machinery lease services. The charging system for bulldozer levelling services by the Agriculture Dept. (Engineering Wing) in case of the Punjab Province, is as under:

Table 3.43 Charging System for Bulldozer Levelling Services

Unit: Rs./hour

Type of Bulldozer	Full Rate	Subsidized	Barani Area
1. Fiat AD-7	171/-	103/-	77/-
2. Fiat AD-7C	186/-	130/-	102/-
3. Komatsu D40	193/-	154/-	125/-
4. Komatsu D50	234/-	187/-	152/-

Source: Agriculture Dept. (Engineering), Gujranwala.

The subsidized rate is applied to leveling services for agricultural purposes, while the full rate for the purposes other than agriculture. (In Barani Area, further lower rate is applied). The difference between the both, to be considered as subsidies, occupies around 1% of the Annual Development Programme expenditures all over Pakistan.

As for grains, consumer subsidies should be taken into accounts. For instance, huge amounts of subsidies have been annually allocated in the procurement and distribution of wheat, whether it is domestically produced or imported. The same kind of measures have been taken also to the edible oil. However, at the post-harvest stage of paddy/rice, no subsidy has been provided to consumers. This is because support prices of paddy/rice, which mean the Government procurement prices, have always been lower than the export price of milled rice, giving a large profit to the Rice Export Corporation of Pakistan and finally to the national treasury.

3.5.4 Legal Provisions

At the post-harvest stage of paddy/rice, particularly strong administrative control is observed in procurement and in operation of regulated markets, with the legal powers. Practical procedures of these are stated hereunder, together with the provisions in the related laws

and rules. At the final part of this Section, the taxation system after the harvesting of paddy is put down.

(1) Procurement procedures and regulations

Government procurement of paddy/rice in Pakistan is exclusively for the appropriation of exports carried out by the Rice Export Corporation of Pakistan (RECP). The RECP does not procure paddy/rice directly from growers/rice mills/rice dealers, but has entrusted the procurement operations to the Provincial Food Dept., only provides the funds required for procurement, establishes standard criteria in inspection, and carries out the inspection. As the subsidiaries, the Pakistan National Produce Company, Ltd. (PNP) and the Doaba Rice Mills, Ltd. undertake direct procurement in limited areas; however, the RECP itself does not operate such activities. In the same manner, the paddy procured by the PASSCO is processed, sometimes stored and then sold to the RECP in the form of milled rice.

The Provincial Food Dept. carries out actual procurement operations on behalf of the RECP as stated above. The Punjab Paddy and Rice (Control) Order, 1981 and the Sind Paddy and Rice (Control) Order, 1973 provide with the rules of business in the actual procurement operations. This kind of Orders have been enforced only in the Provinces of Punjab and Sind, which contains major rice producing areas. Both the Orders were made public by the respective Governors, in exercise of the powers conferred by the Foodstuffs (Control) Act, 1958 (West Pakistan Act No. xx of 1958) which is effective throughout Pakistan. Contents of both the Orders are almost identical. Only in Punjab, more strict control, or a ban on paddy/rice transference, is taken to facilitate procurement of the Basmati variety, producing areas of which are very limited. Outline of the Paddy and Rice (Control) Order is as under:

a) Restrictions on movement of paddy/rice (In Punjab, ban on movement)

b) Transport permits

c) Liabilities of a permit holder (by rail and by road/ rivers)

d) Price control (In case of Punjab, this provision was repealed)

e) Ex-mill price

f) Wholesale and retail prices

g) Appointment of authorized rice millers/rice dealers

h) Restriction on purchase and use of paddy

i) Restriction on processing paddy

j) Restriction on sale or disposal of rice

k) Powers of inspection and search

l) Penalty and powers of forfeiture

m) Powers of Provincial Government

n) Exemption provisions

Paddy/rice procurement operations by the Provincial Food Dept. have put into practice in accordance with the annual rice procurement programme framed in each year. Two major components of that annual programme are the procurement target and procurement prices. The latter is uniform all over the country, based on the support prices of paddy/rice for that year approved by the Federal Cabinet on the advice of the APCOM. The target volume of procurement is the Cabinet Case; drafts are forwarded by the Ministry of Commerce, to which the RECP is attached, taking into consideration export volume requirements, paddy crop conditions, and so on. Nationwide target volume is apportioned to the Provinces (mainly, Punjab and Sind) and then the Province-wise procurement targets are conveyed to the Provinces. Provincial target volume is allocated to each Division in the headquarters of the Provincial Food Dept., and the Divisional targets are further allocated to the Districts inside the Regional Food Office. Under these circumstances, the procurement target by the Office of the District Food Controller is determined.

In the Punjab Province, the "Monopoly Procurement Scheme of Rice" is handed over to the Office of the District Food Controller, which is a configuration of the annual rice procurement programme as described above, and minute rules and regulations to control procurement operations. The following are the obridged contents of that Scheme to apply to the procurement operations for 1985 - 86 paddy/rice. (Refer to Appendix F for details).

- Rice shall be procured under the conventional Monopoly Procurement Scheme for export by the Rice Export Corporation of Pakistan.
- Only Basmati, IRRI-6 (premium grade) and KS-282 rice of the 1985 crop would be purchased. KS-282 would be considered as per with IRRI-6 White (premium) for the purpose of procurement. However, the authorized rice dealers would keep KS-282 paddy/rice separate from IRRI-6 and Basmati rice so that no admixture of these varieties takes place.
- Banned varieties of rice, i.e., Sathi, Permal, Mushkan, Hansraj (Bara), IRRI-Pak (8), Mohran (IRRI-6), PK-196, PK-177, PK-178 and Mayab-6 (IRRI-9) rice shall not be purchased.
- The growers would be ensured the support price of paddy.
- The support prices of paddy and rice for the scheme year 1985 - 86 are as follows:

Table 3.44 Support Prices

Unit: Rs/40 kg

Variety	Support Price of Paddy	Procurement Price of Rice
1. Basmati (White)	93/-	166/-
2. IRRI-6 (Premium)/ KS-282	57/-	95/-
3. IRRI-6 (FAQ)	53/-	86/50

Note: The procurement price for Basmati (White) was revised later to Rs.175/-, because of the crop condition.

- Sela Basmati would be purchased at the same price as that of White Basmati. The premium of Rs.10/- per 40 kg will be given this year, only in the case of parboiled rice supplied by modern parboiled plants.
- The total procurement volume of rice from the Scheduled Areas is 500,000t, comprised of 300,000t of Basmati (White), 50,000t of Basmati Sela and 150,000t of IRRI-6 (premium)/ KS-282. Out of 50,000t of Basmati Sela, 25,000t would be supplied by the PNP mills controlled by the RECP.
- Targets for procurement of rice by the District (As shown in the Appendix F).
- Free sale quota would be permissible for authorized rice dealers/rice millers against the supply of rice to the RECP by the following scales:

  Basmati rice: 25%

  IRRI-6/KS-282: 25%
- Bonus rice would move by rail provided it is decided by the Government otherwise.
- The permissible limit of broken in case of Basmati as well as IRRI-6 and KS-282 would not exceed 33% in any case.
- Movement of paddy within the Scheduled Areas would be free except movement towards R.Y. Khan, D.G. Khan and Rajanpur from other Districts belonging to the Scheduled Areas.
- Movement of paddy from the Scheduled Areas to the Non-Scheduled Areas and also within the Non-Scheduled Areas would be completely banned.
- There shall be a complete ban on movement of all varieties of rice and its brokens within the Scheduled Areas, from the Scheduled Areas to the Non-scheduled Areas and also within the Non-Scheduled Areas.
- Only authorized rice dealers/rice millers would be entitled to deal within paddy and rice.
- Rice would be procured only through the authorized rice dealers/rice millers within the Scheduled Areas.

- Growers may also tender rice directly to the Government, even in lots of 30 - 60 bags. Such small lots would be pooled together by the officer in charge of the purchase center for making a complete lot of 240 bags.
- The growers would get their paddy husked only from the authorized rice millers at the nearest purchase center, under the direction of the official of that purchase center.
- Rice would be packed 95 kg per bag net or 96.06 kg gross.
- The procedures of inspection, sampling and analysis at purchase enters, super inspections after purchase within the Province and at Karachi would continue to operate the same as last year, during the scheme year 1985 - 86.
- Full payment of the price of rice supplied to the Government would be made immediately through the nominated commercial banks, after inspection/analysis by the officials at the purchase center, on the receipt of the consigning bill.

The "Monopoly Procurement Scheme of Rice" of the Food Dept., Punjab is characterized by the intention that 75% of rice would be procured and tendered to the Government within the paddy producing areas. For this purpose, transference of paddy/rice without permission has been prohibited; therefore, strong regulations have been imposed over rice dealers/rice millers. Anti-smuggling units have been specifically established and engaged in vigil watch and exposé of unauthorized movement in concert with police officers and local government officials.

Rice procurement programme of the Sind Food Dept. has been called the "Voluntary Procurement Scheme of Rice", in which only the attainment of procurement targets has relative importance, leaving room for the discretion of rice dealers or rice millers. However, the authorization from the Provincial Government is also required to purvey milled rice for exports, even in Sind.

Here described are the procedures in practice for rice procurement by the Food Depts. of both the Provinces. The role of the Food Dept. differ slightly between the two Provinces, which are observed in the relationship with the officials of the RECP at the time of inspection. Due to the existence of the Basmati variety, the more strict inspection is imperative in the Punjab Province. Records of paddy location are kept, controlled even at the cultivation stage.

1) Selection of rice procurement centers

In accordance with the procurement target within the District, the District Food Controller selects the rice procurement centers. The most-densely located procurement centers inside the flourishing paddy producing areas number around 20 in one District.

2) Appointment of authorized rice dealers/rice millers

Rice millers/rice dealers who purvey milled rice are appointed with authorization, towards each procurement center. At each Office of the District Food Controller, a detailed list of rice dealers/rice millers is maintained and considering the past dealings of rice supplies, processing capacity, etc., suitable rice dealers/rice millers are selected. The appointed rice dealer/rice miller concludes an agreement with the Office of the District Food Controller, in which the prices and volumes of the rice to be purveyed and the obligation to report the purchased/handled volume of paddy and handled volume of milled rice are specified. To become authorized rice dealers/rice millers, it is required to deposit some amount of money as security.

3) Purchase of paddy and milling

This step is undertaken by authorized rice dealers/rice millers. (Rice millers are mostly also rice dealers). Officials of the Office of the District Food Controllers keep a close watch over the working of rice dealers/rice millers by daily visits within their responsible procurement area to ensure that paddy arrival, quality of

milled rice, etc. are accounted for in the relevant documents submitted from rice dealers/rice millers.

4) *Offer to hand over milled rice and its permission*

Mainly by authorized rice millers, the preparation of milled rice to be procured is informed to the officer in charge of the procurement center. At this time, the Office of District Food Controller supplies ganni (jute) bags for filling rice. These ganni bags are purchased by the Provincial Food Dept. in bulk at the expense of the RECP. The staff at the procurement center, after visual inspection of the stocks, issue disposal orders.

