CHAPTER X AN INTEGRATED APPLICATION PROGRAM FOR THE COMPREHENSIVE STORAGE FACILITIES DEVELOPMENT PROJECT

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An integrated application program for the Project is proposed in this Chapter based on the recommendations stated in the Chapter IX.

Since this program is prepared to formulate the new project to establish the necessary storage facilities at the selected places in Thailand, it would be necessary to carry out further investigation in the Feasibility Study Phase II to justify the whole program and make the concrete plan for the implementation.

10-1 Items of Agricultural Products

10-1-1 Rice

Representing over one-fourth of all rice traded in the world, rice production in Thailand is a traditionally important source for the nation to obtain foreign currency. Rice is significant in the Thai economy because it is a staple food and its price is a yardstick for commodity prices.

Rice farmers in Thailand, however, earn less than laborers engaged in other occupations. The Fifth Five-Year National Economic and Social Development Plan emphasizes improvement of farmers' income. The PWO is one of the organizations for implementing such policies, but has not yet achieved the desired results partly due to its shortage of storage facilities.

Rice has been a primary commodity among many kinds of agricultural products handled by the PWO, and will continue to be the most important commodity to be handled by the organization.

In view of the situation, a priority should be given on rice in improveing the storage facilities for the Project.

10-1-2 Maize

Thailand exported about 2.5 million tons of maize out of almost 3 million tons of production in 1982/83. Maize is a good agricultural product for farmers and a promising source of foreign currency earnings for Thailand.

Recent restrictions imposed by the importing countries on the maize quality, particularly on the contamination of mycotoxin, have made it difficult to maintain the existing foreign markets and to develop the new ones.

In addition, there are many facilities handling export bulk maize in both Bangkok and Tarua. Their total storage capacity is amounted over one million tons. A great number of these facilities belong to the private sector.

In view of the present situation, it is considered that new expansion of the bulk maize handling facilities owned by the PWO is not of immediate necessary at this stage.

10-1-3 Cassava Pellets

The export of cassava pellets has increased dramatically in recent years. The current level is approximately 7.5 million tons per year. Cassava pellets are primarily exported to the EC countries in large vessels exceeding 100,000 tons with its dead weight. Large scaled investments should be made in facilities related to processing and handling. Foreign and domestic private enterprises have invested heavily in facilities for processing, storing and shipping cassava pellets in recent years.

Storage facilities for cassava pellets are unique and cannot be used for other agricultural products. Moreover, as they are considered a part of processing and shipping operations, storage function itself cannot be treated independently.

A major marketing obstacle to future cassava pellet export would be the import restrictions including the quota system imposed by the EC,

the largest importer of the commodity. The Government is therefore taking measures to limit the area for cassava cultivation by urging cultivators to grow other plants such as rubber or cashew nut as substitutes.

Consequently, the PWO is not advised to have its own facilities for export operations of cassava products.

10-1-4 Other Agricultural Products

Other agricultural products such as sorghum, mung beans, peanuts and coffee are rather limited in marketing volume when compared with rice, maize and cassava pellets. As the marketing pattern of these other agricultural products is similar to that of rice, space may be allocated for them in the storage facilities projected by the PWO. And it is not necessary to provide specific storage facilities for these agricultural products.

10-2 Warehouse Capacity Required by the PWO

10-2-1 Target Volume of Rice to be Handled by the PWO

The target volume of rice to be handled by the PWO should be decided according to the conditions of the supply of and demand for both producing and consuming areas. The following table shows the supply and demand for paddy and milled rice by regions based on the statistical data of a three-year average from 1979 to 1981.

(Unit: 1,000 tons)

	Marketable Surplus		Delivery	
	Paddy	Rice	Domestic Consumption	Export Shipment
Central	4,163	2,706	1,620	1,086
Lower North	2,201	1,430	434	966
Upper North	1,115	725	294	428
Northeast	2,511	1,507	1,027	479
South	551	358	412	- 54
	10,541	6,726	3,787	2,939

Note: The figures can be referred to the Table VIII-1, in Chapter VIII.

