same variety and quality under the same conditions and that the degree of milling and bran layer on the surface of milled rice must be uniform.

(2) Paddy Drying Method

Changes in the moisture content that occur throughout the processes before milling, namely, reaping, threshing, cleaning, and drying, greatly affect the quality and conditions as paddy. An extremely important requirement in reducing losses in the milling stage is how paddy can be dried to an appropriate moisture content safely and with good timing.

However, it is not easy to determine which drying methods and conditions deteriorate the paddy quality. It is because paddy inside its chaff cannot be seen.

The quality problem that is mainly affected by the drying method is cracked kernels caused by rapid drying and moisture absorption. Crack kernels become broken kernels during milling, and the milling recovery lowers as well. The HYV varieties have a brittle internal texture co with that of local varieties and are susceptible to environmental con therefore their quality tends to deteriorate rapidly.

There is no grading way for cracked kernels or broken kernels for The minimum limit for broken kernels in milled rice is 25%, and no one the trade attempts to take it up as an issue. The actual situation is there is no stimulation to stem the increase in cracked kernels during drying. In fact no efforts are made.

Cracked kernels is a physical phenomenon caused by a distortion i the internal structure of rice due to a rapid movement of the moisture content within. Generally speaking, it is well known that the averag ing speed per hour should be limited to within approx. 1% in order not cause cracked kernels, even though there is some difference depending rice varieties.

This situation, notwithstanding, in many instances, sun-drying in Indonesia under direct sunlight far exceeds the danger limit for dry speed, increasing the proportion of cracked kernels. Rice mills which have empirical knowledge and which directly handle milled rice as a co modity usually make a thick paddy layer during drying in order to pre quick drying to avoid cracked kernels.

Exposing paddy to rain during drying is very dangerous. Several cracks occur in individual rice kernels due to extreme moisture absorp and rapid drying. These kernels are become to small broken kernels a further in finely broken kernels that are discarded with the rice bra, resulting to increase of the loss.

Cracked kernels can be minimized when a during machine is properl used in drying. Various types of dryers are available - a flat bed ty cubic batch type (screen and baffle types), vertical circulation type (screen, buffle, and LSU types), etc. The flat batch type, which is t simplest and cheapest, is generally used in Indonesia at present.

Generally speaking, fuel costs for the blower drive engine and o costs are incurred in machine-drying. In addition to the initial mach costs, these machine-drying costs are about 4 times that of sun-dryin Therefore, unless the ratios of broken rice are reflected in the rice the demand for dryers is not expected to increase.

(3) Moisture Content of Paddy

What should the moisture content of paddy be? No clear answer can be given as to the optimal moisture content for milling machines currently used in rice mills in Indonesia. Generally, paddy with moisture content ranging between 13 and 15% is used. In custom rice milling, rice is actually milled even when the moisture content is above 16%.

From the standpoint of storage, the lower the moisture content the better. Considering the weight of milled rice, a high moisture content would be advantageous. It is said that rice sold as a commodity has a surface luster and tastes good when milled at a moisture content of about 15%.

From the standpoint of machine functions, the husking ratio of the paddy husker is high and capacity of machine increases when the moisture content is low. The husking ratio lowers when the moisture content increases above 16%, increasing the rubber roller pressure, which in turn expedites roller wear and damages rice. All in all, the moisture content should prefereably be below 15%.

In a rice milling machine, paddy are soft when the moisture content is high - more than 16%, when the pressure is increased to remove the bran layer, the paddy is crushed, and the milling recovery greatly lowers. When the moisture content is low, below 13%, the bran layer hardens, the pressure is increased, and this causes broken kernels to increase and the milling recovery to lower.

The rice temperature increases 10 to 20°C during whitening. The temperature increases evaporate the moisture content, and the moisture content generally decreases approximately 0.3 to 1.0%. The moisture content in paddy can be proportionately high for the target moisture content of milled rice.

An assessment of milled rice losses due to the difference in moisture content of paddy under various conditions is also important for the future.

(4) Degree of Milling

The question of what should be the milling degree for milled rice for eating differs depending on the taste of consumers, trends of diet. Generally, rice with nearly completely polished off bran layers is demanded in Indonesia.

Ideally, the bran layer should be uniformly removed to obtain ri milled to its original shape. Rice has several deep grooves. The st layer is also shaved if the bran layer is to be completely removed by action of the machine presently used. This will further increase los

Rice bran in the grooves can be removed to some extent by the fri tion-type milling technique. However, it will be rather difficult to remove the rice bran in the grooves without removing the starch layer the abrasive type.

In BULOG's standard, rice with 90% of its bran layer removed and rice bran remaining to some extent in the vertical grooves is graded a Class 1.

The milling degree is obtaining by calculating the proportion be percentages of thousand-kernel-weight of brown rice and milled rice a as total bran layer of the rice as 100%. Rice in Indonesia is princi inspected by visual observation.

As a recent trend in Indonesia, in which rice production is incre and rice prices are relatively stable, white rice with surface smooth and luster is preferred. For this reason, rice shipped to the market milled more than necessary. This is a hidden problem in milled rice l ses. In custom milling at the farm level, losses by overmilling are l The machine pressure is increased to perform "over milling", and this happen broken rice and low recovery. When the Engelberg-type rice mil machine (generally called a "huller") is used, milling is performed m excessively in order to prevent paddy from remaining in the milled ri Rice bran cannot be removed completely with an Engelberg-type huller l ing a poor rice-surface, and judging from the feature of this machine overmilling is unavoidable.

When judging the degree of milling, a mere comparison of thousand- kernel-weight percentages between brown rice and milled rice is not su ficient to judge the degree of rice bran remaining on rice and is thus inaccurate in terms of measurement errors, either.

In Japan, judgement is made by visual examination based on the re sidual state of rice bran in accordance with the dyeing method using standard samples. One defect of this is that no numbers can be obtain However, this method is considered practical.

(5) Content of Immature Kernels

Fully-ripe and immature kernels are always mixed in paddy. Immature kernels are varied in various stages, from kernels that are nearly fully ripe and empty paddy.

Immature kernels are mostly powdery thin and fragile. HYV varieties have more immature kernels than local varieties have.

Generally, rice milling machines remove rice bran by applying pressure. Sound kernels that have a hard inner layer resist the pressure. However, some immature kernels with a soft inner layer are broken and crushed and are discharged with the rice bran. This is another problem with losses in the rice milling stage.

Rice milling machines can be divided into friction and abrasive types. Most rice milling machines currently in use in Indonesia are of the friction type. This type maintains the inside of the milling chamber at high pressure and shaves only the soft bran layers of epidermises by friction. The inner starch layers, which are hard, are not shaved, and kernels are given a luster to increase their commodity value. However, fragile kernels are easily broken as high pressure is applied. In the abrasive method, epidermises are shaved off by a sharp emery grinder blade maintaining the milling chamber at low pressure. In this method, even kernels with brittle inner layers can be milled without being crushed. By this method, hard starch layers of sound kernels are shaved off, and surfaces of the milled rice look whiteer after being shaved off. There is hardly any luster. The shaved starch layers are discharged with the rice bran, causing losses to increase.

Rice milling machines used recently incorporate improvements to cover the defects of both methods, or to combine their good points. However, machines close to this ideal have not yet been introduced on the narket. What can be done to reduce these losses? In Japan, immature kernels are segregated from sound kernels in the brown rice stage by means of thickness or specific-gravity segregation. Sound kernels are milled with abrasive-type milling machines.

(6) Varieties

The matter of which varieties should be selected as recommended varieties must be decided after considering yield other than resistance to disease and insects, taste, etc. The milling property is another i[illegible] condition that should also be considered.

Even varieties that have been grown to match the weather and cli[illegible] of Indonesia are classified as being superior and inferior from quanti[illegible] tive and qualitative standpoints based on milled rice as a commodity. Generally, short kernel varieties have slender bran layers compared w[illegible] long kernel varieties.' They also have a high yield, and hardly beco[illegible] broken rice as a trend. Comparing Cisadane and IR36, which are main varieties in Java, Cisadane excels in milling characteristics and pro[illegible] a comparatively high recovery provided good handled such as the drying.

Whether or not the present milling machines and their utilizati[illegible] optimal to the Cisadane leaves room for further study. As far as fu[illegible] improvements are concerned, machines equipped with functions to match various other varieties should be developed, improvements should be [illegible] and their utilization should be established without limiting the use [illegible] the present machines only.

6-4 Factors in the Storage Stage

In a tropical country like Indonesia where humidity and temperat[illegible] are high throughout the year, keeping big amounts of food stuff, espe[illegible] ly milled rice, is very difficult whilst preventing quantitative and qualitative losses. In case the rice is scheduled to be stored for a longer term i.e., for more than a six (6) month period, a technical ap- proach for warehouse-keeping is getting more difficult.

In general, three important factors are pointed out as follows.

(1) Nature of cargo (milled rice)

(2) Location and Structure of warehouse

(3) Managing function

These functions shall be adequately maintained, otherwise effecti[illegible] and good control of warehousing shall not be achieved even if modern types of warehouses are provided and appropriate measure are applied [illegible] cargo care.

More precisely this can be easily understood when paddy or milled rice which has a high moisture content is received in best provided war[illegible] house, later on in storage it will be damaged due to heating. Meanwhi[illegible] even though the cargo is found to be in good condition at the time of warehousing, if the warehouse is not in good condition i.e., leakage of rain water, exposure to direct sunshine due to inadequate roofing and siding, damage caused by rodents and insects etc. will cause ultimate losses to the cargo concerned.

(1) Storage at the Farm Level

At present, it is estimated that nearly 65% of the total production of rice is consumed by the farmers in Indonesia. In 1981, it was also estimated that approximately 14.3 million tons of milled rice was under storage by 14 million farmers.

From the above data, it is estimated that about 1 ton of rice (equivalent to 1.5 tons of paddy) is possessed by each farmer concerned, though the exact position and amount of rice under each farmer's storage is subject to the number of family members and its financial status.

At present, since double cropping is employed by most of the farmers, in actuality averaged about 500 kg of milled rice (equivalent to 770 kg of paddy) will be in storage in each farmer's household.

Usually, this paddy supposed to be consumed by the farmer is dried and cleaned and is packed in either specially made containers or bags and is adequately placed in the corner of the farmer's household. The material and shape of containers differ from each other subject to local conditions, BOH coconut leaves or bamboo mattresses are commonly used.

Accordingly to the results of the survey, the quality of the paddy in the farmers' possession is shown as follows:

Moisture content ..... 14.5% - 16.9%
Foreign material ..... 3% - 7%

From the above result, paddy having a considerable amount of excessive moisture content is in farmer's possession.

At least the farmers would believe in this method of stokeing and no problem would be expected, however, the result shows through the various tests such as simulation tests that during the said 6 months' sotrage, an ave. 4.7% loss has been observed at the farm level.

Assuming that providing improvement and decrease of 1/2 of the loss is actualized under such conditions, as per the following calculation;

14.3 million ton x 2.35% ≑ 320 thousand tons, Approximately 320 thousand tons of paddy could be improved qua-tively for storage at the farm level.

(2) KUD Level Storage

In the project areas, most KUDs are provided with warehouses 1? 200 tons in capacity, being utilized for drying and cleaning of paddy the duration of storage is almost 1 - 2 weeks.

Some of the warehouses are used for BULOG's has been storage of but usually excessive amounts of the paddy in storage resulted in da due to the inadequate structural condition such as low roofing which causes direct effect of the heat from sunshine and improper mainte

(3) Storage of Paddy Merchants

The function of a paddy merchants is to purchase small amounts of paddy either from the farmer or village collectors one by one, and the paddy thus collected would be sold to rice mills or to large scale ri merchants located in the consuming areas. Beside the function, for speculation purposes they would sometimes keep the paddy for a certa period.

For example, 2 - 3 tons or sometimes even about 5 tons of paddy stored in a small space adjacent to their living rooms.

In this case a problem may arise that during long storage this ki of paddy which contains excessive amounts of moisture will cause dam especially that of discolored kernels.

(4) Storage of Rice Mill (Private Godown)

Regarding storage capacity of private godown, no correct data ar available at present in Indonesia. According to the survey team's est mation, about 1 million tons of storage capacity is available of which the major part is in the possession of large scale rice mills.

Analysis of the present status and activity of the private godow and its storage function is as follows:

In general, custom milling is popular among the Indonesian villa however, a village rice mill is usually small in milling capacity wit ample warehousing space and sufficient working capital.

Although the capacity differs from each other, those which specialize in milling are usually provided with paddy/rice warehouses. For example, warehouses having several thousand tons in capacity are sometimes owned by the private rice mill. However, recent milling operations by these large scale rice mills are becoming sluggish and maintenance of the warehouses idle, resulting in superannuation of the warehouses.

Meanwhile, recent increases in rice production, require the increase of warehousing capacity to meet the demand, ultimately, since there is no alternative, even the incapacitated warehouse are forced to be utilized.