5) Inspection at procurement centers

Procurement centers are usually located at railway stations or at the places convenient for transporting rice to railway stations. At the procurement center, inspection by the RECP (together with an analyst of the Food Dept., in case of Punjab) carries out inspection of rice whether the quality of rice meets requirements of inspection criteria or not. When the differences are observed in quality, such as excessive amounts of foreign matters, some amount is deducted from the fixed procurement price. After the quality and weights are confirmed, a Weight and Quality Certificate is issued. The Certificate requires a seal and signature of both the Inspector of the RECP and the Analyst of the Food Dept., in case of Punjab; however, in the Sind Province, only the signing by the Inspector of the RECP is needed for validity.

6) Transportation of rice to the RECP godowns in Karachi

The procured rice is transported from the procurement centers to the RECP godowns in Karachi. The only permitted transportation means are railway wagons or the NLC trucks. Utilization of private trucks should be permitted by the Office of District Food Controller, specifically.

7) Preparation of bills

The Office of the District Food Controller checks the Weight and Quality Certificate and consigning bills (railway wagon: P.R. Original Receipt, NLC truck: Convoy Note), and only when there is no inconsistency payment bills are issued.

8) Payment of rice price

With the payment bills (in most cases, in the form of cheques) issued from the Office of the District Food Controller, authorized rice millers/rice dealers go to the earmarked bank and receive payment for the rice sold. The bank has been appointed by the State Bank of Pakistan, towards the procurement center. To the account in the earmarked banks, the RECP deposits the necessary funds in advance.

As for the free sale quota (bonus rice) of 25% of produced rice in Punjab, the officer incharge of the procurement center recommends authorized rice dealers/rice millers who have already tendered the target volume, to the District Food Controller, after confirming the attainment. The District Food Controller authorizes them based on recommendations from various purchase centers, and issues transport permits in which admitted sales volumes are specified.

(2) Market administration

In many other countries, the public markets are administered by the Local Governments. However, in Pakistan, the situation is different. Looking at the Local Government Act, 1975 and the revised Provincial Local Government Ordinances, provisions itself might be found:

> "A corporation, municipal committee or town committee may establish and maintain public markets ... The council concerned may, in respect of a public market, provide by by-laws ..... (a) the fees to be charged for the use or for the right to expose food for sale in the market .....

(e) the fees to be charged from brokers, commission agents, weighmen, and other persons practicing their calling therein." (Nevertheless, the Local Governments in the rural areas have no such powers under the similar provisions).

The above provisions in the Local Government Act, however, has not been functioning in practice, as the Provincial Government together with the Market Committees administer the existing regulated markets. (See 3rd part of 3.5.1)

The legal ground to establish the regulated markets is the provisions of the "Agricultural Produce Markets Act, 1939" and its "Rules, 1940". In the Sind Province, the Act has been supplemented, revised and updated several times but the name of the law itself is still being used. Based on the Act, the Punjab Government promulgated a new law, the "Punjab Agricultural Produce Markets Ordinance, 1978" and the "Punjab Agricultural Produce Markets (General) Rules, 1979". The provisions in force in both the Provinces are similar, except for minor differences in detailed items of market fees and license fees. The enforcement agencies of these laws are the Directorate of Agriculture (Economics & Marketing), Agriculture Dept. in Punjab, and the Bureau of Supply and Prices, Industries Dept. in Sind. (Previously stated in 3.5.1) In the Punjab Province, an ex-officio member of the Directorate participates in the Market Committee.

Establishment and control of the regulated markets may be summarized as under:

Purpose of establishment

To regulate and effectuate marketing of agricultural produce, especially to eliminate malpractice and to prevent excessive marketing costs in transaction. (Safeguarding the interests of growers is another important purpose).

Procedure of establishment

Firstly, a survey of areas is undertaken related to marketing volume of agriculture produce, number of

growers, number of intermediaries and buyers, transportation network, built-up marketing facilities, etc. When the requirements are observed in a particular area, the area is declared a "regulated market" by the notification of the Provincial Government.

Area covered by the market

Objective area usually includes one Tehsil, with a well-defined boundary easy to control administratively. The main market covers 3 to 5 miles, extending over the neighbouring villages to the market facilities. In addition to the main market, feeder markets may be established at remote villages and a group of these markets serve one notified area.

Controlling/supervising body

Each regulated market has a Market Committee consisting of representatives of growers, traders and consumers. In most cases, the Chairman of the Market Committee is selected from the growers' representatives to secure their interests. (In case of Punjab, representatives of the Provincial Government participate as ex-officio members). The Market Committees are classified into 3 types, in both the Provinces, according to the scale of the market.

Functions of Market Committee

In order to exercise effective control and supervision, the Market Committee prepares its budget, frames by-laws, defines market practices and fixed/handling charges payable to the various functionaries (traders, commission agents, etc.) of the market. It also issues/revokes functionaries permits, as well as prepares market-related information (daily, weekly, or monthly basis). Weighing methods used by the functionaries are checked by the Market Committee.

Source of funds

The Market Committee, as its source of funds, imposes a market fee on sellers and a license fee on traders and

market functionaries. It may raise loans to apply to expenses of land, buildings and equipment, from the Provincial Government.

Market charges

Specific charges specified in the laws are commissions, weightment, cleaning, bagging, etc. (varing by item of commodities) These are imposed to growers/sellers. The market fee is charged to the wholesaler/commission agents.

Supervision of market operations

Actual supervision is carried out by the enforcement staff comprising the Inspector/Sub-inspector. Enforcement staff, in practice, issue licences, collect market fees and ensure implementation of prescribed market practices. The strength of enforcement staff varies from market to market, according to the work load and scale of market.

Role of the Provincial Government

Daily market operations are controlled by the Market Committee, while the Provincial Government is responsible for notification of market areas, market yards, commodities to be regulated in the market, constitution of the Market Committees, election/nomination of Committee members, sanction of the budget of the Committees and others.

(3) Taxation system levied on paddy/rice

Taxes are imposed on paddy/rice, after it is released from the growers, by the Provincial Government and further by the Local Governments. The following are the identified taxation systems at the post-harvest stage:

Paddy processing tax levied by the Provincial Governments

Belonging to this type of Provincial tax, the "paddy husking tax" (Rs.1.50 per kg) in the Punjab Province,and the "paddy development fee" (Rs.0.30 per 40 kg) in Sind are existent. In case of Punjab, the tax is imposed on rice mill owners, under the provisions of the Punjab Paddy

Husking Tax Rules, 1978. The paddy development fee in Sind, the legal basis of which is not clearly identified, is payable by rice millers or the commission agents. Uniformly levied throughout the Province, these taxes have been collected by the Provincial Excise and Taxation Dept.

Octroi Tax levied by the Municipal Corporation/Committee

Under the provisions of the Local Government Ordinances, the Octroi Tax is imposed on commodities which are brought in beyond the Municipal boundary; so to speak, local import tax. The levied amount alters by commodity and by the Municipality. In case of Larkana, Sind, Octroi Tax for paddy is Rs.0.24 per 40 kg and for rice Rs.0.25 per 40 kg.

Export Tax levied by the District Council

Also under the Local Government Ordinances, imposed on District commodities when they are transported outside District boundaries. In Larkana, Sind, it is Rs.0.20 per 40 kg for paddy and Rs.0.30 per 40 kg. However, the Sheikhupura District Council enforce the system regardless of paddy and rice, which is Rs.10 per truck. The amount differs by the District.

CHAPTER 4 PROBLEMS AND NECESSITY FOR IMPROVEMENTS

CHAPTER 4 PROBLEMS AND NECESSITY FOR IMPROVEMENTS

4.1 Assessment of Loss during Postharvest Operations

4.1.1 Assessment of loss by traditional reaping methods

(1) Definition of losses

Losses can be divided roughly into quantitative and qualitative losses, and losses in each postharvest operation are defined as follows:

Definition of Losses by Various Postharvest Operation Processes

Operation Process	Quantitative Loss
Reaping	Price reduction of milled rice due to deterioration caused by increasing of broken kernels and cracked kernels which occurred by late reaping.
Drying and keeping in paddy fields	Price reduction of milled rice due to deterioration caused by increasing of broken kernels, cracked kernels and damaged kernels which occurred during drying and keeping in paddy field.
Threshing	Price reduction of milled rice due to deterioration caused by increasing of broken kernels, cracked kernels and husked kernels which occurred during threshing.
Cleaning	
Drying	Price reduction of milled rice due to deterioration caused by broken kernels and cracked kernels which occurred during drying.

(2) Selection of paddy fields

Paddy fields were selected from Punjab and Sind Provinces, the major rice harvesting provinces of Pakistan, to assess losses during paddy field work (reaping, temporary storage, threshing, drying, and cleaning).

Three major rice-producing districts were selected from these two provinces as follows:

Punjab Province: Sheikhupura, Gujranwala, and Sialkot

Sind Province: Larkana, Shikarpur, and Jakobabad

Three rice fields out of each district were selected from these six districts, a total of 18 paddy fields, based on the following criteria: Appendix B-2 lists these paddy fields.

1) Farmers who would understand the purpose of this survey and would be sufficiently cooperative.
2) The rice plants of selected field shall be in the best maturity time on the day of survey.
3) Survey equipment could be transported without difficulty.
4) Condition of growth and maturity would be fairly uniform.
5) Size of one plot of rice field would be almost equal to an average size in the regions.
6) Of the three rice fields in Punjab province, one field would be growing IR-6 and the other two fields would be growing Basmati.

(3) Correction of moisture contents and degree of purity of the sample

1) Moisture contents

Unless a special explanation is given, the weights of all rice in this survey are corrected to the standard moisture content of 14% using the following calculation formula:

$$\text{Formula:} \quad Wb = Wa \times \frac{100 - Ma}{100 - 14}$$

Wa = Sample weight
Wb = Corrected weight
Ma = Sample moisture contents

2) Cleaning degree

Paddy samples were segregated by hand if the amounts were small and by specific gravity if the amounts were large before weighing. Degree of immatured kernels and foreign matter is adjusted to 3%.

(4) Assessment method

1) Reaping

a) Before starting harvesting, three 3 m^2 plots would be randomly selected. Rice plants would be reaped carefully in the manner to avoid gleanings and shuttering and would be carefully weighed after threshing to avoid losses before the yield could be calculated.

b) Farmers would reap in their conventional way.

c) After reaping, three other 3 m^2 plots would be selected in the same paddy fields, and all gleanings and shuttered kernels would be picked up from there to measure loss weights.

d) Percentage of loss weights to the yield would be calculated.