In view of the national economy, the above figure of about 3 million tons represents the export potential of Thailand from 1979 to 1981.

The Government is presently eager to intervene in the rice market up to 10% of marketable surplus rice, which is approximately equal to 670,000 tons of milled rice. However, the operation fund has become so big when the PWO handles the exclusively amount of the marketable surplus on behalf of the Government. The PWO had to depend on the commercial banks, with an interest rate over 18%, for the total funds for the market intervention performed in 1980 to 1982.

The results of the Feasibility Study Phase I suggest that even with its sufficient capacity of warehouses and competent staff, should the PWO lack financial support from the Government, it would be too risky for the PWO to handle a full 10% of total marketable surplus or 670,000 tons of the annual marketable surplus exclusively.

Regarding the target volume of rice to be handled by the PWO, it would be reasonable to set a tentatively target at a 10% of the total rice export, plus another 10% of the total consumption in the metropolitan area.

The following factors are the respective reasons for setting the target at a 10% of the rice exports and metropolitan consumption.

1) If the PWO undertakes the rice export business, as a government organization, its basic purpose should be that of a pioneer to improve the quality of export rice and to modernize shipping facilities rather than competing with the private sector. Therefore, a 10% of the export rice volume is a reasonable target figure for the volume of the PWO's transactions in export activities.

2) Thailand has an abundance of agricultural products. Most people in cities and villages enjoy a variety of food throughout the seasons. However, the metropolitan population have to depend upon the rural area for most of their food. The prices of such daily food usually tend to fluctuate seasonally. The PWO has a duty under the Royal Decree, to stabilize the prices of food, especially by supplying cheap

rice to the low income people. Under these circumstances, it is advisable that about 10% of the total metropolitan consumption should be handled by the PWO so that the PWO can play an effective role in stabilizing the price and supplying the cheap rice.

The following figures show the annual rice export potential in a Three-year average from 1979 to 1981 and in the year 2000:

(Unit: 1,000 tons)

	Export Potential Three-Year Average for 1979 - 1981	Export Potential in the Year 2000 (rounded figures)
Central	1,086	1,200
Lower North	966	1,150
Upper North	428	525
Northeast	479	575
South	- 54	- 50
Total	2,939	3,500

The figures are prepared in order to plan the potential in the year of 2000, for a long-term perspective, and the details of the figures can be referred to Chapter 8-2.

Rice consumption in the Bangkok metropolitan area in the year 2000 is estimated to be 978,000 tons. (Metropolitan population: 8.6 millions as indicated in Appendix 0-30). Accordingly, the target volume of rice to be handled by the PWO in the year 2000 is set at 450,000 tons as shown by the following calculations.

3,500,000 tons x 10%	=	350,000 tons
1,000,000 tons x 10%	=	100,000 tons
Total		450,000 tons

10-2-2 Rice Storage Capacity to be Required by the PWO

Warehouse capacity required by the PWO is determined by two factors: the maximum amount of warehouse space required for rice inventory control by the PWO and the storage capacity of existing the PWO's warehouses appropriated for storing rice.

The capacity of regional warehouses required for the stock inventory control of the above 450,000 tons of rice is indicated as the maximum purchased amount shown in the attached "Monthly Purchasing Schedule for PWO's 10% Rice Market Intervention". In the PWO inventory operations, two turnovers of the storage capacity are planned to set for the Central region due to the recent significant development of rainy season crops in the region. For other regions, one turnover is implemented.

The maximum storage capacities in each region can be found from the figures of accumulative stocks of procured rice by the PWO in the table. The capacity of the maximum requirements in each region are totaled 310,000 tons as follows:

	Maximum storage requirement for the PWO's inventory of 450,000 tons milled rice
Central	110
Lower North	100
Upper North	45
Northeast	50
South	5
Total	310

Warehouses owned by the PWO in the Bangkok area have a total capacity of approximately 110,000 tons, including both Bukkalo and Rajbrana. Warehouse construction is not required for the Central region which will handle 225,000 tons rice with two turnovers. The functions of these warehouses are to store milled rice purchased from the Central region and to deliver those rice to domestic markets and to export shipments as well.