In 1979, BULOG contracted a total of 757,475 tons of warehousing capacity throughout Indonesia, and so far, project areas of 8 states are concerned. The details of the warehousing capacity of private godown and contracted capacity is shown in Table 6-7 below:

Table 6-7 Private Godown Contracted by BULOG in 1979
(ton/Milled Rice)

Province	Capacity of All Private Owned Godown	Capacity of Contracted Godown
Aceh	18,185	5,300
South Sumatra	14,700	7,800
Lampung	21,000	7,500
West Jawa	57,500	49,000
Central Jawa	165,480	101,730
East Jawa	299,630	240,850
South Kalimantan	16,850	16,850
South Sulawesi	24,750	24,750
All Indonesia	999,525 tons	757,475 tons

As stated, the warehouses contracted by BULOG and those of the privately owned are superannuated, moreover from administrative and operational points of view, the location where the warehouses now exist is considered not advantageous.

In the survey in the project areas, an ave. 14.7% of moisture content has been found before the paddy is processed, the paddy which contains excessive amounts of moisture - mostly exceeding the 15% level after milling - might be induced to qualitative losses during its storage [illegible] inadequate conditions and tropical climate, ultimately creating a com[illegible] mercial problem in marketing.

(5) Storage of BULOG/DOLOG

In 1979 throughout Indonesia, 319 units of newly constructed [illegible] warehouses each having 3,500 tons in capacity (1,115 million tons in [illegible] capacity) existed, while 34 units which consisted of 138,595 tons of warehousing capacity were available in 14 provinces making a grand t[illegible] of 1,253,595 tons.

Apart from the above, DOLOG contracted 757,475 tons of warehous[illegible] capacity with the private sector.

In connection with the above, in the eight provinces the follow[illegible] data have been obtained.

Table 6-8 DOLOG's Warehousing Position in 1979

(unit: ton)

Province	New Warehouse	Old Warehouse	Contracted	Total
Aceh	3,500 (1)	9,450 (4)	5,300	18,2[illegible]
South Sumatra	31,500 (9)	3,500 (1)	7,800	42,8[illegible]
Lampung	7,000 (2)	3,900 (2)	7,500	18,4[illegible]
West Java	101,500 (29)	7,670 (4)	49,000	158,1[illegible]
Central Java	101,500 (29)	7,375 (4)	101,730	210,6[illegible]
East Java	276,500 (79)	8,000 (1)	240,850	525,3[illegible]
South Kalimantan	17,500 (5)	-	16,850	34,3[illegible]
South Sulawesi	63,000 (18)	41,100 (7)	24,750	128,8[illegible]
All Indonesia	1,115,000(319)	138,595(47)	757,475	2,019,[illegible]

By the target year in 1983/84, of the 3rd 5 year plan, BULOG inte[illegible] to develop 171 units; 967,000 tons in total capacity in 349 locatio[illegible] throughout Indonesia. At present a number of new warehouses has bee[illegible] constructed.

In general, management and warehousing work are properly done by well-trained warehouse-keepers, however, the warehouses mostly require some rehabilitation for the thermal insulation system of the roofing.

6-5 Factors in the Transportation Stage

Introduction of imported vehicles such as trucks, mini-trucks, pick-ups etc., brought a revolution to the marketing system in Indonesia.

Table 6-9 Number of Trucks in Indonesia

Year	No. of Trucks
1955	45,000
1965	85,000
1970	102,000
1975	196,000
1978	337,000

Source: State police

However, this marketing revolution does not mean a entire change of the marketing system now prevailing in Indonesia i.e., even if the number of trucks increases, these trucks (12 ton) are mainly employed on national roads, while small trucks engage in transportation in villages where inadequate roads are provided.

Generally speaking, due to inadequate road conditions and the situation, marketing operations of this country are still faced with difficult problems.

At present, out of the rice produced in Indonesia, some 7.6 million tons is assumed to be distributed from the farmers to the consumers, and various styles of transportation are summarized as follows:

Location	Description
Paddy Field	
↓	Carrying basket, Carrying Pole, Bicyc Tricycle and Animal, etc.
Farmer's Household	
↓	Bicycle, Tricycle and Ox-cart
Village Merchant (Pedagang Kecil)	
↓	Ox-cart and Mini-truck
Paddy Broker in Consuming Area (Pedagang Besar)	
↓	Mini-truck and Ox-cart
Rice Mill Private Rice Mill KUDs' Rice Mill	
↓	Truck
Warehouse (Producing Area) Private BULOG	
↓	Truck
Warehouse (Consuming Area) Private Dealer/Wholesaler BULOG	
↓	Truck and Mini-truck
Retail Saler	
↓	Mini-truck
Consumer	

Transportation from island to island is carried out by using carg boats, either by BULOG or the private sector, and the quantity handled about 3% of the entire production of rice.

In the process of transportation, the following manner of losses observed:

1) Leakage of cargo due to use of hooks and rough handling

2) Deterioration of paddy/rice due to rain during transportation

Leakage of cargo due to use of hooks usually occurs at the time of warehousing (in and out) while the wet damage mainly occurs in transportation.

As stated previously, though the introduction of trucks has brought a marketing revolution, there are no adequate protective measures being applied to reduce the risk of wet damage which is liable to occur during the long distance transportation in widen areas. For instance, while transportation is done in the rainy season, the necessary number of sheets are not prepared for many trucks, thus the cargo is sometimes exposed directly to heavy rain during transportation.

In summary, those who work in the transportation business in Indonesia, are now facing big problems which usually occur in the transitional period for which adequate measures such as protection and maintenance of cargo delivery are urgently required.

At present, in spite of the above situation/condition, aggressive efforts are being made by the responsible parties to improve the effectiveness of these activities concerning the entire transaction, but it seems more improvement will still be needed.

Cargo hooks causes the heavy damage to be torn in the handling of the bags. At present, since each bag usually contains about 100 kg of rice, this heavy weight makes handling difficult for laborers. Accordingly, change of content from 100 kg to 60 kg - 50 kg might be effective for the protection of the losses concerned.

CHAPTER VII RECOMMENDED WAY TO IMPROVE POSTHARVEST HANDLING METHODS

CHAPTER VII RECOMMENDED WAYS TO IMPROVE POSTHARVEST HANDLING METHODS

-1 Basic Policies

-1-1 Farm Level

Since the 12.26 million rice farming households in Indonesia are ispersed throughout several regions, each of which has its own way of arvesting, technological improvements must be discussed by region. e following are the three basic policies for improvement at the farmer evel.

proving the farmers' bargaining power

If the farmers themselves dry and clean the paddy, they can increase eir income and become more independent by adding a supplemental charge r this service.

crease of regional employment strength

Implementation of these postharvest handling improvements might pose a reat to the livelihoods of some poor farmers who have traditionally elied on the old-fashioned ways. For this reason, plans must be made o increase use of the local labours to the maximum extent in such erations as harvesting, threshing, drying, cleaning and transporting.

ete practical and economic effectiveness

The improvements shall be on a realistic basis of farmers who are in omic distress and they must be planned to be interrelated and mutually fective with other processing operations. Since, in addition to improve- ts on the level of the individual farmer, economic innovations for mer-group operations are effective also, it is desirable to employ the s Training and Visiting System for the improvement at this level.

7-1-2 KUD Level

In Indonesia, recognition of the importance of cooperative activity, which has the role of core to the farmers economy, is generally low. Furthermore, individual and organizational property keeps such functions in an unactive state. At present, poor transportation and processing facilities had made subcontracting to private individuals. Ideally, the KUDs will become the center of rice transportation, drying, cleaning and milling. Under the circumstances, improvement is desirable in connection with the following derections.

Independent farmer management

Until the present, KUDs management has been based on an arrangement in which, not the affiliated farmer themselves, but such small business group as village collectors, custom rice mills, transportation sectors, and private mills who contribute to regional rice trade have been invirtually total control. This is probably an inevitable state of affairs in the course of KUDs development in this country. But, in the future, management must always be planned with the idea of the profit of the affiliated farmers.

Introduction of facilities and technology to make possible competition with privately owned mills

In general, the scale of experiences and equipments at KUDs are inferior to those at privately owned mills. In the future, it will be important to install good machinery and other equipments to the KUDs, and conduct through programs of staff training to put them on a par with private organizations.

Strengthening of KUD and PUSKUD cooperation

PUSKUD is the business-support organization of the KUDs. It is necessary to strengthen them and manage them in a more efficient and economically effective way. Strengthening the PUSKUD is especially important in regions where large volumes of paddy must be handled.

2-3 BULOG Level

Procurement and transportation and storage of rice by BULOG are essential to the national economy. Appropriate supply-and-demand operations are essential to the prevention of losses.

Improvement of transportation system

The system of transporting imported and domestic rice is not appropriate, and it often results in loss caused by unnecessarily long periods of storage in domestic warehouses. Improvement in the supply-and-demand is essential since it is the cause of the trouble in this situation.

Appropriate quality standards and inspection

The method of inspection and the standardization used by BULOG/DOLOG and KUDs at the time of rice purchase are not best suited to the conditions under which Indonesian rice is produced or to local consumption. Improvement is required in this field since the current system introduces confusion and thus causes great qualitative and quantitative loss.

Expansion and Rehabilitation of storage facilities

Because of the nature of its functions, BULOG must frequently keep on hand an amount of rice equivalent to what is needed for market operations. For this reason, it must expand storage facilities to enable them to accommodate the capacities needed for buying and selling. Appropriate plan should be taken to reduce loss by shortening the storage period as much as possible. Even measures like installing thermal insulation in warehouse roofs and ceilings and the introduction of simple ventilation systems can contribute to the reduction of losses.

7-1-4 Promotion for Improvement

The following obstacles must be overcome if recommended improvements are to be implemented.

a. To a greater or lesser extent all of the 12.26 million rice growing farmers in Indonesia require improvements in postharvest work, however to give them guidance is the most difficult job to implement.

b. In villages all over the nation, 7.23 million landless farmers make their livelihoods by doing agricultural work.

c. Since farm operational scales are small, and also farmers in villages, which are swamped by the modern consumer culture, investments in agriculture are tight and offer little hope.

d. Since the social and industrial infrastructure tends to exert a controlling influence on processing, storage and transportation, improvements in these phases of work will demand time and patience.

e. Although increase of rice production is a matter of paramount concern to Indonesia, ironically, losses are high in those regions where crops have increased and are continuing to increase.

Actually, such loss is looked on as a necessary evil. In other words, when rice crops per unit of land area double or triple and when two crops a year of five crops in two years are possible, it is deemed inevitable that a certain percentage of the paddy be lost.

Even, if implemented, the proposed improvements not only will have a good effect on the national economy, but also will have the secondary effect of calling attention to the need for raising farmers' standard of living and will stimulate improvements in postharvest handling of such secondary crops (Palawija) as corn and cassava.

Furthermore the proposals rest on the fundamental idea that, as Indonesian rice dealings become gradually more transacted, the major current will be from KUD/BUUD/PUSKUD to BULOG/DOLOG. And these operations will be unable to function successfully unless they are strengthened and modernized. For example, even if Indonesia becomes self-sufficient in terms of rice production, as long as public organizations function weakly, farmers, who will be unable to sell at the floor price, will fall prey to commercial rs and will lose the will to produce. Moreover, unless transportation storage capacities are increased, surplus in producing areas and it in major consumer regions will go uncorrected. This in turn will bilize rice prices. Clearly, then, the cooperation of the farmers, and BULOG is essential if improvements in postharvest handling are realized.

For the sake of accomplishing these improvements, incentives and/or shall be provided to farmers and KUDs in order to encourage and sate them for their work as the following chart indicates.

Initial Drying and Cleaning

Incentive ↑ ↓ Sell paddy after drying suitable enough for short-term storage and cleaning empty kernels and foreign matter.

- Increase the farmer's bargaining power and stimulate local employment
- Operated by farmers groups
- Guidance by PPLs

Final Drying and Cleaning

Premium ↑ ↓ Dispatch paddy/milled rice being capable of long-term storage

- Carry out KUD operation by farmers
- Install better machinery for milling and drying
- Close cooperation with PUSKUD

Marketing ; Milling, Storage, Transportation

- Operation on the base of an appropriate supply/demand plan
- Proper inspection at time of purchase
- Improve facilities; warehouse, transportation, milling

7-2 Practical Ways of Improvement to Postharvest Handling

7-2-1 Reaping

The introduction of the HYV developed by IRRI has succeeded in increasing rice production. But its three main properties of high yielding, shattering habit and uniformity of maturity induce a large loss in the rice reaping process.

In many major rice producing centers in Indonesia, cutting rice panicles with ani-ani has been gradually giving way to reaping the stalks with sickles. The methods are roughly classified depending on the condition of drainage in the field and postharvest practices such as threshing and transportation and are as follows:

Reaping at the higher portion ..... Performed mostly in a field with bad drainage where panicles reaped are put in bags or baskets for transportation (It is mostly seen in wet and muddy fields)

Reaping at the middle portion ..... Performed in a field with bad drainage where panicles reaped are threshed at the field or carried somewhere else for threshing.

Reaping at the lower portion ...... Performed in a field with good drainage where threshing on the spot is practicable.

In this country, the water distribution system is maintained for irrigation but the drainage is rather poor and gives adverse effects on harvesting efficiency. An instance of this kind can be seen in the northern plains of West Jawa where is an major rice producing region with a well furnished irrigation system on a large scale.

Most areas in the main rice producing centers suffer from bad drainage at the time of harvesting. In such cases, mechanical reaper will not work so well as expected. Therefore it is not advisable to mechanize the reaping process at the present time.