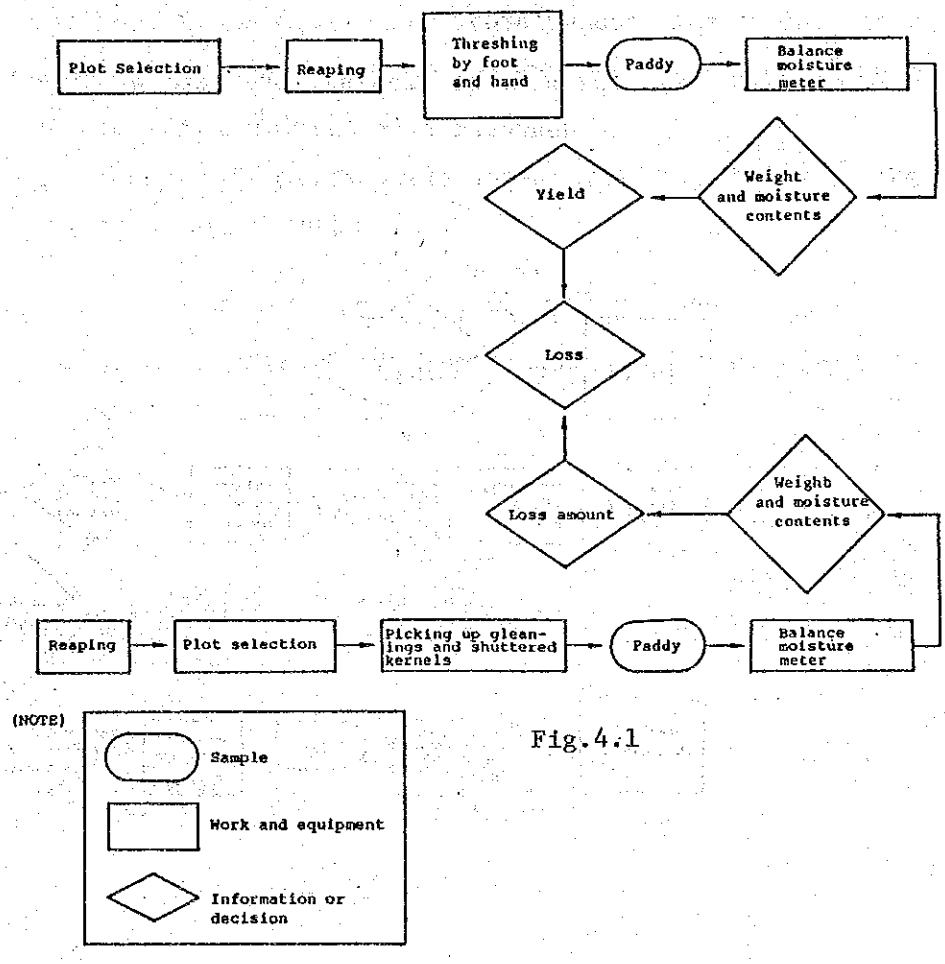

Fig.4.1

2) Drying in paddy fields of Sind Province

a) Three 3 m^2 plots would be selected in paddy fields immediately after drying in the paddy field, and the number of hills and average number of tillers would be calculated.

b) 100 stalk paddy would be randomly picked up after drying and the average weight per ear would be calculated after carefully threshing and weighing in manner to avoid loss.

c) The yield would be calculated based on the number of hills, the average number of tillers, and the average weight per ear.

d) Three 3 m^2 plots would be selected randomly from the same paddy fields and the loss weight would be calculated after picking up all gleanings and shuttered kernels from these plots.

e) The percentage of the yield of loss weight would be calculated.

f) The average reaping loss rate of Sind Province would be deducted from the value obtained in e).

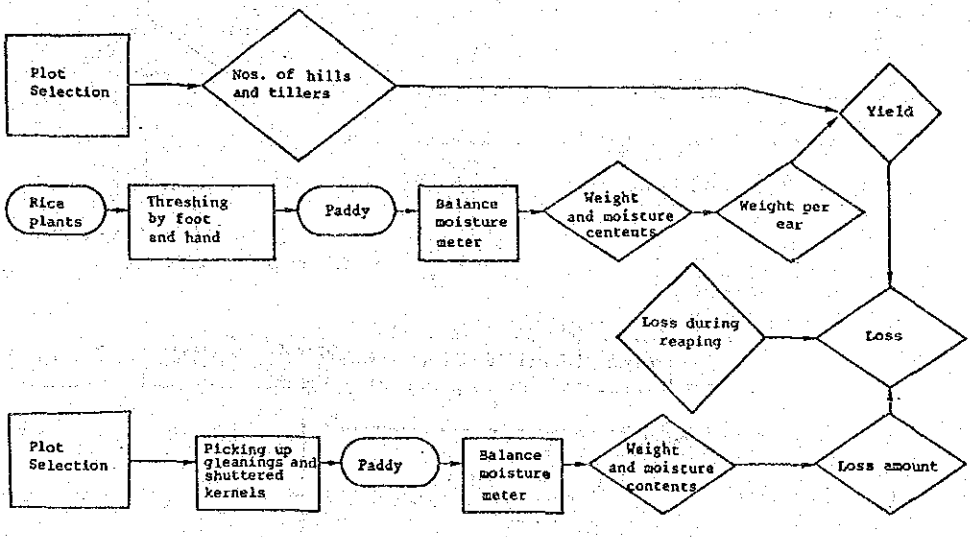

Fig. 4.2

3) Temporary storage (Heaping)

a) The temperature inside heaping (50 to 100 cm inside from outer surfaces) actually made by farmers would be measured in three parts - upper, middle, and lower.

b) Paddy samples would be drawn from the parts measured for temperature in order to measure moisture contents and to examine quality.

4) Threshing by beating

a) A fixed amount of stalk paddy is threshed at the center of a sheet 10 x 10 m and the weight of paddy (T) remaining on the sheeting would be weighed.

b) The weight of paddy scattered outside the sheeting (TL_1) would be weighed.

c) The weight of paddy remaining inside rice straws after threshing (TL_2) would be weighed.

d) Kernels unthreshed and remaining on rice straws after threshing would be rethreshed and the weight of them (TL_3) would be weighed.

e) The loss would be calculated based on the following calculation formula:

$$\text{Formula: } \frac{TL_1 + TL_2 + TL_3}{T + TL_1 + TL_2 + TL_3} \times 100$$

f) The procedure to assess the loss in this stage, is shown in Figure 4.3.

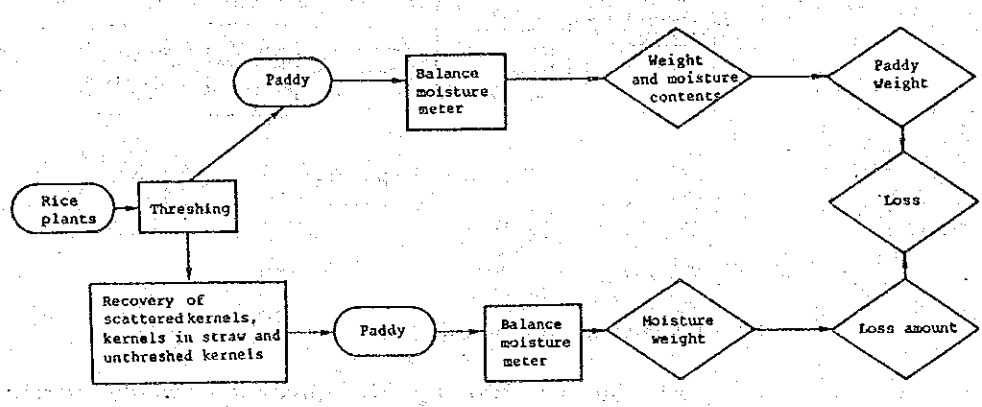

Fig. 4.3

5) Threshing with bullocks

a) Approximately 100 rice plants before threshing would be randomly picked up from the heaping and would be carefully threshed in the manner to avoid unthreshed or scattered kernels. The weights of paddy and of straws would be weighed to calculate the paddy straw ratio.

b) Approximately 100 threshed rice straws after threshed would be randomly picked up and the weights of straws and paddy would be weighed after separating unthreshed kernels and paddy remaining in the straw.

c) The straw weight obtained in b) would be multiplied by the paddy straw ratio to calculate the estimated amount of production.

d) A percentage would be calculated relative to the estimated amount of production of the paddy weight calculated in b) above.

e) The procedure to assess the loss in this stage, is shown in Figure 4.4.

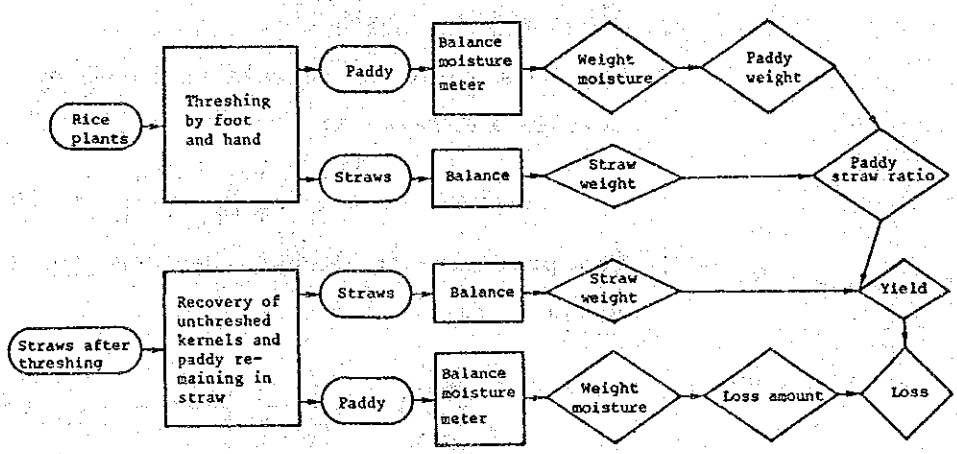

Fig. 4.4

6) Cleaning and grading

a) 50 to 100 kg of threshed paddy would be randomly selected to clean by the conventional way.

b) The paddy weight (c) after cleaning would be weighed.

c) Mature kernels would be recovered from segregated immature kernels, straws, etc., and the weight of them (c') would be weighed.

d) The cleaning loss would be calculated based on the following calculation formula:

$$\text{Formula: } \frac{c'}{c + c'} \times 100$$

e) The procedure to assess the loss in this stage, is shown in Figure 4.5.

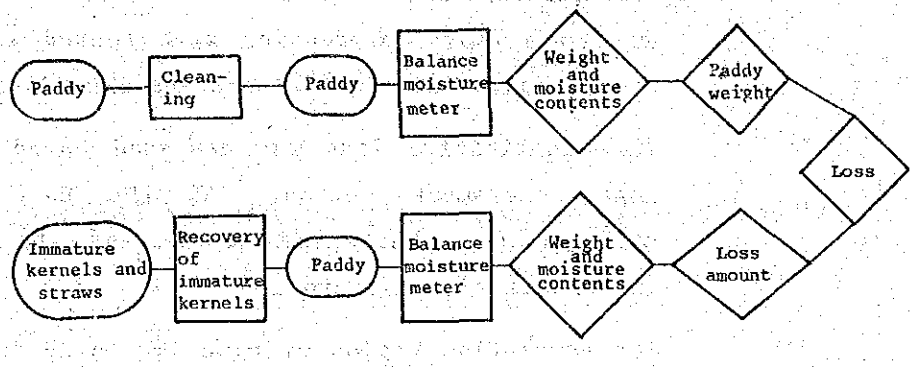

Fig. 4.5

7) Drying

a) Approximately 100 kg of paddy is weighed after threshing and cleaning.

b) Losses during drying, namely, the loss amount due to birds and rodents, as well as the amount scattered during handling, were estimated by observation, and a percentage relative to the weight of paddy before drying would be calculated.

c) The procedure to assess the los in this stage, is shown in Figure 4.6.