There are a great number of small owner farmers tenants and landless agricultural workers in this country and harvesting is mostly done by them. In addition, wages earned from this work are their only source of income for support of their family living in rural societies. Therefore mechanization of harvesting must be the most serious social problem because it deprives them of the base of their livelihood.

On the other hand, there are some areas where BIMAS and INSUS have succeeded in increasing rice production and those like the outer islands where the harvest cannot be accomplished smoothly because of the shortage of labor. In such areas it may of course be necessary to take up efficient mechanical means for harvesting. But as far as the reaping is concerned, various technical and social factors have not ripened yet for the use of any sophisticated implements. Under this situation, therefore, it would be recommendable at present to improve other processes such as threshing and transporting processes first. Mechanization of reaping should be taken up together with the improvement of drainage in rice fields under a long term program.

Although it may sound insignificant, sickles now used should be improved. Their size and shape of blade vary with different regions. Some are quite inefficient, it will be very important to extend more efficient ones most suitable for the reaping work.

2-2 Threshing

When Indonesian farmers used ani-ani for cutting rice panicles, they did not need threshing until before the milling process. However, after the HYV was introduced, it became necessary to thresh it soon after the harvest because of its shattering habit, and then to transport, dry, clean and store it.

As farmers experienced these changes for a short time after the latter part of the 1960s when the HYV was introduced, they were unable to find a reasonable and efficient method for its works. The popular threshing methods now applied are as follows:

Threshing by beating on the wooden board
Applied where the field is well drained and rice plants cut at the lower portion

Threshing by trampling

Already applied to the local varieties. After the introduction of the HYV, this method was applied to field where rice plants cut at the middle or higher portion

Threshing by striking with stick

Applied to the plants cut at the middle or higher portion instead of threshing by trampling in the case that the field is not well drained.

Pedal thresher

Applied to rice plants cut at the lower portion. It has lately been spreading rapidly in Central Java

At present, however, beating and trampling are most popular in the country. As mentioned above, the former is generally practiced in the well drained field and the latter where the drainage is incomplete. Threshing by beating can account for 30 kg to 40 kg of paddy per hour and is little larger to the capacity of trampling. But in the case of the former, the average loss of paddy is about 3% more than the latter because it makes them scatter in all directions.

In a field, for instance, a tractor is used for plowing, a sprayer for pest and disease control and 100 kg of urea per hectare while on the same field hands and feet are applied for the threshing. The farmers' economic status and adaptability to farming practices are now beside the question. It is important here that the harvesting is exclusively done by poor farmers whose harvesting practice is much behind the times owing to the traditional farming habit special to Indonesia. On the contrary, the pedal thresher is becoming popular in Central Java where the tebasan system (a contract harvesting system) is popular.

Threshing is closely related with the other postharvest handling such as reaping, transport, drying, cleaning and so on. Therefore the improvement of threshing work will be very significant in making farmers' other postharvest work highly efficient. For instance, in the case that colored kernels due to the delay of threshing in Aceh should be reduced, it will be vital to make the threshing more efficient as soon as possible. This is effective in those areas where BIMAS and INSUS program have been carried out the increased production program, especially on the outer Java and

Madura where are suffering from a labor shortage.

In order to improve the threshing efficiency, there should be replacement first of all of the primitive methods such as beating and trampling with modern equipment or machinery.

Foot threshers or power threshers may be introduced for improving threshing efficiency. On their introduction the team opines the following:

The team made a test on pedal thresher and found that its efficiency was not so much higher than beating or trampling as to recommend it, though it will be attractive in considerably reducing hard labor and losses.

The pedal thresher as its structure is simple it can easily be produced by a small local manufactures. In Central Jawa its price was only Rp 20,000 to 30,000. But it should be noted that as it is manually operated, its use may be limited to those areas where sickles are used to cut the plants at the lower portion. If the stalk is short, some danger may follow in its operation. Power threshers are of course more efficient than the traditional threshing methods and also pedal thresher. From observation of the machine in operation, it was learned that its actual efficiency was rated at 70% to 80% of its nominal capacity. It is made by many manufactures of farm machinery in domestic and priced at a quite high level of Rp 1.5 to 2 million. There are two kinds of power thresher: one works for either hand-hold and/or panicles-thrown, and the other only for hand-hold applied to it.

In light of the above, the pedal thresher will spread to relieve farmers from hard labor. On the other hand, the power thresher will spread into major rice producing regions but its high price may inhibit its quick extension.

7-2-3 Cleaning

Farmers are not accustomed to cleaning paddy in this country except in some of the outer islands. When ani-ani was used for reaping, the harvest was collected in the form of stalk-paddy for which cleaning was not necessary. On the contrary, however, winnowers are widely used in South Kalimantan and West Sumatera where rice has been marketed in the form of paddy (Gabah) instead of stalk paddy.

In most rice producing regions in Asia, winnowing which is utilizing natural wind, the most primitive way of cleaning is performed after reaping and threshing. In Indonesia, it is practiced most widely in Aceh and part of Central and Eastern Jawa. In general, however, the primitive process is not seen in major rice producing centers in this country.

The harvest collected in the form of paddy (Gabah) usually contains some impurities such as foreign material and empty kernels averaged at 8[illegible] which of course varies with different areas.

Generally Indonesian farmers are very careful in handling their produce. This was learned from observations of agricultural products on sale in the market. Stalk padi was no exception when it was reaped with the ani-ani. Despite such traditional good habits, since the Gabah took the place of stalk padi after the introduction of the IR varieties, the paddy with many impurities became to trade in the market.

Harvesting practices are different depending on regional customs. But one thing common among them is that the harvesters are poor farmers in the neighborhood and the landowner pays their wages according to the traditional way. In this case, the harvesting work includes reaping and threshing and sometimes carrying the crop from field to farm house. The cleaning is usually excluded from the harvesting work. If the cleaning work is wanted by the paddy owner, additional wages must be paid or some extra workers employed.

A village merchant is, of course, not in a position to make a careful checking of moisture, impurities, immature or yellow or red colored kernels and always asks farmers to discount the price. Moisture content is usually judged by grasping paddy tightly in hand or nibbling them, and impurities are judged by the naked eye. For this judgement even a sack of paddy is not opened usually.

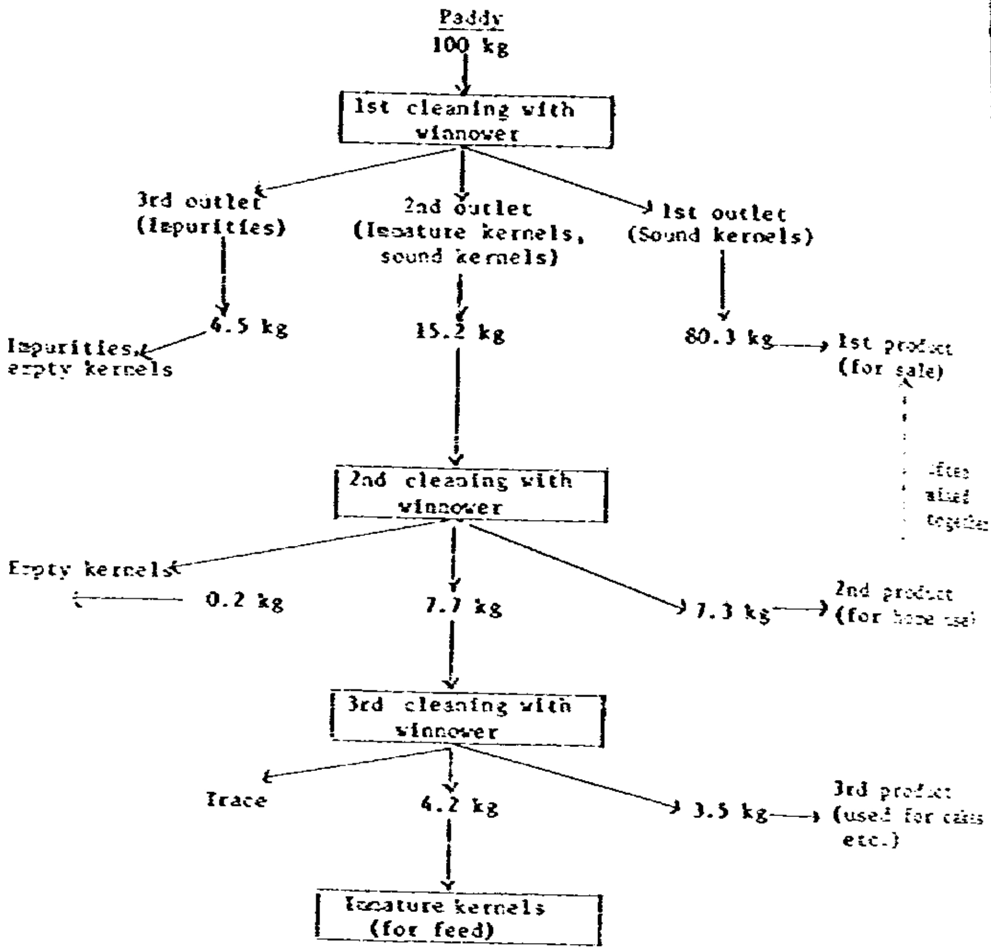
Farmers selling paddy have, of course, no knowledge about moisture content and impurities in their produce. As undried paddy, if left as they are will easily deteriorate through heat generation, farmers wish to sell them so soon as possible. In addition, their financial condition also requires them to release their produce sooner. Farmers in such a weak position have to accept price offered by the merchants without much resistance.

In brief, the fact that farmers do not try to clean paddy by themselves means that they abandon to improve their product in quality and price, which is their bargaining power.

Now the team considers it vital to confer this bargaining power on farmers. To realize this, efficient methods and equipment for cleaning come to the fore. They should as such be operated easily and extended roughout the country.

For farmers, winnowing by natural wind is most simple and easy to handle. t it takes quite a long time to finish the work because some helpers are red or family labor is used. In this case, the team recommends the use of nnower (Gumbaan) with higher efficiency and requiring less labor.

The winnower has been used in China since several hundred years ago. s function is based on winnowing. As the winnower is of a very simple ructure, it can be easily manufactured in this country and be priced at ly Rp 10,000 to Rp 15,000. At present it is widely used in South Kalimantan d West Sumatera. The following figure shows one of the actual result of eaning test made by a winnower in South Kalimantan:



Paddy	100 kg	
1st product (paddy) (for sale)	80.3 kg	91.1 kg (1st outlet)
2nd product (paddy) (for home use)	7.3 kg	
3rd product (for cakes, etc.)	3.5 kg	
Immature kernels (for animal feed)	4.2 kg	(2nd outlet)
Impurities, empty kernels	4.7 kg	(3rd outlet)

Fig. 7-1 An Example of paddy cleaning by Winnower in South Kalimantan

The above process is characterized by the sound and immature kernels discharged from the second outlet being sorted again to remove the immature and empty kernels. It was considered a serious problem in transactions where paddy grown in the wet season in 1981/82 contained many green kernels and they were found everywhere in the country. This problem will not be solved for many years to come where the IR varieties with short growing times are produced. Among green kernel which have a specific gravity and a comparatively light. If the latter could be cleaned by farmers, great progress would be expected in paddy marketing in Indonesia.

It is even now possible for farmers to sort out a part of the impurities, the empty kernels and some portion of immature kernels from their product. But to extend the improved method further, there should be some incentive given to farmers.

Private mills and the KUD/PUSKUD presently perform their cleaning in the following way: Part of the rubber roll of the huller is opened, and through this opening paddy are passed as the huller's winnowing function works to remove impurities and empty kernels.

It is desirable to set up new equipments with a capacity meeting the actual demand.

<u>Drum sorter with long hole</u>

<u>Specific gravity sorter</u>

(These machines are explained in Sec. 2-5-(3)-2)

Cleaning should be done with each of the above two or both in combination. As there is no effective cleaner suited for Indonesian rice, further studies should be made to design the best.

Cleaning paddy in Indonesia is only to sort out impurities and empty kernel out of the harvest and is not much concerned with the removal of immatured paddy. Then, it has become a serious market problem that a lot of imature kernels is found in paddy produced from the IR varieties with the short growing time.

According to the BULOG's regulations, brown rice whose surface is colored with green listed as immature kernels. But this provision of the regulations is often misunderstood. Because even if a kernel is green in surface but its texture is hard and transparent crystal, it should be listed as a sound kernel. On the other hand, if the surface is green and the texture soft and chalky, it should be classified as immature kernel.

The present cleaning method is to sort out only impurities and empty kernels. From now on, it should extend its objective further to sort out chalky, immature kernels which should be removed as much as possible. (As far as green bard kernels are concerned, it will be impossible to sort them because their specific gravity is the same as that of sound kernels.) With such improvement, the cleaning process should finally achieve a constant yield of milled rice.