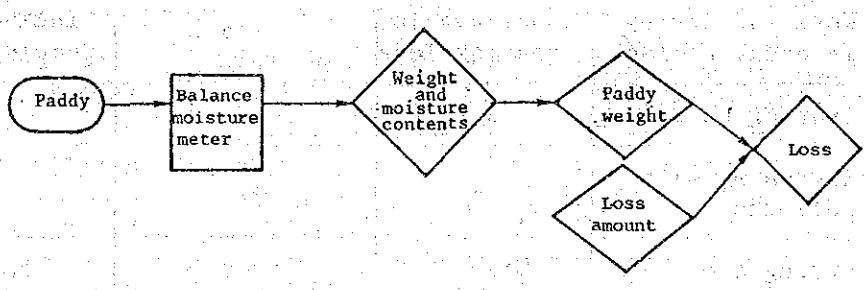

Fig. 4.6

8) Cracked kernels

The cracked-kernel ratios of paddy would be measured immediately after reaping, manual threshing and drying, and after threshing and drying using various methods. Then, the condition of cracked kernel will be surveyed.

9) Comparison of reaping time

The quantitative loss and brown rice quality variations due to a delay in reaping were tested with Basmati 370 every 5 days between the 43rd and 63rd days after heading.

The quantitative loss was assessed based on the reaping loss assessment method. At the same time, tensile strength for shutterine degree and the cracked kernel ratio were also measured.

The generation ratios of blue immature, immature, damaged and colored kernels were measured for brown rice quality.

(5) Results

The following Table 4.1 summarizes the survey results from the 18 paddy fields selected in Sind and Punjab Provinces.

Table 4.1 The Loss during in the Rice Field Work

Province / Work	Sind		Punjab	
	Green Fodder	Paddy Field Drying+Threshing with Bullocks	Basmati	IR-6
Reaping	0.5	0.5	3.5	0.5
Work and drying in paddy fields	Included in reaping loss	1.9	Included in reaping loss	Included in reaping loss
Beating threshing	3.7	-	2.9	4.2
Threshing with bullocks	-	5.7	-	-
Drying and cleaning	Trace - 0.1	Trace - 0.1	Trace - 0.1	Trace - 0.1
Total	4.3	8.2	6.0	4.8

1) Reaping

Due to the nature of the loss assessment method, shuttered kernels before and during reaping and during paddy field work after reaping cannot be clearly divided, therefore the losses during reaping mentioned in this section include all losses.

The Tables below 4.2, 4.3 and 4.4 present reaping losses of the paddy fields surveyed in the two provinces.

Table 4.2 The Loss in Reaping Work

in Sind Province

Paddy Field	Variety	Yield(kg/ha)	Loss Amount(kg/ha)	Loss(%)
Larkana-1	IR-6	6,272.2	46.5	0.7
" -2	IR-6	5,148.1	22.0	0.4
" -3	DR-83	5,051.2	4.8	0.1
Shikarpur-1	DR-83	6,839.1	48.0	0.7
" -2	IR-6	6,888.9	37.0	0.5
" -3	IR-6	6,226.0	18.0	0.3
Jakobabad-1	IR-6	6,777.6	24.2	0.4
" -2	IR-6	5,986.6	55.7	0.9
" -3	IR-6	6,773.5	25.3	0.4
Average				0.5

Table 4.3 The Loss in the Reaping Work

IR-6 in Punjab Province

Paddy Field	Yield (kg/ha)	Loss Amount (kg/ha)	Loss (%)	No. of days for Drying inside Paddy Field(days)
Sialkot-1	3,777.0	19.7	0.5	0
Gujranwala-1	3,312.7	27.7	0.8	2
Sheikhupura-1	4,219.9	10.0	0.2	1
Average			0.5	

Table 4.4 The Loss in Reaping Work

Basmati 370 in Punjab Province

Paddy Field	Yield (kg/ha)	Loss Amount (kg/ha)	Loss (%)	Lodging Degree (%)
Sialkot-2	925.0	73.2	7.9	30
" -3	3,560.6	53.4	1.5	<10
Gujranwala-2	3,258.2	42.4	1.3	<10
" -3	2,606.1	96.7	3.7	70
Sheikhupura-2	3,498.9	80.8	2.3	>90
" -3	3,642.2	49.2	1.4	70
Average			3.0	

Due to the survey schedule, the survey in Sind Province was limited to rice plants reaped for green fodder. The reaping loss averaged 0.5% in Sind Province.

The average values for IR-6 and Basmati in Punjab Province were 0.5 and 3.0%, respectively.

Both provinces coincidently showed the same values in the loss ratio of IR-6. This indicates that nearly no losses are generated during drying inside paddy fields for short periods of time. According to the results of a previous survey by the FAO, the loss occurring of paddy field drying in 5 days in Punjab Province was 0.28% with IR-6 and 0.15% with Basmati.

Compared with IR-6, the loss ratio for Basmati is very large. This can be explained by the easy threshability and low lodging resistance of Basmati compared with IR-6. Lodged rice plants are difficult to be reaped and the ears are easily treaded on during reaping, increasing the factors which cause losses. In fact, the survey also showed that paddy fields had large losses the higher the lodging degree was.

As mentioned earlier, this survey included losses generated by work inside the paddy field after harvesting in reaping losses. According to our observations, a large

loss during reaping occurred during work in the paddy field after harvesting, and losses by shuttering before and during reaping are considerably lower than those shown in the table. Losses due to work inside the paddy field after harvesting are estimated to be 0.2 to 0.3% for IR-6 and approximately 0.5% for Basmati.

2) Drying in the paddy field in Sind Province

A long time passes from drying in the paddy field till heaping, anywhere from 7 to 10 days. Loss generation during this period was surveyed. Rice plant reaping and drying periods in paddy fields till heaping differed greatly from one farmer to another, and it was not possible to efficiently assess drying losses in the nine paddy fields mentioned earlier. For this reason, loss assessment was made in only three random paddy fields which were heaping rice plants in Larkana Province by coincidence on the survey day.

The results is shown in Table 4.5.

Table 4.5 The Loss during Drying in the Rice Field in Sind Province

Paddy Field	Yield (kg/ha)	Loss Amount (kg/ha)	Loss (%)	Loss (0.5%)	No. of days for Drying in the Paddy Field(days)
A	4,285	141.7	3.3	2.8	10
B	5,867	159.0	2.7	2.2	12
C	6,386	85.7	1.3	0.8	7
Average			2.4	1.9	

According to the survey, the losses during this period averaged 1.9%. An FAO survey showed the drying loss in the paddy field for 10 days in Sind Province to be 0.93%.

After drying, rice plants are carried from paddy fields to designated places for heaping. Before being carried, rice plants are bundled in large bundles at the paddy fields. During this bundling a large amount of paddy grain is inadvertendly lost as naturally dried rice easily falls

off the stalk when it receives any kind of shock. This is the largest cause for losses.

3) Temporary storage (Heaping)

The following table presents measurements of temperature and moisture of paddy during heaping.

The time gap between reaping time and heaping is large, and this survey was also made in six random places other than the nine paddy fields mentioned earlier.

Both temperature and humidity of air showed below critical storage condition, and deterioration in quality of paddy inside temporary storage places did not seem to occur. In fact, samples of paddy showed no heat generation or offensive odor. They showed no defects in appearance either. The farmers heap dried stalks paddy as shown in Figure 4.7 considering that rice plants are not affected by the external environment during storage.

Table 4.6 The Temperature and Moisture Contents of Paddy during the Heaping

No.	Size (m)		Temperature(°C)			Unhulled Rice Moisture Content(%)			Days after Marking (Days)	External Temperature (°C)	External Humidity (%)
	Diameter	Height	High	Medium	Low	High	Medium	Low			
1	9.80	3.05	22.3	23.9	24.3	15.0	15.6	-	10	23.0	75.0
2	9.20	2.65	27.0	30.0	27.3	14.0	12.4	15.3	10	28.0	52.0
3	10.50	2.25	31.0	28.9	27.7	16.0	15.5	13.3	10	29.5	50.0
4	12.50	3.05	28.2	26.3	24.5	12.1	13.2	14.5	15	26.5	56.0
5	8.10	2.70	25.2	26.6	25.5	14.6	13.5	14.0	15	26.0	58.0
6	6.90	2.70	29.8	28.9	29.9	13.5	15.5	13.5	20	30.0	45.0

* Stalk paddy is randomly filled inside after firmly tightening the outside and lower part so that ears are placed inside.

Fig. 4.7 Heaping

However, according to an FAO report, the ratio of broken kernels to milled rice due to heaping increased the longer the heaping period was. It was assumed that many cracked kernels were produced during heaping. However, as far as our survey shows, the generation ratio of cracked kernels is not very high.

Loss assessment by test was made with quantitative losses during heaping. Compared with other Southeast Asian countries, the number of rodent holes around rice fields is less, and damage by birds is considered nearly nill judging due to the heaping method. Therefore, quantitative losses were estimated to be negligible.

4) Beating threshing

Losses during beating threshing in Sind and Punjab Provinces are shown in Tables 4.7, 4.8 and 4.9.

Table 4.7 Loss by Beating Threshing

in Sind Province (%)

Paddy Field	Scattering	Loose Grains	Unthreshed	Total
Larkana-1	Trace	0.4	2.2	2.6
" -2	Trace	0.4	1.8	2.2
" -3	Trace	0.6	13.3	13.9
Shikarpur-1	Trace	0.2	3.9	4.1
" -2	Trace	0.2	0.5	0.7
" -3	Trace	0.7	3.8	4.5
Jakobabad-1	Trace	Trace	0.9	0.9
" -2	Trace	0.1	1.2	1.3
" -3	Trace	0.2	3.3	3.5
Average	Trace	0.3	3.4	3.7

Table 4.8 Loss by Beating Threshing

IR-6 in Punjab Province (%)

Paddy Field	Scattering	Loose Grains	Unthreshed	Total
Sialkot-1	Trace	0.2	3.9	4.1
Gujranwala-1	0.2	1.0	3.2	4.4
Sheikhupura-1	Trace	2.0	2.1	4.1
Average	0.1	1.1	3.0	4.2

Table 4.9 Loss by Beating Threshing

Basmati in Punjab Province (%)

Paddy Field	Scattering	Loose Grains	Unthreshed	Total
Sialkoct-2	0.2	0.2	1.4	1.8
" -3	0.1	0.2	1.3	1.6
Gujranwala-2	Trace	0.2	0.6	0.8
" -3	0.2	0.5	2.6	3.3
Sheikhupura-2	0.2	0.6	7.4	8.2
" -3	0.3	0.2	0.9	1.4
Average	0.2	0.3	2.4	2.9

Only trace amounts due to scattering in Sind Province were found. This is because the threshing places of the farmers surveyed were wide areas of 10 x 10 m or larger. The paddy field Larkana 3 had very large unthreshed stalk paddy. This is because many immature kernels are contained due to earlier reaping.

Compared with IR-6, losses with Basmati were smaller, which is contrary to the loss survey during reaping. This can be explained by the difference in the threshability among various varieties.

In Punjab Province, people living nearby were recovering straws after threshing. Some threshing losses are recovered this way.

5) Threshing with bullocks

As in the survey of drying and heaping in rice fields, the time gap between reaping and threshing with bullocks is also large. Threshing time differed greatly from one farmer to another. Due to time limitations, surveying the above-mentioned nine paddy fields was given up, and losses were assessed in five paddy fields which were randomly selected. The assessment results are shown in Table 4.10.

Table 4.10 Loss by Bullock Threshing

	1	2	3	4	5	Average
Loss(%)	2.7	8.2	3.3	5.7	8.6	5.7

In spite of labor-intensive work by farmers, losses due to unthreshing showed a high value, 5.7% on average.