The traditional and improved processes are compared in a chart as below:

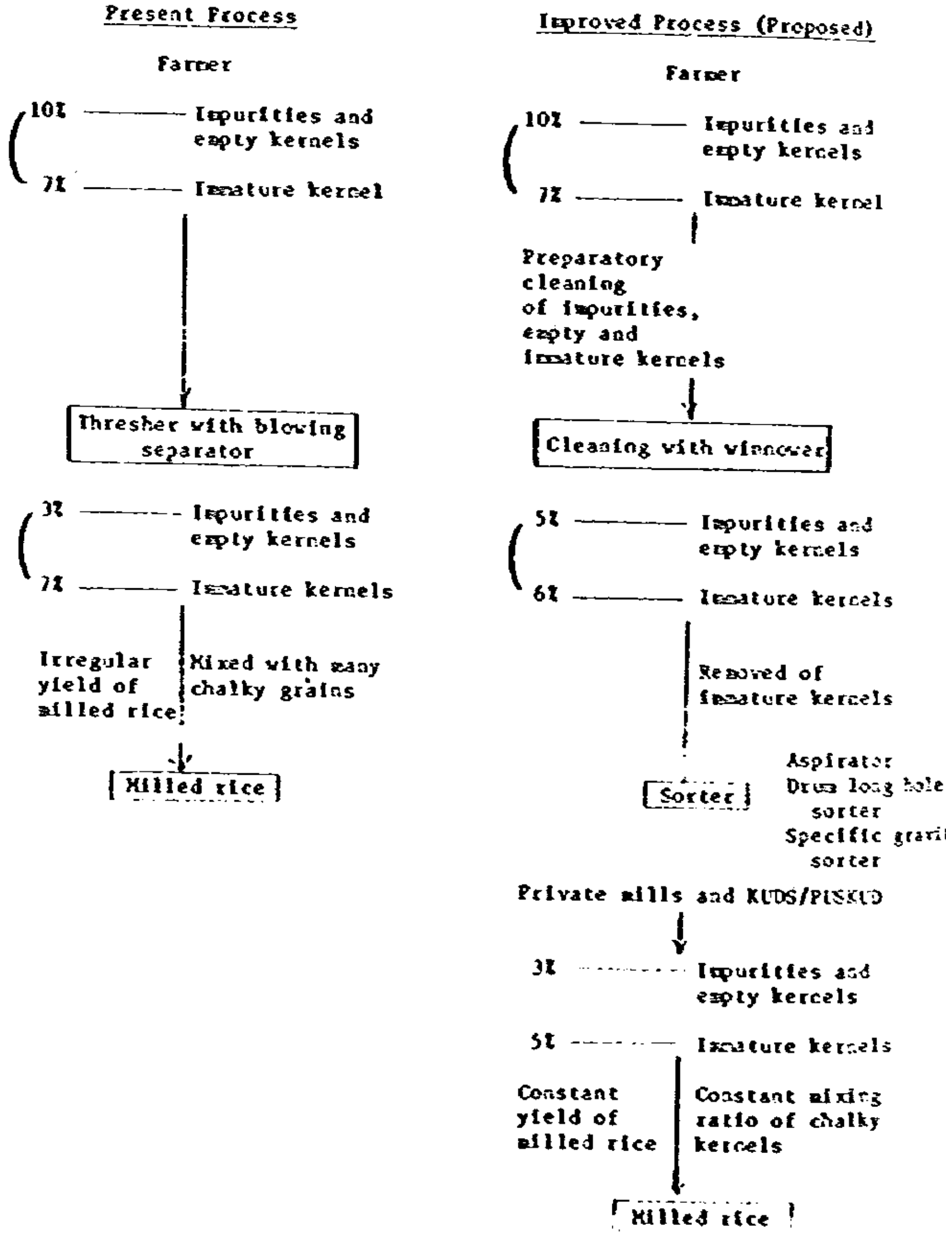


Fig. 7-2 Comparison of Traditional and Improved Paddy Cleaning Processes

3-2-4 Drying

Many of the postharvest practices have changed since the introduction of IR varieties as mentioned before. The drying process is no exception. As most farmers in rice producing centers usually sell their undried paddy to buyers immediately after the harvest, the majority of such paddy are carried to private mills or KUDs for drying.

Changes in the drying process easily invite losses of rice and pose also a serious problem of deterioration in its quality because paddy harvested are not immediately dried and are left as they are on the field or farmers house for several days awaiting the buyer to carry them away. The undried paddy are put in polyethylene bags without aeration, in which their respiration and fermentation causes, and then they generate heat in a few days. In addition, as the bags are exposed to the sunlight or rain, their contents deteriorate soon. Such deterioration of paddy quality is especially remarkable in the wet season when the paddy contain excessive moisture and easily get wet from rain.

In the paddy drying process in private mills and KUDs/PUSKUDs, a large amount of paddy collected from farmers in a short time has to be processed with a limited number of facilities in only a few days. Difficulties are mounting up in this case, too. Although a number of the Lister's type air dryers have recently been introduced, their absolute number is not enough to meet the actual demand. Therefore, the paddy drying is now mostly performed on cemented floors where paddy are spread in the sun. Some large rice mills and PUSKUDs have large drying floors with a daily capacity of 20 to 30 tons. But most of the mills and KUDs can dry paddy to the amount of only 5 to 8 tons a day.

Paddy collected from producers usually contain moisture of 22% to 25%, which has to be reduced to less than 14.0% in conformity to the BULOG's standard. In the harvest season, however, it is usual that paddy are gathered all at once in such an amount as to exceed the existing drying capacity. In addition, in the wet season, paddy on the waiting may often be caught in the rain.

1. Paddy collected to an amount exceeding the processing capacity are forced to be piled up in the open yard.
2. Paddy piled out of doors deteriorate due to solar heat and high temperature.

3. Paddy caught in sudden rainfalls are much damaged.

4. Paddy which have got wet in the rain lack a uniform moisture content when dried again.

In the above cases, large losses are incurred on paddy in the drying process, including deterioration in quality.

Therefore, should the quality of paddy be well kept and losses minimized, it would be essential to prevent generation of heat, fermentation and spoilage of the commodity. It is more important to improve the handling of undried paddy by farmers at first and then to make the drying process better. In handling paddy, among others, protection from rain will be most important for minimizing losses. Deteriorated or spoiled paddy cannot recover their original state by any means.

To keep paddy sound with the least possible losses, it is a must that farmers dry paddy first at their own place.

How to dry paddy first at the farmer's place was described in Section 2-5 of this Chapter. If it is technically successful, the major causes of loss will be improved. And it will be accompanied by the following merits:

1. More farm income.

2. Heavy operation of private mills and KUDs will be relieved.

3. Superfluous paddy on the market at harvest time will be leveled down, the market price of rice stabilized and transportation and storage freed from overload.

The above improvement measures may be illustrated better in the diagram below.

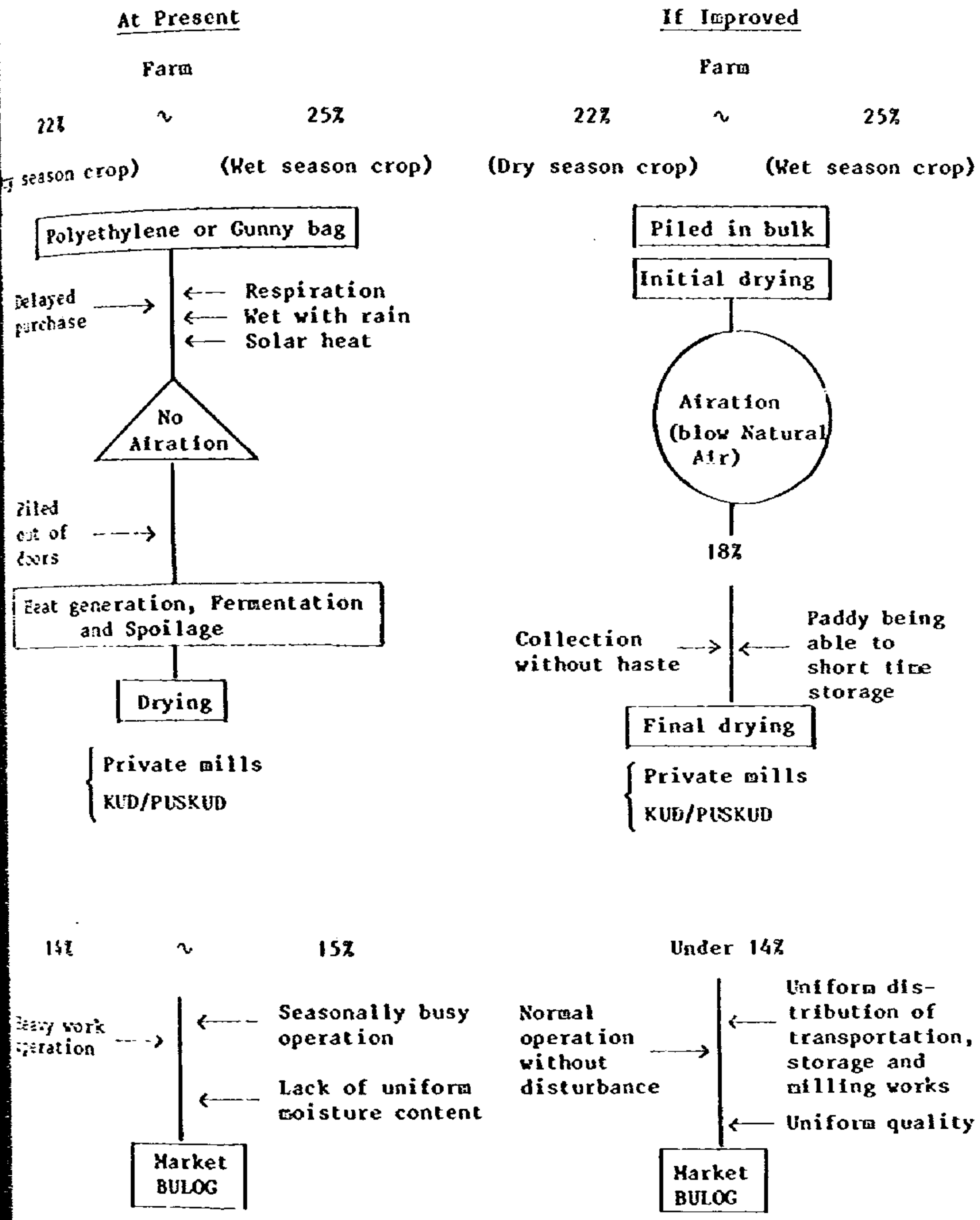


Fig 7-3 Comparison of Present Method and Proposed Method of Drying

If undried paddy (with moisture content of 20 ∿ 22% in dry season and 23 ∿ 28% in wet season) are left without ventilation, they begin to generate heat within 46 hours resulting in fermentation and putrefaction which may-ly bring forth large losses. If those paddy were kept with fresh air through ventilation, they could avoid all the adverse effects as mentioned above and be dried into a sound commodity.

According to Team's experiment, the humidity in air recorded 75% or in January and February during the wet season, though that much was noticed only for few hours a day. When fresh air was given to paddy in this space of time, they definitely reduced their moisture of 25% ∿ 18% at a small rate of 0.2% a day. In the case of paddy with moisture contents of 18% or less a wind velocity generated by human power could control the degeneration of quality due to heat but could not contribute to drying paddy further.

The experiment such as was done by the team should be repeated under different conditions and should be reviewed in each case. If its results as above were right, it would be practicable for farmers to reduce the paddy moisture content to a degree of about 18%. Paddy in such degrees of mois-ture content would be kept without changing quality for 15 to 20 days at least even under the tropical conditions in Indonesia.

It will then be concluded that Indonesian farmers though with some additional cost and labor could ship their paddy with added value to the market whenever they desire, while the buyers receive the comparatively sound commodity with less damage. In traditional marketing, paddy have suffered large losses at each stage of channel from producer to commercial sector and KUDs. If the improvements as suggested above were implemented, the losses would be considerably decreased. Paddy to which the initial drying has been applied by farmers should be dried again in the sun to a moisture content of 14% or less, then they would be the best commodity available at the farmers' stage.

The drying process by KUDs/PUSKUD presently induces large losses of paddy, especially those cropped in the rainy season because of poor facili-ties as aforementioned. If the initial drying were efficiently done by farmers, KUD/PUSKUD would be freed from heavy work. If their business were relieved from this jam, they could operate more orderly to the drying and eventually help reduce losses in the commodity.

The improvement proposed by the Team is to share the drying process between the farmers and the KUDs/PUSKUD according to their respective capacities. It is diagrammed and shown in the following figure.

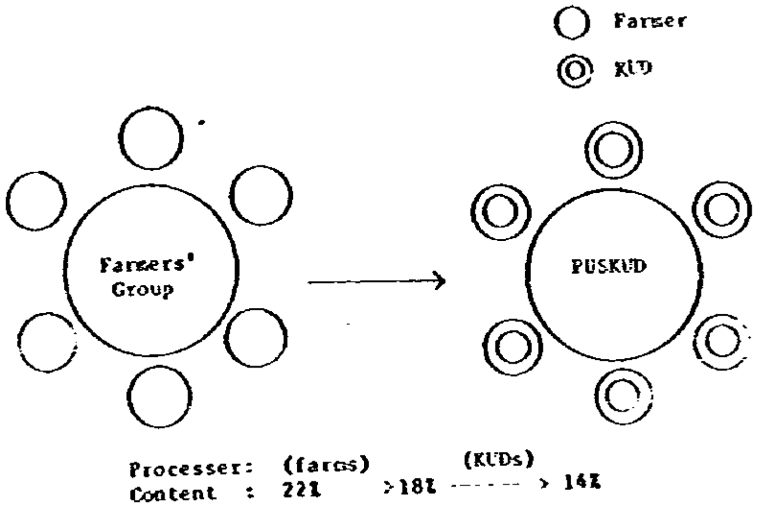


Fig. 7-4

The initial drying process will be performed by farmers or their group (KELOMPOK) and the second one by KUDs or PUSKUD. How much paddy will be handled in each case is outlined as below:

Farmers (50) / Farmers' group → 300 tons
- 50 tons for home consumption
- 250 tons
  - 200 tons for commercial shipment
  - 50 tons for shipment to KUD

↓ Initial drying

KUD (10 farmers' groups) 500 tons (50 tons x 10)

↓ Final drying

PUSKUD (20 KUDs) 10,000 tons (500 tons x 20)

Fig. 7-5

In this case it is most desirable to set up two 3-ton dryers of various types at each of the 10,000 farmers. In fact, however, the farmers which are generally poor can hardly afford such equipment exclusively used for drying paddy for such a short limited time of about 30 days in a year. Therefore, if the engine portion is taken up, it should be also utilize as a water pump or rice milling machine through the replacement of some parts with others. The Team has the impression that such equipment can be mass produced without much difficulty at a price of about Rp 200,000 in Indonesia. If the cost of this product should be higher than that of water pumps on sale now, the Government could afford a credit loan to farmers and help them use it widely.

For the final drying, 4 machines each with a 250-ton capacity should be set up at KUDs/PUSKUD in some selected areas. The dryers run about 3 months a season or about 6 months in total for both dry and wet seasons. In this case, the dryers should function in compliance with the following conditions:

1. As it fluctuates due to changes in rainfall, undried paddy may be delivered. Therefore the dryers should be designed so as to be capable of processing such ones satisfactorily.

2. As KUD/PUSKUD are overloaded with the business of drying in the harvest time, the dryer should also play a role in storing paddy for a short time.

3. The facilities should be protected with thermal insulation system because they are set up in the tropics.

4. The storage should be of a type, such as silo for bulk, which can immediately check heating portion.

In the past, however, similar equipments had once been introduced in this country but was left almost idle. In view of this fact, such dryers should be introduced after its operators have been trained well for several years through some technical assistance program. In addition, the equipment should also be carefully designed and operated in light of the climatic conditions of Indonesia, quality and features of rice produced here, and marketing conditions.

Summarizing the foregoing, sun-drying should be the principal mode of drying performed by farms, KUDs, private rice mills, and in all other stages for the moment. Machine-drying will be utilized only when sun-drying is not possible. However, machine-drying and natural-air drying and storage should gradually be introduced whenever circumstances permit.

4.3-5 Milling and Other Processing

1) Approach to Improvements

Drying and milling are the most important final processing stages that determine the value of rice when it is marketed as a commodity. In Indonesia, however, milled rice that is low in quality and has an extremely low commercial value is abundantly sold in the market. The Indonesian people, who are rice consumers, eat low-quality milled rice as a staple food. The quality difference is significantly large compared with the international level. It is the necessity of those concerned to improve the qualitative value of rice.

The necessity of increasing quantity and of enhancing quality in the drying and milling stages has already been recognized by those knowledgeable of the field in Indonesia. The truth is that there is a lack of concrete measures to implement improvements.

The improvements recommended in accordance with the survey first aim at setting technical solutions considering local and natural condition, as well as economic and social, environments. These solutions are embodied in machines and implements. A follow-up system is planned to be established by offering technical guidance to disseminate these machines and implements, as well as technology, throughout Indonesia.

Various types and models of rice milling machines have been imported throughout the world for use in Indonesia. They do not actually suit rice produced in Indonesia or the social conditions of Indonesia. Therefore, an approach should be made to determine what kind of machines will meet the situation in Indonesia, and what machines and implements should be developed and improved on after focusing on the precise requirements.

The improvement objectives cannot be accomplished merely by milling machines. What is important is that at the farm level, KUD level, and BULOG level individually and mutually share their roles and vertically accomplish the improvements.

(1) Farm Level

At the farm level, the quality of paddy produced should be maintained, and drying and milling should be made to an extent that rice is smoothly accepted by the next stage. Effective utilization of an abundant labor force, which Indonesia's farming population has, will be the most effective.

Recognizing that by distinguishing quality standards and price dif- ferentials, rice can be sold at a high price by processing it to high qu Even if this means more labor, efforts should be made to secure quality r and to increase farmer income levels.

In order to achieve this goal, appropriate drying and cleaning mach and implements should be supplied to farms.

1) Dryers and Temporary Farm Storage Facilities

In the past, Indonesian farms have lacked place and way to dry a large quantity of high-moisture content paddy. The largest current problem for the farm level is how to temporarily store a large quan of high-moisture content paddy after harvesting without deteriorati and how to dry it. This problem has become acute parallel with the introduction of high yielding varieties and increased harvest during the rainy season.

As a means to solve this problem, the introduction and dissemina- tion of low-cost drying and storage equipment for farms are recomme

According to another test on a various drying methods, compared with sun-drying, paddy dried by natural air drying produces fewer broken kernels, has a high milling recovery, and produces high-quali milled rice.

Assuming that farmers have to sell high-moisture content paddy, part of which has already degenerated or is degenerating, to traders at about 89 Rp./kg. By processing this paddy to dried paddy of high quality meeting the BULOG standard, paddy can be sold at the govern- ment floor price of 135 Rp./kg. Even when the reduction in quantity by drying and various expenses are considered, the introduction of equipment that can be easily used within the range of this 35 Rp./kg is recommended.

By drying high-moisture content paddy to 16 to 18% at the farm level after threshing, the storable period can be extended from 3 - 5 days to 20 - 30 days.

The capacity and models of the equipment differ depending on the situation in the particular region, farm size, etc. A vertical cyli type is hereafter introduced as an example to permit combinations for the following:

(1)	Storage Capacity	1, 3 and 6 tons
(2)	Blower Fan	Manual or air-cooled engine type
(3)	Air Temperature	Natural air drying, sun-drying, and hot-air-drying with husk-burner

The equipment can be easily designed and manufactured with an elementary knowledge and technology of paddy drying. The principal parts of the equipment can be produced in Indonesia in large quantities to permit a large cost reduction.

By using them in large quantities, losses can be prevented quantitatively and qualitatively, and at the same time contribute to increasing the farmer income.

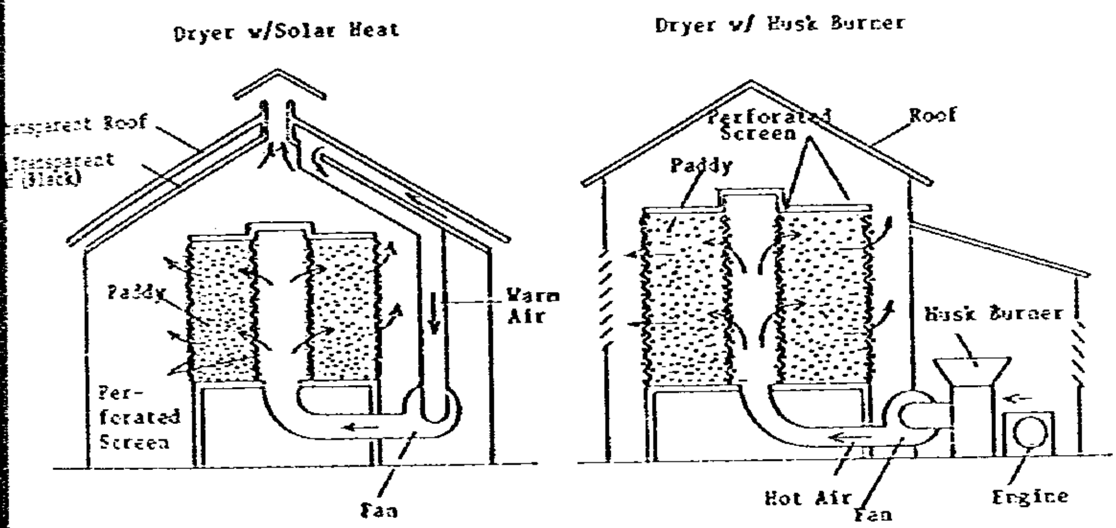


Fig. 7-6 Drying Paddy in Lumbung

2) Cleaning Equipment

Cleaning is another important work parallel with drying to enhance the quality of paddy at the farm level.

The content of foreign matter has increased after high yielding varieties have been introduced throughout Indonesia.

Compared with local varieties, more empty paddy and immature kernels are contained in paddy of high yielding varieties. When they cannot be cleaned effectively, paddy is not processed to the required quality level in the milling process.

Paddy of high quality and meeting certain standards can be obtained by installing cleaning equipment in combination with dryers. It is necessary to impress on the farmers that it will be to their advantage to dry and clean paddy by clearly showing them revised standards and price policies of the Indonesian Government. The advantages offered by cleaning machines further enhance their effects when they are combined with dryers.

Low-cost, hand-driven (can also be driven by an engine) cleaning devices that can be operated easily and that meet the situation in Indonesia are recommended to be disseminated.

These cleaning machines are principally for paddy cleaning in fresh paddy stage with a moisture content of less than 20%. They separate large foreign matter such as straw and lightweight foreign matter. When used on dry paddy with less than 18% moisture content, cleaning is performed to segregate foreign matter, empty paddy, and immature paddy that is almost empty paddy. Their capacities are approximately 1 and 2 tons/hr.

The function is a combination of an air-cleaning winnower and width separator. Feed inlets have forced ventilating devices. The unit bodies are made of wood, steel perforated with long slits and other materials which are procured separately. They are made to be driven both by a manually-rotated handle and by engine.

This equipment can be easily manufactured with a knowledge of winnowers and width separators.

Winnower w/ Immature Grain Separator

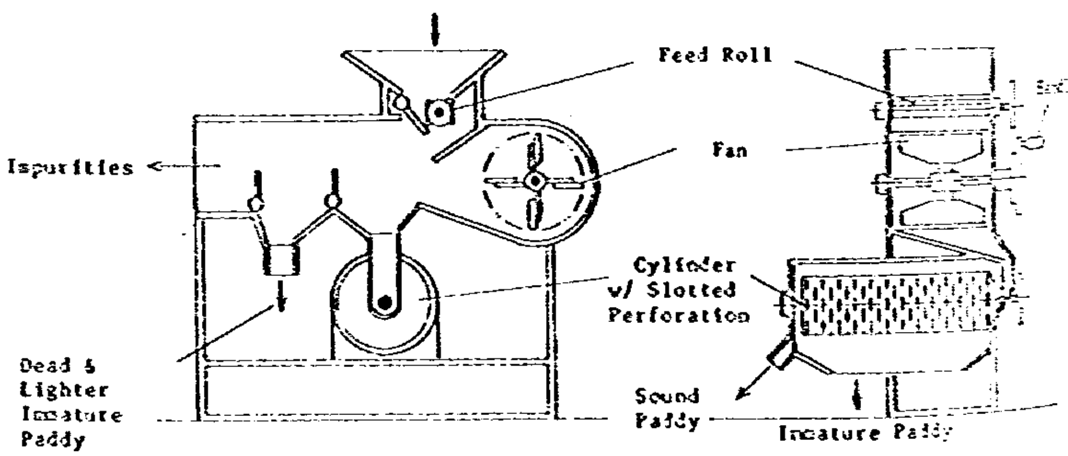


Fig. 7-7 Improved Winnower

3) Husking and Whitening Set for Farm Groups

In the milling stage, losses in milling by small custom rice mills are the largest, and these losses will be an enormous quantity when all losses throughout Indonesia are counted. The losses are due to over-milling because of long adjustment time at the start and end of operations. One charge brought by farms is too small compared with the capacities of huskers and rice milling machines.

In terms of work, these machine are functionally too large for custom rice milling for farms. For 40 kg of paddy, the appropriate milling capacity of a rice whitening machine for brown rice is 30 to 60 kg/hr. With this machine size, losses at the start and end of milling can nearly be eliminated. The introduction and development of husking and whitening sets to be installed among farm groups are recommended.

Whitener which farms use are 30 kg/hr 0.5 hp and 60 kg/hr 1.0 hp machines. Huskers with rubber roll 2.5" in width are the practical machines. These small huskers have the same performance as that of large machines. Most of them have an aspiration device, and their capacity is approximately 150 kg/hr with double husking.

A set of a 2-1/2" small husker and a 0.5 hp small whitener mill installed in each farm group will permit custom rice milling of rice consumed by the farms collectively.

A trial calculation of small rice milling machines installed in farm groups is shown in the following.