6) Drying and cleaning

As mentioned in the section for actual conditions of work, there is nearly no drying or cleaning of paddy in rice producing areas of Pakistan. Loss assessments were made for drying and cleaning work of several farmers for rice to be consumed by them. Nearly no losses occurred, and assessment values were trace to 0.1% in all cases.

7) Cracked kernels

Cracked kernels occurred in the 18 paddy fields as shown in Table 4.11.

Table 4.11 Acquiring of the Cracked Kernels

in Sind Province (%)

	Manual Threshing Immediately After Reaping	Manual Threshing + Drying	Beating Threshing + Drying
Larkana-1	3.0	7.5	9.1
" -2	4.0	12.0	13.9
" -3	1.3	7.2	5.7
Shikarpur-1	1.3	15.4	14.8
" -2	2.0	7.1	9.9
" -3	6.0	9.1	11.6
Jakobabad-1	3.3	7.3	9.1
" -2	5.3	12.9	14.2
" -3	3.1	9.3	6.5
Average	3.1	9.3	10.5

in Punjab Province (%)

	Manual Threshing Immediately After Reaping	Manual Threshing + Drying	Beating Threshing + Drying
Sialkot-1	26.0	22.6	24.2
" -2	3.3	5.8	6.9
" -3	6.0	5.0	9.1
Gujranwala-1	9.3	15.9	19.1
" -2	6.0	6.0	6.7
" -3	5.3	5.9	10.0
Sheikhupura-1	4.7	10.9	9.4
" -2	4.0	7.1	7.8
" -3	6.0	5.4	6.1
Average	7.8	9.4	11.0

There is a great difference in the generation ratios of cracked kernels in these two provisions immediately after reaping. This may be explained by the fact that the survey in Sind Province covered of the purpose to green fodder rice, which tended to be reaped early, whereas the survey in Punjab Province covered rice which tended to be reaped late.

However, paddy manually threshed and sun dried had high cracked kernel ratios of 9.3 and 9.4% for these two provinces. Sun drying offsets the effect of reaping early to obtain paddy with few cracked kernels.

The differences between manual and threshing done by the study team beating threshing in these two provinces were 1.2 and 1.6%. Assuming that these differences were not caused entirely by impacts during beating threshing, cracked kernels due to beating threshing are estimated to be approximately 1%.

Generation ratios of cracked kernels with samples of paddy during heaping and after threshing with bullocks were measured, and the results are shown in Table 4.12.

Table 4-12 Acquiring of the Cracked Kernel by Bullock Threshing after Heaping

Work \ No.	1	2	3	Average
Heaping	32.3	30.5	37.6	33.5
Threshing with Bullocks	42.8	45.0	43.9	43.9

The samples were randomly obtained from the heaps, and there is no interconnection among the samples by sample Nos. Therefore, it is not natural to discuss generation conditions of cracked kernel ratios based on these values. More cracked kernels are estimated to occur due to a rapid increase in cracked kernels during drying in paddy fields before heaping and to threshing by bullocks thereafter.

An FAO survey shows that broken kernels occurs approximately 7% more if paddy is milled 10 days after reaping at an appropriate time, compared with milling paddy immediately after reaping. The broken kernels generation ratio of paddy threshed with bullocks and paddy threshed by a machine is approximately 3% after heaping stalk paddy six weeks. These results verify the foregoing assumptions.

8) Loss survey by reaping time

A survey was made every 5 days beginning with the 43rd day after heading (one week after suitable reaping period). Figure 4.8 shows losses during reaping increased the later the rice was harvested. Parallel with this trend, the shuttering tensile strength lowered. The shuttering tensile strength lowered prominently particularly between the 48th and 53rd days after heading. Reaping losses rapidly increase at different times, instead of gradually increasing at a fixed rate as reaping is delayed, even though there is a suitable period for each variety and for growing conditions.

Figure 4.9 shows variations in brown rice quality. Test values of the cracked kernel generation ratio, which directly relate to broken rice during milling, greatly fluctuated, and increased the longer the delay in reaping was. Damaged and discolored kernels showed only a slight increase with the exception of cracked kernels. Immature rice decreases the longer the harvesting delay was.

The FAO, as well as rice research institutes of both Sind and Punjab Provinces are also studying loss generation due to reaping time. Except for the FAO report that the reaping loss increase due to delayed harvesting times is not prominent, all other reports mention that the reaping loss increases as the harvesting time becomes delayed and that the broken rice generation ratio of milled rice thus obtained also increases.

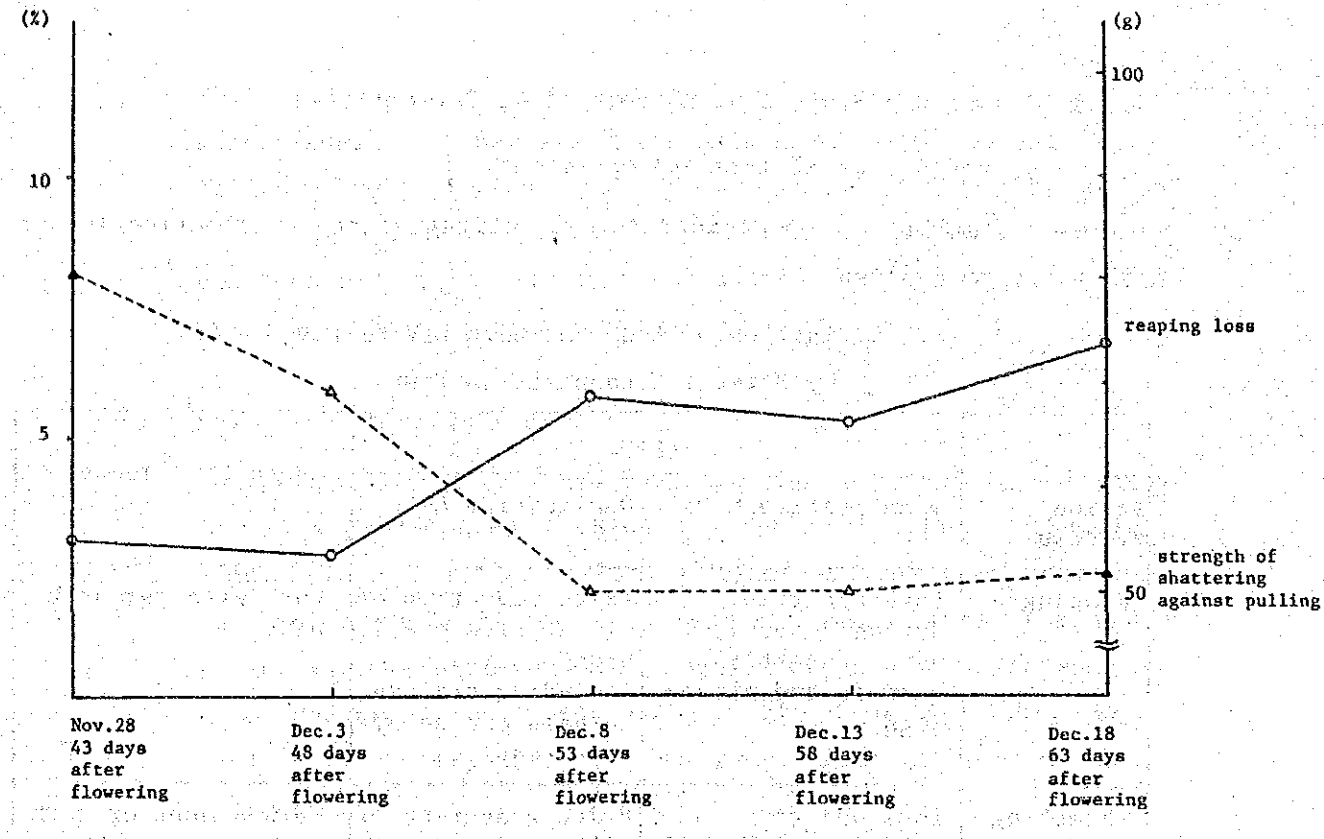

Fig. 4.8 Loss by Different Harvesting Time

(Basmati 370)

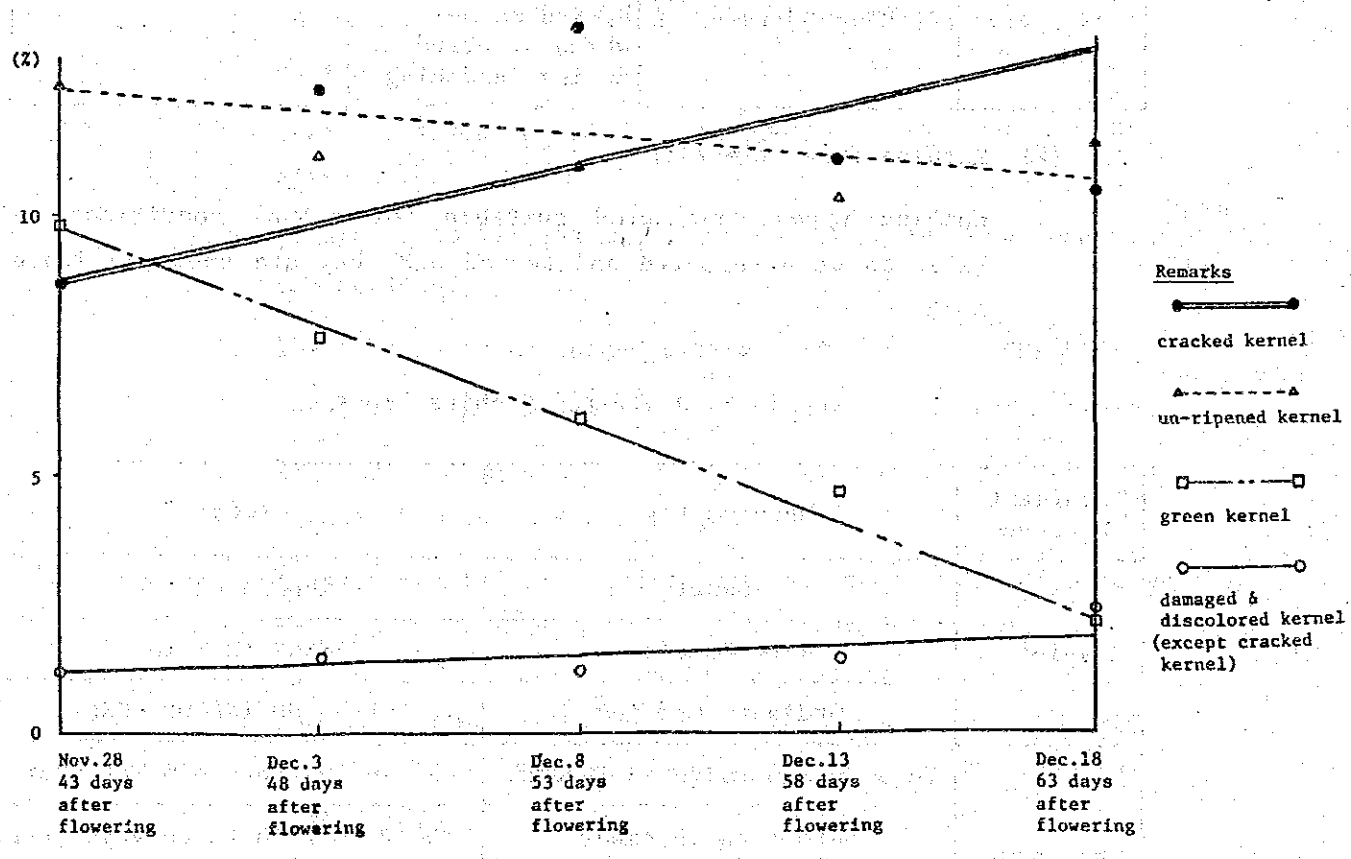

Fig. 4.9 Brown Rice Quality by Different Time

(Basmati 370)

4.1.2 Assessment of loss by harvest mechanization

(1) Definition of loss and efficiency

Losses can be divided into quantitative and qualitative losses as follows:

Definition of Loss and Work Efficiency by Harvest Mechanization Tests

Operation Process	Loss		Work Efficiency
	Quantitative Loss	Qualitative Loss	
Reaping	Loss occurring during reaping, namely shattering kernels and gleanings	Price reduction of milled rice due to broken kernels including cracked kernels caused by late reaping.	Work area per unit hour
Threshing	Loss due to scattering of paddy during threshing, paddy remaining on the stalk and unthreshed paddy	Price reduction of milled rice due to broken kernels, including cracked kernels, and husked kernels which occurred during threshing	Work amount or work area per unit hour

(2) Machine type selection

Machine types considered suitable for actual conditions in Pakistan were selected and tested and they are shown in Table 4-13.