Number of People	40 (farms) x 5 people	= 200 people
Annual rice consumption	150 kg/person x 200 persons	= 3000 kg
Custom milling charge	30000 x 6 Rp/kg (custom milling charge)	= 180,000 Rp
Cost for rice bran	30000 x 0.08 x 25 Rp/kg	= 60,000 Rp
Annual expenditures (for custom rice milling)		= 240,000 Rp
Machine Cost	Husker(with air cleaner)2.5"	150,000 Rp
	Rice Milling Machine 0.5 hp	150,000 Rp
	Total:	300,000 Rp
Fuel	75 Rp x 2ℓ x 800 hr	= 120,000 Rp
Annual handling quantity	26kg/hr x 5.8hr/day x 200 days =	30,000 Rp

Annual Depreciation (5 years depreciation)	300,000 Rp ÷ 5	= 60,
Interest	300,000 Rp x 18%	= 54,
Annual Cost (Fuel + annual depreciation + interest)		= 234,
Increased yield	2% x 30000kg x 200 Rp	= 120,
Income from rice bran	30000 kg x 0.08 x 25 Rp	= 60,
Net annual consumption	[annual cost - (increased yield + rice bran income)]	= 54,
Cost per kg of polished rice 54,000 ÷ 30,000 kg		= 1.8

By using machines owned by farm groups, all the farms have to pay is only 1.8 Rp per kg.

Unlike commodity such as wheat and sugar cane, one marked advantage with rice is that final processing at the farm level is possible. Until recently, Indonesian farms were milling rice for their own consumption by hand pounding. It is significant that advanced husking and milling machines will be used by farmers themselves.

While Engelberg type huller is still used by some custom rice mills, owning such improved machine by farmers group, they can obtain milled rice of high quality at low cost.

Dryer engines can be utilized in parallel as a power.

Rice bran as a by-product can be used as livestock feed, or can be sold. Husk can be utilized as a fuel for dryers.

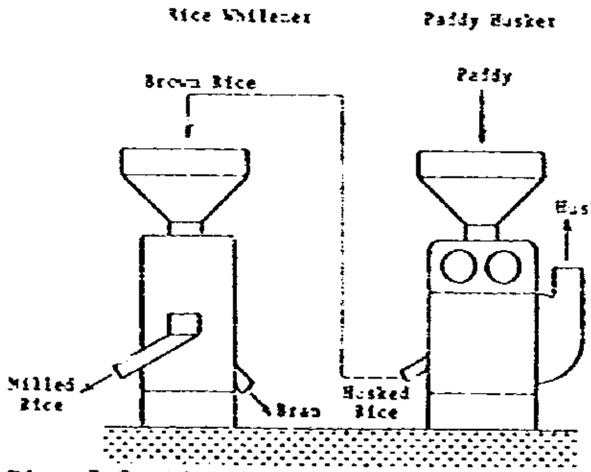


Fig. 7-8 Rice Milling Machine at farm level

(3) KUD Stage

It is an important issue as a policy matter to strengthen the farmers' cooperative organizations as a means to protect farmers and to enhance their standard of living.

Nevertheless, KUD of today are not sufficiently fulfilling their functions in coordinating with farmers as regards the postharvest handling of rice. This is because the farmers' cooperatives lack a powerful system to accept paddy which fully meets the farmers' situation. The farmers' cooperatives also lack technical know-how.

Facilities required to accomplish this goal are as follows.

1) Receiving, Drying, Temporary Storage, and Cleaning Facilities at KUD Buying Depots

The paddy which farms can handle is limited. Drying, and cleaning is insufficient. Paddy is not uniform in quality and is generally low in commodity value.

The farmers' cooperatives will be able to strengthen their solidarity with farmers by possessing facilities to process unsufficiently processed paddy into high-quality dry paddy. Hence, the installation of facilities to accept unsufficiently processed paddy is necessary.

Unsufficiently processed paddy will be accepted, cleaned, weighed, and graded for quality, to obtain dry paddy nearly uniform in moisture content of about 16%. Paddy will be stored in temporary storage bins during which time it will be processed as completely dry paddy (less than 14% in moisture content). Paddy stored in bins will be sent to a cleaner and width separator, to be processed into uniform and high-quality paddy.

(1) Sold to BULOGs after weighing and bagging.

(2) Sold to the market as high-quality rice after husking and milling.

(3) Continue to store paddy in storage bins watching the market price.

At a suitable time, paddy can be sold to the market as paddy, or as milled rice. Thus, temporary storage facilities can be used.

(1) Paddy Cleaners

Capacity: 5 to 10 ton/hr

To remove small and light foreign matter and dust. When receiving paddy, impurities which would cause problems in the next processes are eliminated. Impurities and empty kernels are removed after drying.

(2) Weighing Implements

Capacity: 5 to 10 ton/hr

To attach an implement to extract sample paddy. (moisture content, milling grade, and other items of grading by qual[illegible] Purchased paddy is handle individually and on a cumulative basis while paddy is received. When handling, paddy is weighed to obtain a certain weight and is interlocked with bagging device.

(3) Width Separators

Capacity: 5 ton/hr

Its principal function is to separate immature kernels to meet the BULOG standard by using special long slit-perfora[illegible] steel.

(4) Dryers

Capacity: 6 ton

Drying rate per hour: 0.5 to 0.7%

Low-temperature, large air volume circulation type

(5) Temporary Storage Bins

Storage Capacity: 100 to 200 ton

Outdoor installation type equipped with ventilation and stirring devices

(6) Motive Power

Generators

(7) Inspection Equipment

Moisture content meters, test dryers, test husters, test milling machines, test immature kernel separators, and test broken rice separators

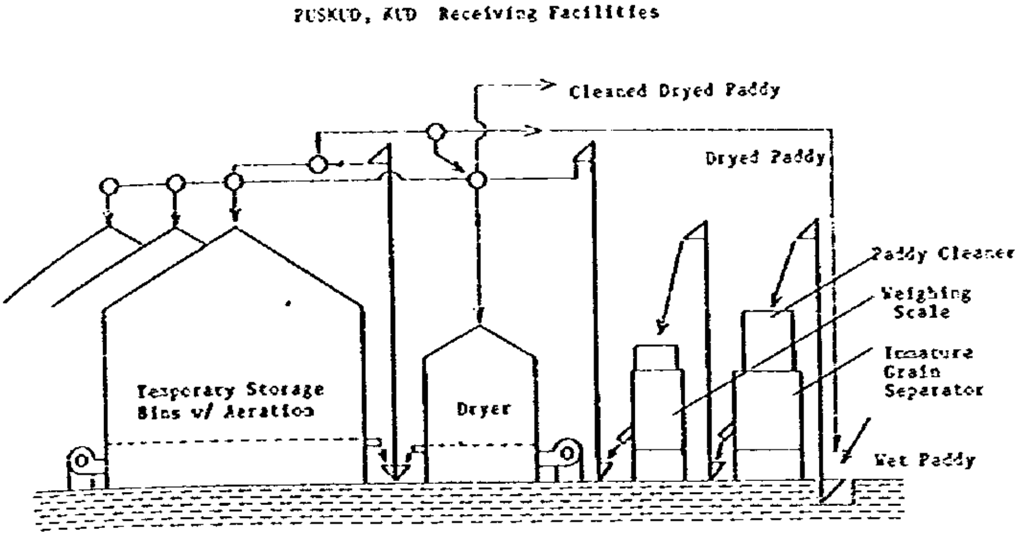


Fig. 7-9 Proposed Facility for Drying and Temporary Storage at KUD/PUSKUD level

2) Immature Kernel Separators

In many instances, paddy fails to conform to the BULOG standards regarding impurities and immature kernels. Conventional rice mills do not have machines to separate them. As a way to improve this situation, installation of cleaning and immature-kernel separator equipment is recommended.

The equipment is a combination of a cleaning machine and separator. The cleaning section has a vibrating sieve and air cleaner to mainly remove straw as large impurities, sand as small foreign elements, and empty kernels as light impurities. The separating section is made of long slit-perforated steel sheet. Immature kernels are separated while paddy passes through a cylinder. The appropriate capacity is 1 to 2 ton/hr.

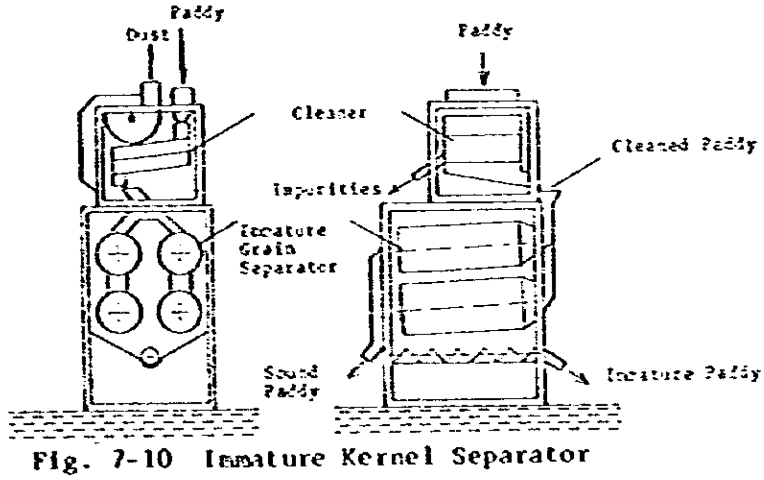


Fig. 7-10 Immature Kernel Separator

3) Husking and Milling Equipment

From the standpoint of reducing quantitative losses in the milling stage, the highest milling yield can be obtained by passing rice twice through a combination of a rubber roller husker and jet-air friction-type rice miller, which can be found in ordinary small rice mills in large quantities, adding a locally-made metal-mesh paddy/brown rice separator. Rice thus obtained has relatively high commodity value.

Nevertheless, the present mode of work in processing into milled rice is to move rice held in containers such as baskets into hoppers, which are situated high up, and handling by using many man power in the action in relaying the heavy baskets of rice. This causes large economic losses and is not desirable from the standpoint of quality as well.

The installation of rice milling facilities is recommended to suit the actual situation to process a large quantity of rice into a high quality commodity and at a high yield by KUD. These facilities can be utilized more effectively by building them with paddy receiving and processing facilities.

This rice milling facility with a capacity for 1 ton/hr of paddy will have the following equipment.

(1)	Pre-cleaner	- Only large foreign matter is removed.
(2)	Husking air separator	- Rubber roller type husker 6" + chaff aspirator
(3)	Paddy separator	- To separate brown rice and paddy
(4)	Initial process rice whitener	- Jet-air friction-type rice whitener for primary milling 10 - 15 hp
(5)	Final rice whitener	- Jet-air friction-type for finishing, 10 hp
(6)	Broken rice separator	- 2-stage type to separate small foreign matter and small broken kernels

(7) Elevator	- Bucket type, 4", for paddy and brown rice, 2 unit
(8) Engine	- Diesel, 40 hp
(9) Counter Shaft	- Motive power received from the engine and driving of units
(10) Platform frame	- To install husker and rice Whitener

2.1.6 Transportation

Extension of trucks has contributed very much to the improvement of transportation in this country as earlier mentioned. Although it may be said that the revolution is now under way through the big extension of motor trucks, it is still far from overcoming the difficulties in the infrastructure as listed below:

(1) Poor Roads in Rural Areas

(2) Truck Roads without Much Improvement

(3) Shortage of Ships and Poor Harbor Facilities for Transportation between Islands.

(4) Inadequate River Transportation Facilities in Swampy Areas.

(5) Urgent Delivery of Rice to Large Consuming Centers.

These situation make transportation costs so high as to inhibit smooth movement of rice. As a result, rice is forced to be kept in store too long and induce a large amount of qualitative and quantitative losses. The actual situation of each problem will be explained and some suggestions will be made for its solution hereafter.

1) Poor Roads in Rural Areas

In rural villages where road conditions are good, 2-ton trucks are running very actively for the collection of rice. But almost all roads in rural villages are so bad in Indonesia that even small trucks can not pass. In most villages, therefore, a rice collector (Pedagang Kecil) carries a 50 to 150 kg lot of paddy to a nearby rice market by bicycle, ox-cart or tricycle. The cost of this kind of transportation usually amounts to 5 to 10/100 of the price of paddy carried, though it may change depending the distance. In some areas (for instance the outer islands) suffering from labor shortages, paddy are often carried from field to farm in the same primitive way as above.

In the case that roads are bad and transporting means are poor, a village merchant who has a truck or an ox-cart has an absolute advantage over farmers in transactions.

To improve a farmer's position in the transaction, a small multipurpose carrier (with 2 to 3 hp and capacity of 500 kg to 1,000) should be developed. In this case, the engine could be used for the drying, milling and also tractor.

(2) Truck Roads without Much Improvement

Figure shows a truck road which permits the use of large 12-ton and medium 5-ton trucks, from which the road situation in this country will be learned. It illustrates how poor the situation is even in Jawa Island where the population is dense and traffic conditions are said to be most developed in Indonesia. From this, one may judge the rest. Of course there are many roads other than that shown in this figure. But bridges on them are not strong enough even for a small 2-ton truck. In addition, their surface becomes much worse in the wet season.

The truck roads are now used mainly for long distance transportation of rice from producing areas to consuming centers. But traffic jams are expected on these roads in the future as non-agricultural industries develop further. Then the only way to relieve the jam will be the construction of modern highways.

Another improvement for long distance transportation of rice will be more efficient use of the national railways. For this purpose, modern warehouses should be built at the terminal stations in both producing and consuming centers. Now about 100,000 tons of rice are carried by trains only in Southern Sumatera and a few other regions. However, a large amount of chemical fertilizers have recently been moving by train. In view of this trend it will be highly probable that the railways may increasingly participate in transportation of rice in the future.

3) Shortage of Ships and Poor Harbor Facilities for Transportation between Islands

Indonesia consists of a large number of islands, of which only Java and few other islands produce most of the rice in this country. As a result, these islands are almost destined to have surpluses of rice while the others are to suffer from definite shortages.

Supply of rice to the islands suffering from shortages is made using the BULOG's large ships under Government direction and also with private small ships of 5 to 20 tons on an non-official basis. (In this case large ships are sometimes used through the BULOG's approval). About 3% or 30,000 tons of rice shipped moved between islands on a Government basis. It will not be less than 700,000 tons a year if those carried by private small ships are added.

Thus BULOG's transport on a Government basis must be done to secure and stabilize prices for the many islanders as a national operation every year. But in fact chartered ships are hardly available due to the shortage of ships as a whole. As a result, rice has to be kept an unusually long time in store causing great loss to the rice quality. In the case of rice which is transshipped at a harbor to another conveyance, it takes an unusually longer time to get an available ship or truck because of the shortage of such transportation means.

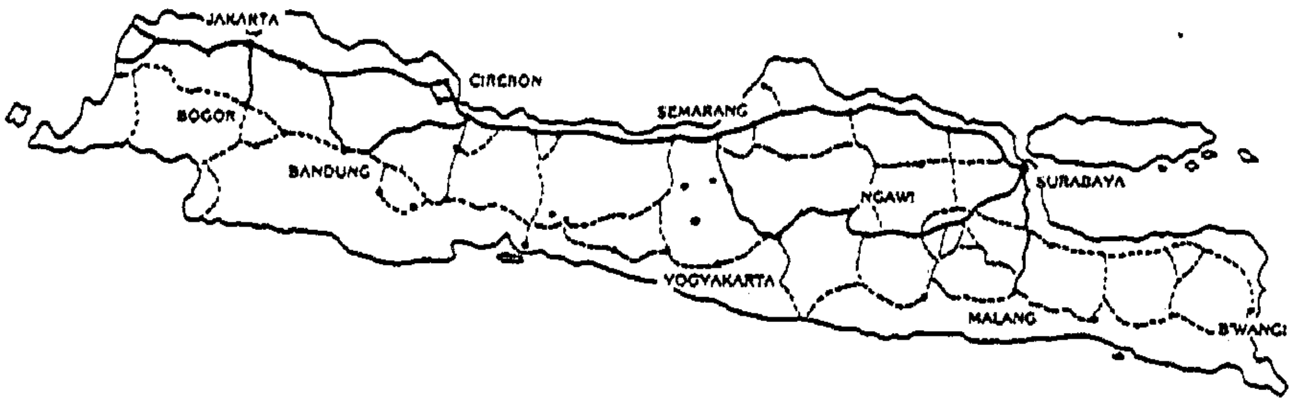
For the improvement of such situations, it is vital to secure an adequate number of ships operated on a Government basis. And also this should be done in parallel with the improvement of harbor facilities and cargo handling efficiency. All of these will require a huge amount of money and time.

According to the BULOG, Rp 90 billion was spent for rice transport in 1973, and for the transport of rice between islands Rp 15 billion or 25 million U.S. dollars are spent annually as calculated below:

30 Rp/kg x 500,000 tons = Rp 15 billion

equivalent to $25 million

In addition, the transport of chemical fertilizers and others cost 31 billion rupia a year. Therefore, expenses relating to rice may be totaled at Rp 120 billion. Since the expenses caused by the bad transport conditions could be prevented, such high costs of rice transportation as mentioned above could be reduced by all means for the benefit of the national economy.



Source: Surat Keputusan No. 04/KPTS/DJ/VII/77, July 21, 1977.

Notes: ——— Roads can be licensed for trucks up to 12 ton loads.
- - - - - Roads can be licensed for trucks up to 5 ton loads.

Fig. 7-11 Roads on Java Permitting Truck Licensing for Heavy Loads

Under these conditions, the Team would like to recommend the B.O.S. system (Barges onto Ship System) as the most economical and immediately effective means for marine transportation. At the port of departure, rice in bulk or sacks is loaded on certain barges before the arrival of the carrying vessel. On arrival of the vessel, the barges are loaded on board together with rice in them and shipped to the port of destination. At the destination the barges with rice are unloaded in a short time. If there are empty barges at this port, they are loaded and directed toward other ports for delivery. This system is applicable even to small ports with poor harbor facilities. Therefore it will be very convenient for a country like Indonesia where there are many islands with small ports as many as 134. In addition, barges are used for storing rice for a time if necessary. Not only sugar, wheat and other products handled by the BULOG, but also massive commodities such as cement, fertilizer and others could be shipped in such a way as mentioned above if a business agreement were concluded between the manufacturers of those commodities. These barges are also used for collecting rice in the Barito River, a swampy area in the Province of [illegible] and other river areas.

i) River Transportation in Swampy Areas

As river transportation facilities are inadequate in the Provinces of Kalimantan, South Sulawesi and Riau, an increased amount of rice produced in these provinces has to stay there and to suffer much losses both in quality and in price while it is kept at farming families or local KUDs. It will of course dampen to a large extent the farmers will to produce more. To improve the situation, it is advisable to provide KUDs with small boats with outboard motors of 3 to 5 hp to collect paddy from farmers or deliver them to the BULOG or individual consumers. Apart from such measures, the BULOG should be equipped with large barges which can be used for collection and short term storage of rice.

In any case, it will not be advisable to build many warehouses in swampy areas because of the high humidity and poor infrastructure of transportation. It is essential to store rice for the least possible length of time to avoid losses as much as possible in swampy areas.

(5) Urgent Delivery of Rice to Large Consuming Centers

It is beyond question that rice should be daily supplied to cities constantly and without fail and that the BULOG should make the market operation to stabilize prices. In the operation of the consumers' market, imported rice has always been released. The reason was that ocean liners full of rice on board could directly head toward a port where the consumers market needed price controlling.

In fact, however, it happened sometimes that the price had already been stabilized when the liners arrived at the port or that imported rice could not be properly disposed of due to the lack of transportation capacity and did not contribute to effective market operations. As a result, most of it has to be stored in various places. Losses in such cases can be estimated as follows:

Loss in quantity would roughly be more than 2%. If that in quality and cost of re-processing be added to the above, the sum will be more than 5% and could be as much as 15% at worst.

In view of all the above, the B.O.S. system (Barge onto Ship System) seems best. To make it successful, however, it should be established at a harbor near a rice producing or consuming center and the harbor be furnished with paddy storing facilities, large rice mills and others all situated around the harbor and always operated immediately if demanded.

These problems concerned about transportation are related to the loss in the handling of postharvest. As for their improvement, it should be viewed from wider viewpoints to examine possible measures. The team merely pointed out the existence of the problems only.

7-2-1 Storage

In 1979, warehouses owned by BULOG had the following storage capacities:

New warehouses	1,115,000 tons
Old warehouses	138,595 tons
Total	1,253,595 tons

BULOG plans to build 171 units capable of storing 967,000 tons at 349 locations throughout Indonesia by 1983/84 when the Five Year Development Plan III is completed.

Private rice warehouses are estimated to have the following capacities:

Rented to BULOG	757,475 tons
For private use	295,289 tons
Total	1,052,764 tons

In addition, KUDs have small warehouses throughout the country capable of holding 100 to 200 tons. Only a few of these warehouses are utilized as functionally complete storage facilities. Therefore, KUD warehouses are not included as warehouse spaces.

In summary, rice warehouses with the following holding capacities will be available throughout Indonesia by 1983/84:

BULOG	2,220,595 tons
Private	1,052,764 tons
Total	3,273,359 tons

Approximately 35% of rice produced in Indonesia is sold in the market. Estimating the rice production to be 22,000,000 tons in terms of milled rice, the quantity of rice marketed can be estimated by using the following calculation formula:

$$22,000,000 \times \frac{35}{100} = 7,700,000 \text{ tons}$$

Assuming further that the quantity of rice distributed in the market is equally divided into dry- and wet-season crops, the rice quantity distributed in the market during one season would be:

7,700,000 tons ÷ 2 = 3,850,000 tons

According to the foregoing estimate of rice quantity distributed in the market, warehouse space for rice in Indonesia is nearly sufficient to accommodate the required quantity provided appropriate warehousing control is exercised.

Improvements to be recommended in the storage stage can be classified into distribution items and warehouse structure and management items.

The recommendations in terms of distribution required to be implemented urgently are as follows:

1. Additional installation of warehouses in production areas in which rice production is increasing rapidly through BIMAS and INSUS.
2. Strengthening of port warehouses in production and consumption areas that are strategically important to inter-island transportation.
3. Long-term storage warehouses needed for market operations.

Port warehouses may require large rice mills adjacent to them, as well as efficient loading and unloading facilities.

The recommendations in terms of warehouse structure and management are as follows:

1. Shielding of solar heat by utilizing heat-insulating materials.
2. Improved exhaustion and ventilation by installing ventilation systems.
3. Enforcement of the first-in and first-out principle for warehousing.
4. Separate wet and dry season crops. Wet season crop lots should not be stored for a long time.

Prominent improvements will be possible by installing heat-insulating materials or ventilation systems on existing warehouses, uncomplete drying of rice.

Mouth of bags containing wet season crop rice should be tied with cords that are dyed a special color to distinguish them from dry season rice crops. They should be stored separately and should not be stored for a long period of time.

Generally, most of private warehouses are old and their structures are weak. They are not managed well. The use of these private warehouses should be gradually discontinued pending completion of BULOG new warehouses.

Management of warehouses by DOLOG (pest control, piling, cleaning, etc.) is generally good, and no large problems could be found in particular.

3-3-8 Grading for Quality

(1) Problems in Grading for Quality

The genuine purpose of grading for quality is to smooth distribution grading v.s. inspection of commodities. This means that the grading method and grading standards must meet the actual situation of distribution in the country, that is, the actual situation of production of goods (rice in this instance), quality level, and the actual situation of distribution (price, interests of parties in business, position of inspectors, packing style, transportation means, etc.)

The actual situation for the grading of rice in Indonesia does not necessarily meet this objective. Rice is sold and bought when rice producers sell rice to merchants, rice mills, or Koperasi Unit Desa (KUDs), when brokers, rice mills, or KUDs sell rice (paddy or milled rice) to BULOG, and when rice is sold and bought between private rice merchants. Improvements desired to be made in grading of rice by BULOG and by KUDs, which will will be the parties that will have the most effect in the proposed improvements to be made in postharvest handling, will be described below.

First, in making improvements in grading the quality of rice, grading standards and methods must be clearly prescribed, and they must meet the current situation for transactions. For this purpose, the definition and grading methods prescribed in the grading standards should not depart from their contents. Unfortunately, there is a considerable difference between the current definition and grading methods. There are quite a few grading items that lack clarity. Improvements desired will be described item by item in the following.

1) Moisture Content

Regardless of whether it is paddy or milled rice, the moisture content of cereals greatly affects their storage property (quantitati and qualitative losses by disease and insects). This is the most important item for Indonesia which is located in the humid tropical zone. Experienced experts grade moisture by the so-called senses assessment (gripping it in the hand, biting down on it, piercing the cereals with a cereal prick, listening to the sound when it is dropped on a hard plank, gauging the hue, luster, etc., and a knowledge of the conditions in which rice is placed). This practice may actually be utilized. However, a universal standard that can be understood by all the parties concerned is required for grading the crop when transactions take place. Because KUDs and sub-DOLOGs grade rice thro the country, what is most suitable will be to use a simple moisture tester that is easy to operate and can measure moisture quickly even though its accuracy is slightly inferior.

At present such moisture testers as Cere and Iseki are used. Before their accuracy or their operability is discussed, it must be mentioned that moisture testers are lacking in grading yards at KUDs. Also, more moisture testers will be needed in the near future during drying work. Moisture testers are not calibrated. Under these circumstances, KUDs' grading fails to win the confidence of those who ask KUDs to grade their rice. Therefore, a large number of moisture testers need to be distributed.

The maximum allowable moisture content in the current standard is 14%. Is this limit reasonable in light of the current situation? It is only natural that the demands of those who actually require rice when determining numeric values for standards (upper-limit moisture needed for storage,particularly for long-term storage) be considered. However, a variety of unreasonable conditions are caused when the actual situation in primary drying in the farm stage and secondary drying in the distribution stage are neglected. At the farm level and in the drying and procurement process the facilities are not necessarily equipped to dry all paddy to a 14% moisture content. For instance, the moisture content of paddy distributed in private channels is 15 to 16%, not 14%.

Based on an average relative humidity of 78% and an average temperature of 16°C in Indonesia, the equilibrium moisture content of paddy is 15%. The equilibrium moisture content would be 14% when the average relative humidity is 73% and the average temperature, 26°C. The average annual temperature and humidity in individual provinces and districts differ, therefore it does not make sense to utilize average tempeature or humidity for all of Indonesia. In any event, tests made in Japan show that a considerably long period of time is needed before the moisture content of paddy stored under natural meteorological conditions returns to the equilibrium moisture content once it is dried beyond the equilibrium moisture content and provided paddy is heaped in bags. This also applies when paddy is stored in bulk in certain quantities. The situation is different when paddy is dried far in excess. Under the circumstances, it seems that a return to the equilibrium moisture content need not be considered in particular when deciding a standard moisture content.