Table 4.13 Tested Machine Types

Treatment Process	Machine type	Model
Reaping	Reaper	KUBOTA AR120
	Auto Combine	YANMAR TC 2710 EX
	Ordinary Combine	CLASS DOMINATOR 68RP
Threshing	Locally-Manufactured Thresher	Axial-flow throw-in Thresher
	Auto-feed Thresher	YANMAR TC 2710 EX Conveyor type
	Auto Combine	YANMAR TC 2710 EX
	Ordinary Combine	CLASS DOMINATOR 68RP

The specifications of reaper auto combine and locally-manufactured thresher are shown in Appendix C-32, 33 and 34. An auto-feed thresher could not be obtained locally, and a YANMAR auto combine TC2710 EX was used in the test. Ordinary combines were partially surveyed after they were provided to a private harvesting contractor for use.

(3) Selection of paddy fields

The cultivation system had regional characteristics, and paddy fields were selected in Sind and Punjab Provinces. However, problems occurred with loaning machines and transportation. Therefore, paddy fields were selected mainly from the paddy fields of the Rice Research Institute, Dokri (Sind) and the Rice Research Institute, Kala Shah Kaku (Punjab), which implemented the paddy fields survey based on the following criteria:

1) The paddy field custodians would understand the purposes of this test and would cooperate fully.
2) The survey day would be during the suitable reaping period.
3) Test machines could be transported and moved without difficulty.
4) Growth would be uniform, and harvest would be average for the regions.
5) There would be no lodged rice plants. (for reaper test)
6) Paddy field plots would be an average size for the region.
7) Samples consisted of IR-6 for Sind Province and IR-6 and Basmati 370 in Punjab Province.
8) Locally-manufactured axial-flow threshers were considered not to be capable of threshing high-moisture content samples and were used to thresh only low-moisture content samples. Due to the survey schedule, auto-feed threshers were used to thresh only high-moisture content samples of Basmati 370.

The places of experiment for thresher are shown in Table 4.14.

Table 4.14 The Places of Experiment for Thresher

Item / Machine	Location	Sample	Remarks
Reaper	Klalashahkaku, Sheikhupura, Punjab	Basmati 370	R.R.I. paddy fields
Locally-made Thresher	Dokri, Larkara, Sind	IR-6 (Low-moisture content)	R.R.I. paddy fields
Locally-made Thresher	Khot, Gujranwala, Punjab	IR-6 (Low-moisture content)	Farmer paddy field
Locally-made Thresher	Klalashahkaku, Sheikhupura, Punjab	Basmati 370 (Low-moisture content)	R.R.I. paddy fields
Auto-Feed Thresher	Klalashahkaku, Sheikhupura, Punjab	Basmati 370 (Low-moisture content)	R.R.I. paddy fields
Head Feed Combine	Klalashahkaku, Sheikhupura, Punjab	Basmati 370 (High-moisture content)	R.R.I. paddy fields
Conventional Combine	Daska, Sialkot, Punjab	Basmati 370	Farmer paddy field

(4) The contents of moisture contents and degree of cleaning of the samples are the same as in 4.1.1.(3)

(5) Assessment method

1) Reaping

a) Three 3 m^2 plots were randomly selected before harvesting, and rice plants were carefully reaped to avoid gleanings and shuttered kernels. After carefully threshing and weighing so as not to cause losses the yield would be calculated.

b) Test operation would be made outside the selected plots.

c) Reaping for the plots would be made in standard operations suiting the conditions of paddy fields and crops.

d) Required time would be measured to calculate work area per unit hour.

e) In reaping work, three 3 m^2 plots other than those in a) above would be selected in the same paddy field after reaping and all gleanings and shuttered kernels would be picked up in these plots to determine loss weights.

f) A percentage relative to the yield of loss weight would be calculated.

g) The procedure to assess the loss in this stage, is shown in Figure 4.10.

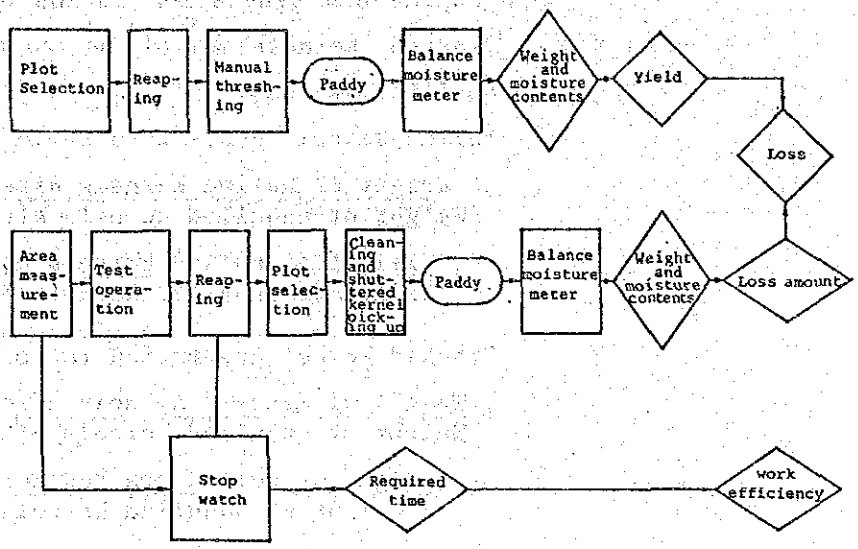

Fig. 4.10

2) Threshing

a) Threshers would be tested by spreading rice plants of a fixed amount on a 10 x 10 m sheet. Auto and ordinary combines would harvest a fixed area while recovering straw and dust ejected from outlets in the rear of the machines by using a 3 x 3 m sheet.

b) In measuring the work efficiency, threshers would be operated continuously for a fixed duration, and auto and ordinary combines would harvest one plot.

c) The amount of paddy (T) discharged by the first outlet would be measured.

d) The amount of paddy (TL_1) scattered through the third outlet would be measured.

e) The amount of paddy (TL_2) of loose kernels remaining in rice straws would be measured.

f) The amount of unthreshed kernels (TL_3) remaining with rice straws would be measured.

g) The quantitative loss would be calculated based on the following formula:

$$\frac{TL_1 + TL_2 + TL_3}{T + TL_1 + TL_2 + TL_3} \times 100$$

h) Unhulled rice before and after threshing would be sampled and generation ratios of hulled kernels and cracked kernels would be calculated to obtain a qualitative loss.

° Hulled kernels generation ratio =

$$\left(\frac{\text{Weight of hulled kernels after threshing}}{\text{Weight of unhulled kernels after threshing}} \times 100\right) - \left(\frac{\text{Weight of hulled kernels before threshing}}{\text{Weight of unhulled kernels before threshing}} \times 100\right)$$

° Cracked kernel generation ratio =

$$\left(\frac{\text{Weight of cracked kernels after threshing}}{\text{Weight of unhulled kernels after threshing}} \times 100\right) - \left(\frac{\text{Weight of hulled cracked kernels before threshing}}{\text{Weight of unhulled kernels before threshing}} \times 100\right)$$

i) The required work hours for a fixed amount or for a plot would be measured to calculate work hours per unit hour.

j) The procedure to assess the loss in this stage, is shown in Figure 4.11.

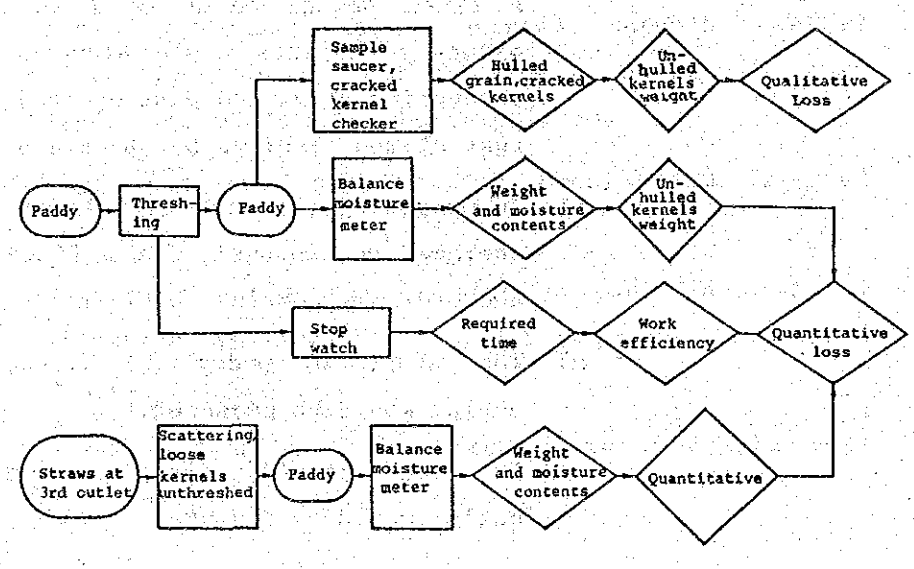

Fig.4-11

(6) Results

The losses acquiring from machine works and conventional works are shown in Table 4.15.

It is recognized from the above table that the mechanization works enable not only to speed up the threshing stage about also to minimize the loss occurring in the stage.

Table 4.15 Harvesting Losses and Capacities of Different Methods

item				method	sickle	reaper	manual threshing	bullok threshing	local thresher	auto thresher	auto combine	combine
Losses	quantity losses (%)	reaping			3.0	0.3	-	-	-	-	1.1	< 0.3
		collecting and transporting			-	-	0.5	1.9	0.5	0.5	-	-
		threshing	scatter		-	-	0.2	0.1	1.3	1.1	1.1	< 1.0
			remaining in the straw		-	-	0.3	Trace	0.3			
			un-threshed		-	-	2.4	5.7	0.2	1.8	1.8	
		Total			3.0	0.3	3.4	7.7	2.3	3.4	4.0	< 1.3
	quality losses(%)	threshing	unhusked		-	-	Trace	0.2	0.3	0.5	0.5	2.2
			increasing * ratio of cracked kernels		-	-	1.6	5.5	7.6	4.1	4.1	3.0
capacity		number of manpower			8	2	8	3 persons + 4 bulloks	6	5	2	2
		capacities(ha/hour)			0.14	0.27	0.14	0.06	0.25	0.23	0.11	0.92

* This means that how many percentages of the cracked paddy increases by threshing work only. These cracked paddy wouldn't be broken all in the milling stage, but most of them will break.

° This table's figures are shown in the case of Basmati 370 except bullok threshing to understand the differences easily.

° Average field size is 0.2 ha which is the standard in Pakistan.

Table 4.16 Estimated Annual Working Area by Machine

Item / Unit / Machine	Working Capacity					Working Capacity per Day				Annual Working Days			(I)x(L)
	Theoritical Working Capacity			Effi-ciency	(C)x(D)	Working Hours			(E)x(H)	Theoriti-cal Work-ing Days	Workable Day Ratio	(J)x(K)	
	Reaping Width (A)	Reaping Speed (B)	Working Capacity (C)	(D)	(E)	Working Hours (F)	Effi-ciency (G)	(F)x(G) (H)	(I)	(J)	(K)	(L)	
	m	km/hr	ha/hr	%	ha/hr	hr	%	hr	ha/hr	day	%	day	ha
Reaper	1.1	3.5	0.38	65	0.25	8	85	6.8	1.70	40	95	38	64.4
Auto Combine	1.25	1.3	0.16	65	0.10	8	80	6.4	0.64	40	95	38	24.3
Ordinary Combine	4.0	3.5	1.40	55	0.77	8	70	5.6	4.31	40	95	38	163.8
Local Thresher	-	-	-	-	0.25	8	80	6.4	1.60	40	95	38	60.8
Auto Thresher	-	-	-	-	0.23	8	80	6.4	1.47	40	95	38	55.9

Remarks: 1) Estimation has been done in case of paddy harvesting only.

2) Dimension of the field is assumed to be 30m x 100m in the estimation.

The size of one field is not so large, about 0.2 ha, because of unskilled levelling technic in Pakistan. The ratio of length to width is small, therefore, the working efficiency of ordinary combine is reduced in 26 - 51%. In order to upgrade 70% of the working efficiency of combine, the combinations of shape of rice field shall be as followings:

30m x 210m, 0.63 Ha.
40m x 190m, 0.76 Ha.
50m x 150m, 0.75 Ha.

Source: The Study Team

4.1.3 The assessment of losses in rice milling process

Based on the following test program, the study team planned to assess losses occurring in the rice milling process, and this program was enforced.

(1) Study test program

1) In assessing losses occurring in the husking and rice milling processes. The definition of losses in stage of rice milling shall be the difference between the milling recovery and rate of generation of the broken kernels from the standard milling method and those from existing rice mills.

2) Standard milling recovery and quality were obtained by standard husking and rice milling equipment every time the test was conducted. Machines used for this purpose were high-performance test husker (with paddy separator, testing whitener (abrasive type and friction type) and a rice grader.

3) According to the general classification in Pakistan, the existing rice-milling facilities were classified into Hullers, Shellers and Modern mills.

4) Paddy used for this test was IRRI variety and Basmati variety.

5) The quantity of samples tested by an existing factory was 1,000 kg per test and the quantity of samples tested by a standard husking and whitening machine was 100 kg.

6) Each test was repeated three times.

7) Weight was measured and the quality of milled rice samples was analyzed.

Note:

° The best method and condition of machine and handling in order to obtained the standard milling recovery and rate of broken kernels, shall be set by the preliminary test, then the standard rice milling shall be established.

° The standard milling degree

The standard milling degree has been decided based on the average milling degree in Pakistan.

(2) Testing

1) The method of assessing losses

As described in the Study Test Program, machines used for this test were those possessed by the existing mills and those brought there by the study team. Machines brought by the study team were the commercial machines of minimum scale but not testing type. The material paddy of the same quality was given to those machines to compare quality (such as total milling recovery and cracked rice occurring rate). Six mills were selected in both the Sind and Punjab Provinces, 12 in all. As shown in Appendix B-3, the related rice mills for these tests were: four hullers, four shellers and four semi-modern type mills which used rubber-roll type huskers.

2) Survey result

Table 4.17 shows the results of these tests. Since varieties and quality of paddy (such as solidity of kernels and foreign matter), milling degree differ between mills, it is difficult to compare directly the results of milling recovery the yield and cracked rice kernels of one mill with another. Therefore, we compared the performance of one mill with that of another on the assumption that the above-mentioned conditions are the same. Table 4.18 shows the results.

Table 4.17 Comparison Experiment of Milling Between Existing Rice Mills and Testing Machines in Sind and Punjab

(percent)

Code No.	Supplied Paddy		Existing Rice Mill							Testing Machines							Difference	
	Variety	MC	General Classification	Husking Recovery of paddy base	Total Recovery of paddy base (A)	Head (B)	Broken	Tip	Milling (whiteness) Degree	Husking Recovery of paddy base	Milling Recovery of brown-rice base	Total Recovery of paddy base (C)	Head (D)	Broken	Tip	Milling (whiteness) Degree	Total Recovery (A) - (C)	Head (B) - (D)
S - 1	IR-6	9.9	Huller	-	68.9	57.3	42.7	-	34.5	77.9	91.7	71.4	76.8	23.2	-	34.0	-2.5	-19.5
S - 2	IR-6	9.9	Huller	-	63.8	57.7	42.3	-	36.2	77.9	91.4	71.2	75.1	24.9	0.4	36.4	-7.4	-17.4
S - 3	IR-6	13.4	Semi-Modern	-	63.7	77.0	22.3	0.7	43.1	74.1	87.4	64.8	80.1	19.8	0.1	44.1	-1.1	- 3.1
S - 4	IR-6	12.4	Semi-Modern	-	66.7	74.2	24.7	1.1	45.5	78.6	88.4	69.5	81.1	18.7	0.2	45.6	-2.8	- 6.9
S - 5	IR-6	13.0	Sheller	-	62.6	81.4	17.6	1.0	45.0	75.4	87.5	66.0	80.4	19.5	0.1	46.0	-3.4	1.0
S - 6	IR-6	13.6	Sheller	-	61.8	75.8	22.5	1.7	44.6	76.3	88.0	67.1	84.8	15.1	0.1	43.8	-5.3	- 9.0
P - 1	Basmati 370	13.0	Huller	-	59.0	32.3	66.3	1.4	34.3	76.1	89.7	68.3	66.5	33.2	0.3	37.3	-9.3	-34.2
P - 2	Basmati 370	9.2	Huller	-	68.9	70.4	28.5	1.1	36.2	76.8	92.3	70.9	84.5	15.4	0.1	33.7	-2.0	-14.1
P - 3	KS-282	10.1	Sheller	-	63.4	76.9	20.8	1.7	33.9	74.4	90.5	67.3	71.1	28.7	0.2	32.5	-3.9	5.8
P - 4	Basmati 370	14.9	Sheller	76.6	68.2	82.4	16.2	1.3	30.5	76.5	90.7	69.4	82.3	17.5	0.2	31.8	-1.2	0.1
P - 5	IR-6	13.1	Semi-Modern	-	67.8	75.2	24.0	0.8	35.1	75.8	91.1	69.1	73.8	25.8	0.4	38.3	-1.3	1.4
P - 6	Basmati 370	13.5	Semi-Modern	-	70.4	73.4	24.1	2.2	33.9	77.1	90.3	69.6	83.0	16.8	0.2	34.6	0.8	- 9.3

Note: 1. Same quality of paddy was fed to both existing rice mill and testing machines.

2. 3 replications of the test for existing rice mill.

3. Head, broken and tip are showed as the percentage in the milled rice.

4. Milling degrees by the testing machines were adjusted to the degree by existing rice mill in order to get the close level as much as possible by using the whiteness meter (Kett C - 300).

5. Testing machines are consisted of the following,
   - Rubber roll (2 1/2") husker with paddy separator
   - Abrasive type milling machine (2 hp)
   - Friction type milling machine (2 hp)

Source: The Study Team

Table 4.18 The Efficiency in Each Type of Mill

The classification of Mills	Existing Rice-cleaning Equipment		Testing Machines	
	Total Yield	Occurrence of Cracked Grains	Total Yield	Occurrence of Cracked Grains
Huller	59 - 63%	30 - 40%	66 - 69%	15 - 25%
Sheller	63 - 67%	25 - 35%	"	"
Semi-modern	64 - 68%	20 - 30%	"	"

As seen from this table, the performance of the test machine set is not considered to be best as the test machine set, because there are some difficulties to design it as the almost smallest commercial milling machine, however, that the testing machine is superior to the existing machine, which means that there still remains room for machinery and technical improvement. Difference in the results are shown in the Table 4.19 for this purpose.

Table 4.19 The Possibility of Improvement in the Existing Rice Mill

The Classification of Mills	Increase in Total Yield	Decrease in the Occurrence of Cracked Grains
Huller	6 - 8%	15%
Sheller	2 - 3	10
Semi-modern	1 - 2	5
Modern	<1	<5

(3) Test for comparing the performance of an under-runner sheller with that of a rubber-roll sheller

1) The purpose of the test

The performance of an under-runner sheller was compared with that of a rubber-roll sheller in terms of husked kernels rate, cracked kernels occurring rate, and brown rice recovery. This comparison aims at recognizing the validity of replacing the old under-runner sheller with the rubber-roll sheller.

2) Testing method

Materials supplied from the same tank are husked by the two kinds of machines to measure the difference in the hulled kernels and the cracked kernels occurrence rate.

In addition, weight of paddy and brown rice is measured to obtain the difference in the brown rice recovery.

3) Test results

Test 1

December 14, 1985

Place: Mirza Ihsam Rice Mill, Gujranwala

The quality of material paddy

Variety: Basmati 370

Red kernel mixing rate : 1.8%

Paddy moisture contents: 13.2%

Cracked kernel rate : 16.5%

Immature kernel mixing rate: 1.9%

Dried paddy weight: 20.0g

The ate of cleaning paddy: 99.8%

Table 4.20 Test Results (1)

(%)

Item \ Kind of Hullers	Under-runner Disc Sheller	Rubber-roll Sheller	Compared Items
Supplied paddy	100.0	100	
Chaff	12.8	11.5	
Paddy	30.6	28.7	Difference in the occurrence rate of hulled kernels 3.2
Brown rice	56.6	59.8	Difference in the occurrence rate of cracked brown rice 3.7
Whole rice	(84.9)	(88.6)	
Broken rice	15.1	11.4	

Test 2

November 13, 1985

Place: Abadgar Rice Mill, Mirokhan Road, Larkana

The quality of material paddy

Variety: IR-6

Red kernel mixing rate : 10.3%

Paddy moisture contents: 13.6%

Cracked kernel rate : 13.6%

Immature kernel mixing rate: 3.3%

Dried paddy weight: 23.3g

Table 4.21 Test Results (2)

(%)

Kind of Hullers / Item	Under-runner		Disc Sheller	Rubber-roll Sheller	Compared Items
	First	Second	First+Second		
Supplied paddy (After separating husk)	100	100	100		
Husk	-	-	-		
Paddy	34.6	29.9	30.8		Difference in the occurrence of hulled kernels
Brown rice	65.4	70.1	69.2		
Whole rice	(90.3	(90.0	(87.7	(90.8	The occurrence rate of cracked brown rice
Broken rice	9.7)	10.0)	12.3)	9.2)	

Test 3

December 17, 1985

Place: Popular Rice Mill, Kamoke, Sheikhupura

The quality of material paddy

Variety: KS-282

Red kernel mixing rate : 0.04%

Paddy moisture contents: 10.1%

Cracked kernel rate : 21.7%

Immature kernel mixing rate: 5.2%

Dried paddy weight: 22.4g

Table 4.22 Test Results (3)

(%)

Kind of Hullers / Item	Under-runner Disc Sheller		Rubber-roll Sheller	Compared Items
	First	Second (Return)		
Supplied paddy	100	100	100	
Husk	-	-	-	
Paddy	18.9	37.6		
Brown rice (Difference in brown rice recovery)	81.1 (77.9 / 22.1)	62.4 (81.4 / 18.6)		
Difference in brown rice recovery	73.3		74.4	Difference in brown rice recovery 1.1

Test 4

December 7, 1985

Place: Muhammard Siddique, Mushtang Ahmard Rice Mill

Table 4.23 Test Results (4)

(%)

Kind of Hullers / Item	Under-runner Disc Sheller		Rubber-roll Sheller	Compared Items
	First	Second (Return)		
Supplied paddy	100	100	100	
Husk	-	-	-	
Paddy	29.8	18.3		
Brown rice (Difference in brown rice recovery)	70.2 (94.1 / 5.9)	81.7 (86.4 / 13.6)		
Difference in brown rice recovery	76.7		76.5	

Test 5

Table 4.24 Test Results (5)

	Rubber-roll	Under-runner	(%)
Husking rate	83.4	79.4	
The occurrence rate of cracked grain	10.3	16.3	

4.1.4 Assessment of storage losses

It is desirable to estimate losses against various storage conditions by sampling over a long period.