Approximately 10% of paddy or milled rice purchased by BULOG (approx 2 to 2.5 million tons in terms of milled rice) requires long-term storage at present. One idea is to specify the moisture content for this 10% to be 14%, specifying 15% for the rest, respecting the actual situation of distribution. In that case, two grades are recommended to be set up for grading the quality of rice, specifying the moisture content for the first grade to be 14% and for the second grade, 15%. The question is whether or not first-grade rice needed for long-term storage can be secured for the individual regions. However, it will be possible to solve this question depending on how inter-grade prices are set. Inter-grade prices must at least reflect a quantity shrinkage by drying (shrinkage: $\frac{100-15}{100-14}$ x 100 x applicable weight: 1.1628% which is slightly larger than 1%) and appropriate drying costs. It will not be possible to expect a moisture content of 14% in primary drying at the farm level. It will be possible, however, to purchase rice for long-term storage by the individual regions by utilizing drying facilities at KUDs or private drying and cleaning suppliers and by adding an appropriate cost.

Regarding the correlation between paddy and milled rice in moisture, the moisture of brown rice is higher by about 0.3% on an average than that of paddy when paddy is husked and milled to brown rice in Japan in summer (average relative humidity 78%, average temperature 26°C). The moisture of milled rice is lower by 0.5% on an average than that of brown rice when brown rice is milled to polished rice. Therefore, during the milling process from paddy to milled rice the moisture of rice lowers 0.2% on an average. According to the results of tests with milled rice made by the survey mission in Aceh and West Jawa Provinces in the dry season, the moisture of milled rice which was a product, was lower by 0.2 to 0.5% and 0.35% on an average than that of paddy. This trend is common to all countries even though there are some differences in degree. Therefore, judging from the actual situation of rice production and handling and considering the measuring errors of simple moisture testers, a difference in moisture content of 0.5% between paddy and milled rice should be allowed.

Therefore, the upper-limit moisture content of first-grade paddy will be 14.5% if that for first-grade milled rice is 14% based on customer requirements. The upper-limit moisture content for second-grade paddy will be 15.5% if that for second-grade milled rice is 15%. These upper-limit moisture contents should be decided carefully, however, after studying the actual situation.

2) Paddy Grading Items (Empty Rice Kernels and Foreign Matter)

By definition, foreign matter is a substance other than rice kernels, and the definition is clear. The method of grading leaves room for further study. Empty rice kernels which are half solid are defined to be empty rice kernels. It is not clear how judgment can actually be made when grading in the field. Judgment differs from one person to another and from one district to another when grading paddy. First of all, one half is one half of what? Granted that the basis of 100 as against one half is a kernel with an average solidity among paddy kernels to be graded, is it 100% in terms of weight or volume? It is not clear. Even if it is clarified by definition, how can it be measured? There are a number of questions. The degree of immaturity of chalky and green kernels cannot be distinguished, and there has been some confusion in grading for these two items.

3) Paddy Grading Items (Chalky and Green Kernels)

"Chalky kernels" are brown rice kernels (husked paddy) that are white but have become chalky and soft due to physical factors. Kernels that are immature (green) and soft due to early harvesting and that are chalky are regarded as chalky kernels. "Green kernels" are those brown rice kernels that are green in color and solid (but not chalky)." That "brown rice kernels" are prescribed in defining grading items for paddy before studying the definition shows that no judgment can be made in the form of paddy. This seems to be natural. However, in no grading method is it shown how paddy is husked to make brown rice to be tested. In fact, the moisture of paddy immediately after harvesting is 22 to 23% in the wet season and 20 to 21% in the dry season. That of undried paddy after husking is approximately 16 to 18%. It is extremely difficult to husk sample paddy for grading in the field.

There is no standard for the chalky portion in a kernel when defining chalky kernels. There are no prescriptions limiting, for instance, to 1/2 or 2/3 of the volume of a kernel. This is not logical because paddy containing a kernel having even a small chalky portion is counted as chalky kernels. White-core and white-belly kernels that normally exist as properties special to species are also counted. This is also illogical. Opaque kernels with hard kernel textures do not greatly affect the milling yield. Therefore, it will be necessary to stipulate "those kernels that are white and opaque and whose kernel textures are mealy. Kernels that are white and opaque should not be counted if their textures are flinty."

Those chalky kernels clearly in an advanced powdery state, namely, dead kernels, should normally be counted as damaged kernels, and not as chalky kernels.

There are two types of green kernels. One type is normally called live green kernels. Their chlorophyll, which is principally present in Aleuron layers of kernels, vanishes 2 to 3 weeks after harvesting through after-ripening. Generally, live green kernels should not be counted as green kernels. The other type is a kernel which is green in color. The kernel texture is hard and translucent.

After the definition of paddy grading items has been clarified, the next question will be what should be the allowable limit for chalky kernels. The degree of chalkiness differs depending on the variety, and it should be decided after considering its balance with damaged or immature kernels.

4) Milled Rice Grading Standard (For Milled Rice IB)

a) Degree of Milling

The degree of milling is expressed by percentages relative to 100% after calculating 100% of the milling degree obtained by a ratio in accordance with 1000-kernel-weights of brown rice and milled rice. In principle, this is considered correct. However, in field grading, the milling degree is graded by comparing it to a standard that has a 90% milling degree. However, it is difficult ot compare because of spot milling and other elem One suggested method is to judge the retention of the brown layer by using a new MG solution (a mixture of eosine and ethylen blue dyes in a certain ratio). According to this method, the endosperm, which principally consists of starch, becomes redish pink and the brown layer (mostly protein) is colored bluish purple, permitting a judgment of the retention of the brown layer.

b) Broken Kernels

The standard value for broken kernels should also be decided spontaneously in accordance with the variety characteristic of the paddy, drying conditions, types and combinations of milling machines, level of milling technology, and other production and handling conditions, and by the degree of consumer demand.

In terms of the definition of broken kernels, there seems to be more broken kernels in milled rice than the analyzed percentage of broken kernels in Indonesia as viewed by a foreigner. This is explained by the fact that the size of broken kernels differs from that for other countries. In other countries, the upper limit of broken kernel size is mostly less than 3/4 of a whole kernel. In Indonesia, kernels are stipulated to be whole kernels even if they are less than 6/10 of a sound kernel. That those kernels are 7.5/10 and 6/10 of whole kernel size and not regarded as broken kernels considerably affects the external view of the overall milled rice. The lower limit of broken kernel size must be more than 2/10 of the whole kernel. In other countries, in many instances, the upper limit is set after the crop is divided into large and small broken kernels. Kernels are not divided into large or small sizes in Indonesia, and there is a considerable difference in the external appearance between when there are more broken kernels that correspond to large broken kernels and when there are more broken kernels that correspond to small broken kernels even though there are 35% broken kernels in both instances.

c) Finey Broken Kernels

The definition is "Sound kernels 2/10 or below of whole kernel size and that do not pass through BULOG standard sieve with sieve openings of 2 mm." It will be necessary to stipulate whether those that have been sieved through a 2-mm mesh sieve are to be counted as foreign matter.

(2) Improvements Recommended for Grading Quality

1) Grading Items

a) Sampling

It seems that samples used for analysis do not necessarily represent the entire lot in grading in the field carried out in Indonesia. Therefore, stipulations regarding sampling should be provided. At least, sample dividers should be available at KUD grading yards.

b) Simple Husker

Simple huskers need to be installed to analyze grading items that have to be analyzed with brown rice (or milled rice) in grading paddy, namely, chalky, green, empty, damaged, colored, and other kernels.

c) Moisture Testers

As mentioned earlier, simple moisture testers need to be provided at KUD grading yards.

2) Revision of Grading Standard Values

As mentioned already, the current standard values do not match the current situation. A project team needs to be formed to study the revision of grading standards.

3) Appropriate Intergrade Price Differences

A pricing structure needs to be studied when revising grading standards so that the intergrade quality difference matches the price difference. The current price conversion table for different quality specifies only moisture and foreign matter as grading items and the price difference is not necessarily large enough to provide an incentive to enhance quality.

4) Test Weight

The most common grading method employed at present to judge paddy quality is to measure the paddy quality from an overall standpoint after measuring various grading items, that is, after examining it from various angles, whenever a direct measurement of "milled rice quality x milled rice yield" is not possible. These grading items are important in determining quality. The test weight has the highest correlation to "milled rice quality x milled rice yield" as one grading item. The test weight is used in the grading of paddy in Japan and several other countries. Volume testers can be operated easily. However, a thorough study will be needed in the future in deciding upper- and lower-limit values.

5) Determination of Basic Grading Method and Standards

In determining the quality of paddy, the conventional approach to paddy grading can be altered fundamentally once the value of "milled rice quality x milled rice yield" is obtained, as paddy is a raw material in rice milling. The survey mission believes that it is not too difficult to develop a simple milling machine for grading that can be utilized to accomplish this purpose. It is recommended that a grading improvement project team be organized to develop such a milling machine for grading

7-3 Recommendation

Methods for improvement have already been described with regard to each stage of postharvest handling and processing. Out of these methods, the team proposes 4 items; two of them (7-3-1, 7-3-2) require the long-term and basic approaches for the improvements and the others (7-3-3, 7-3-4) are the urgent one.

7-3-1 Establishment of Research and Development Center for Postharvest Technology

In order to improve postharvest processing, the results of this survey shall be given careful attention referred in studying further how to apply practical methods and develop technical aspects. Also, these accomplishments must be widely instructed to all concerned. If the efforts above are neglected, no real achievement will be expected.

The subjects to be studied and developed in the new center from a technical point of view have been described in 7-2 of this report. Since these subjects relate to a wide scope including harvesting, cleaning, drying, storage and transportation processes, all the related elements discussed in 7-2 should be carefully taken into consideration in organizing a new functional structure.

In order to minimize the losses and to improve the postharvest condition where the losses are occurring and increasing daily, it is quite effective to let the existing Working Group of Postharvest to handle the activities of the Center to cope with the tasks abovementioned, until the Center is officially established.

Among the themes to be studied and developed the following three items should be urgently implemented in the Center.

(1) The Improvement of Rice Standardization

In order to minimize postharvest losses, standardization of grading method, unity and development of apparatus and machines for inspection, the establishment of grading standard to be adopted for Indonesian situation and rationalization of inspection system shall be implemented in the Center.

(2) The Study in Storage Technology

It is essential to study how to store the rice to minimize qualit[illegible] and quantitative losses under the circumstances in the oceanic tr[illegible] region, especially for long period storage such as a storage with c[illegible] stant temperature and relative humidity, a storage with aeration a[illegible] bulk-handling system.

(3) The Study and Development on the Machinery and Implements to be Used in the Stage of Postharvest Practice

In order to meet the requirement of Indonesian rice production, marketing and the specific characteristics of Indonesian rice, it i[illegible] essential to study and develop the machinery and implements such as thresher, dryer, cleaner, husker, and whitener.

In the near future, the unity and standardization of specification for them are also important tasks for the Center.

7-3-2 Increase of Storage and Transportation Capacities for Surplus Ri[illegible] in South Sulawesi

Surplus rice raised in South Sulawesi is estimated at 520,000 tons for 1980 and 760,000 tons for 1981. Since crops are steadily increasing, it is thought that the excess will reach a million tons in the near fu[illegible] No doubt, this surplus will be shipped to areas Sulawesi Province and o[illegible] parts of Indonesia. But currently insufficient storage and transportati[illegible] facilities in the province and low shipping capabilities at ports not o[illegible] causes qualitative and quantitative loss to the surplus rice, but also lower rice prices and discourage farmers to produce. For these reasons, is difficult to maintain high production.

It is therefore urgently needed to work out a transportation system for the surplus that can be shipped to consumer centers so that such surplus may replace imported rice. In addition, it is important to pro[illegible] major producing regions and shipping ports with storing facilities and a quality-control system.

7-3-3 Elimination of Discolored Rice in Aceh

Because of labor shortage and poor postharvest practices, in Aceh reaped paddy is left piled up in field for two to three days, sometimes as long as two weeks, beside exposed to rain for several times during this period, the interior temperatures of the sheaves reach about 60°C with the result that discoloration occurs during storage in later stage. In an extreme instance, 90% of the rice discoloured after being stored in a KUD warehouse for a year. On average, 30 to 40% of stored rice discolours within a few months. Introduction of powered threshers is desirable to reduce this huge qualitative loss. Since no particular financial or social limitations on their introduction have been indicated in Pidie and North Aceh, the development of suitable threshers for the region and their application would greatly enhance the efficiency of this improvement.

2-3-4 Improvement of Methods for Drying and Cleaning of Paddy in West Java

In the six districts of the northern plain of West Java, a rich rice-growing region, drying paddy in the rainy season is very difficult. For this reason, farmers sell largely undried paddy to KUDs or to private sectors. Paddy consumed by the farmers as their food are also inadequately dried. These paddy being not well sufficient dried condition is a major cause of deterioration of quality during storage. Improvement of the situation requires guidance on sun and mechanical drying at the farmer's level. The function should also be required at the KUD and PUSKUD levels through installation of mechanical drying system. In addition, there is a serious problem of immature kernels in early harvested paddy of rainy-season. The causes of the immature kernels must be tracked down, and the guidance must be provided in ways of eliminating them.