However, for this survey, loss-assessment was based upon existing reports on storage losses because of the limited survey period and main-power.

There are a very few reports on paddy/milled rice storage losses. Of these reports, reliable reports are limited. The most reliable figures are shown in the following Table 4.25.

Table 4.25 Storage Losses in Rice and Paddy

Season	Storage Period	Type of Storage Facility					
		Warehouses		Bins		Plinths	
		Quantity	Quality	Quantity	Quality	Quantity	Quality
Rice (Punjab)							
Monsoon	1 month	0.15	-	no data	no data	0.60	1.00
Dry season	1 month	0.15	-	no data	no data	0.50	0.50
Paddy (Punjab)							
Dry season	3 months	0.35	0.10	0.20	0.05	1.50	1.50
	6 months	0.75	0.25	0.50	0.10	3.25	3.50
	12 months	1.50	0.50	1.00	0.25	6.75	8.75

Source: FAO 1985, "Rice Grading, Inspection and Analysis" Page 214

According to the survey results, the biggest rice losses were observed in paddy stored in open space, i.e. 15.5% per year, if paddy is not moved. The paddy losses estimated simulating to the monthly stock conditions mentioned in Chapter 3.4.1 are worked out to be 3.67% of the total handled paddy for open-space storage and 0.57% for indoor storage, as shown in the following Tables 4.26 and 4.27.

Table 4.26 Losses of Paddy Stored in Open Space of Rice Mills

(Unit: %)

	Dot-wise Monthly Stock Condition											
	Paddy	Loss	Initial Stock	Paddy	Loss	Initial Stock	Paddy	Loss	Initial Stock	Paddy	Loss	Initial Stock
Nov.	5.0	0.28	30.0									
Dec.	10.0	0.20	24.72	-	0.45	45.0						
Jan.	10.0	0.10	14.52	-	0.45	44.55	-	0.20	20.0			
Feb.	4.39	0.03	4.42	10.61	0.39	44.1	-	0.20	19.80	-	0.05	5.0
Mar.			-	15.0	0.31	33.1	-	0.20	19.60	-	0.05	4.95
Apr.				15.0	0.14	17.79	-	0.23	19.40	-	0.05	4.90
May				2.63	0.02	2.65	12.37	0.18	19.17	-	0.06	4.85
Jun.						-	6.57	0.05	6.62	4.76	0.03	4.79
Jul.									-			-
Total	29.39	0.61		43.24	1.76		18.94	1.06		4.76	0.24	

Remarks: 1) Total milled rice, 96.33%
Total loss, 3.67%

2) The above paddy means that ratio of amount of monthly milled rice to that of annual milled rice and concerted to the paddy amount.

Table 4.27 Losses of Paddy Stored in Warehouse of Rice Mills

(Unit: %)

	Lot-wise Monthly Stock Condition											
	Paddy	Loss	Initial Stock	Paddy	Loss	Initial Stock	Paddy	Loss	Initial Stock	Paddy	Loss	Initial Stock
Nov.	5.0	0.04	30.0									
Dec.	10.0	0.03	24.96	-	0.07	45.0						
Jan.	10.0	0.02	14.93	-	0.07	44.93	-	0.03	20.0			
Feb.	4.91	-	4.91	10.09	0.06	44.86	-	0.03	19.97	-	0.01	5.0
Mar.			-	15.0	0.05	34.71	-	0.03	19.94	-	0.01	4.99
Apr.				15.0	0.02	19.66	-	0.04	19.91	-	0.01	4.98
May				4.64	-	4.64	10.36	0.03	19.87	-	0.01	4.97
Jun.						-	9.47	0.01	9.48	4.96	-	4.96
Jul.									-			-
Total	29.91	0.09		44.73	0.27		19.83	0.17		4.96	0.04	

Remarks: 1) Total milled rice, 99.43%
Total loss, 0.57%

2) The above paddy means that ratio of amount of monthly milled rice to that of annual milled rice and concerted to the paddy amount.

4.1.5 Loss assessments for transportation stages

(1) Causes of loss during transportation

Rice is transported in many stages from harvest to the consumer. At each stage, transportation losses of rice occurred.

Causes of transportation losses are as follows:

- disorderly handling
- tearing or breaking bags
- incomplete sewing of the open side of the bag
- using hooks while handling

However, lost portions are recovered by the following methods:

- Collect leakage using brooms or by hands
- mending bags

Therefore, rice loss rice during transportation is not as much as it seems. Rice is handled carefully, especially in stages close to harvesting.

(2) Quantity of transportation losses

In this study, measurement of transportation losses was not included, but the study team estimated transportation losses for each level and the losses occuring in the marketing stage were estimated based on existing reports and interview results, as shown in Table 4.28.

As the source used was, "Foodgrain losses During Transportation & Processing in Pakistan" 1980 University of Agriculture Faisalabad. This was used because the data of transportation losses was reasonable compared with results from interview, and losses were assessed by transportation level.

In order to have more reliabilie figures in the table, transportation losses were verified by using raw data of the above report.

Table 4.28 Transporation Losses in Rice Level of Market

(Unit: %)

Level	Punjab	Sind	Average
In farm	0.58	0.56	0.57
Farmer to Commission Agent	0.07	0.42	0.25
Commission Agent to rice miller	0.28	0.65	0.47
Total	0.93	1.63	1.28

Note : Loss in milled rice level is not included.

Source : "Foodgrain Losses During Transportation & Processing in Pakistan Vol.IV 1980 by Department of Agricultural Marketing University of Agriculture Faisalabad.

For the analysis of lossin the stage, loss in consumer level is excluded.

Total of loss of transportation in Sind was 2.24% and more in punjab. Average of both area was 1.98%.

In Punjab, losses at the farm level were largest, 0.58%. In Sind losses in processing level were 0.65% and losses at the farm level were 0.56%.

Losses at the farm level were larger (.57%) than losses at the processing level (.47%).

4.1.6 Losses during postharvest operations

Assessment results of losses generated in various stages are summarized in Table 4.29. These losses occur between reaping and arrival in front of warehouses of milled rice wholesalers in a consumption area.

(1)

Table 4.29 Loss in paddy field stage (%)

Province / Work	Sind		Punjab	
	Green Fodder	Paddy Field Drying + Threshing with Bullocks	Basmati	IR-6
Reaping	0.5	0.5	3.0	0.5
Paddy field drying		1.9		
Beating threshing	3.7	-	2.9	4.2
Threshing with bullocks	-	5.7	-	-
Total	4.2	8.1	5.9	4.7
Weighted average by province		7.1		5.4

Notes 1: Measured values by the study team.

2: The reaping ratio as green fodder is approx. 25%. The ratio of paddy field drying + threshing with bullocks is approx. 75%, and production volume ratio of Basmati in Junjab was 55.7% in 1984 - 1985.

(2)

Table 4.30 Loss in rice milling stage (%)

Rice mill type	Milled rice yield	Broken kernel generation ratio	Weighted average rice milling yield	Weighted average broken kernel generation ratio
Huller type	6.5	15	3.3	10.0
Sheller type	2.5	10		
Semi-modern type	1.5	5		

Notes 1: Measured values by the survey mission.

2: The weighed average values were calculated assuming the ratios of unhulled rice amounts milled by the rice mills of the various types to be 20%, 79%, and 1%.

3: The above rate of 10% broken kernels shall be the qualitative loss occurring in the rice milling stage and the calculations are necessary to evaluate the above qualitative loss in relation to the price.

However, how much influence it has on the price of milled rice, have to calculate.

The evaluation must take into consideration fluctuation in the market price of milled rice due to area, season, variety of rice, yet it is almost impossible.

(3) Losses during storage

According to a World Bank survey, loss due to storage of paddy in the field from December to June in the following year is 3.67%, compared with 0.57% for losses during storage in warehouses. The loss due to storage of paddy in the field is at least 3.67% - 0.57% = 3.1%.

(4) Losses during transportation

The results of survey for foodgrain losses during transportation (see Table 4-25) show that transportation losses in farm, between farm and market, market ro rice mills are 1.63% in Sind and 0.93% in Punjab. These losses occurred during transportation of paddy but not including the losses of milled rice.

(5) Losses during rice postharvest operations

Loss ratios were assessed for each processing process between (1) and (4) above. The loss ratios assessed by process should be added cumulatively, instead of adding simply, to assess losses generated during the entire rice postharvest operation. Below, loss ratios calculated by cumulative and simple additions are mentioned:

1) Sind

$$0.929 \times 0.967 \times 0.969 \times 0.984 = 0.0857 = 0.857$$

$$100 - 0.875 \times 100 = 14.3\%$$

Punjab

$$0.946 \times 0.967 \times 0.969 \times 0.991 = 0.0876 = 0.878$$

$$100 - 0.878 \times 100 = 12.2\%$$

Qualitative losses of the 10% broken rice generation ratio during rice milling are not included.

2) Simple addition loss ratio

Sind

field		milling		storage		transportation	
7.1	+	3.3	+	3.1	+	1.6	= 15.1%

Punjab

5.4	+	3.3	+	3.1	+	0.9	= 12.7%

Qualitative losses of the 10% broken rice generation ratio during rice milling are not included.

(6) Losses in paddy field work using machinery

Though the machinery for harvesting operation is not yet popular in Pakistan, losses occurred in paddy field when machineries for harvest are applied, are assessed as the reference for future mechanization. The results is shown in Table 4.32.

This assessment was done only to the harvest of Basmati 370 variety.

The losses of the above are not considered to be the existing.

Table 4.32 Losses in Paddy Field Work Using Machineries

Losses / Machine	Quantitative loseses %	Increasing rate of cracked and hulled kernels %
Reaper	0.3	-
Local thresher	1.8	7.9
Auto thresher	2.9	4.6
Auto combine	4.0	4.6
Ordinary combine	<1.3	5.2