Table X-1 Monthly Purchasing Schedule for PWO's 10% Rice Market Intervention (unit: 1,000 tons)

(0)	(1)		(2)	(3)		(4)		(5)		(6)		(7)
Month	%, milled rice purchassed by PWO		Amount of milled rice in all regions	Amount of Milled Rice Purchased by PWO								
	Control Region	Other Regions		Central (1)x 225	Accumulative	Lower North (1)x 115	Accumulative	Upper North (1)x 52.5	Accumulative	Northeast (1)x 57.5	Accumulative	Accumulative all regions including South
October	-	-	-	-	-	-	-	-	-	-	-	-
November	20	25(I)	101.25	45.0	45.0	28.75	28.75	13.125	13.125	14.375	14.375	101.25
December	15	20	78.75	33.75	78.75	23.0	51.75	10.5	23.625	11.5	25.875	180.00
January	15	20	78.75	33.75	112.5	23.0	74.75	10.5	34.125	11.5	37.375	258.75
February	-	15	33.75	-	-	17.25	92.00	7.875	42.0	8.625	46.0	292.50
March	-	5	11.25	-	(110)(III)	5.75	97.75 (100)(III)	2.625	44.625 (45)(III)	2.875	48.875 (50)(III)	303.75 (305)
April	-	-	-	-		-		-		-		(5)...South
May	-	-	-	-		-		-		-		310 (IV)
June	-	-	-	-		-		-		-		
July	20	10(II)	67.50	45.0		11.5		5.25		5.75		
August	15	5	45.0	33.75		5.75		2.625		2.875		
September	15	-	33.75	33.75		-		-		-		
	100.00 (%)		450.00	225.00		115.00		52.5		57.5		

(I) Heavy rice market intervention at earlier season of harvest in main rice crop.

(II) Rice market intervention at second rice crop.

(III) Maximum requirement in rounded figure for storage of milled rice in each region.

(IV) Maximum requirement of warehouse capacity.

Two of the PWO-owned warehouses with a storage capacity of 10,000 tons, one in Ban Pai and the other in Bua Yai in Northeast region, were found suitable for storing milled rice. As the total warehouse capacity required in the region is 50,000 tons, new warehouses will be provided to have a total capacity of 30,000 tons.

The following table indicates that the total capacity of regional warehouses required by the PWO is 180,000 tons.

(Unit: 1,000 tons)

	Required Capacity	Capacity of Existing Warehouse	Capacity of Warehouses to be provided
Central	110.0	110.0	-
Lower North	100.0	-	100.0
Upper North	45.0	-	45.0
Northeast	50.0	20.0	30.0
South	5.0	-	5.0
	310.0	130.0	180.0

Warehouses attached to the Central Shipping Complex shall function storage spaces for the transferred milled rice from regional warehouses, totaling 225,000 tons annually, 115,000 tons from Lower North, 52,500 tons from Upper North and 57,500 tons from Northeast region, and also function storage spaces for milled rice being ready to domestic and overseas shipments after necessary processing in the complex.

The warehouse capacity to be required for the above functions shall be 28,000 tons to store milled rice storage with 8 months delivery schedule from regional warehouses to the complex. In addition, 7,000 tons milled rice storage capacity shall be needed for handling and storing shipping rice in the complex. Accordingly, the requirement of warehouse capacity attached to the Central Shipping Complex is totally 35,000 tons.

10-3 Location to be selected for Regional Warehouse

Selection of locations and sites for warehouse construction in regions must be carefully justify and determined after detailed studies on operational and economic analysis of the PWO rice procurement and sales operations in each region.

Possible locations for regional warehouse construction can be selected from the following areas which are known as local trading center of rice marketing in the respective regions:

Central	:	Bangkok, Ayutthaya, Angthong, Prachinburi, Nakhon Nayok, Suphanburi
Lower North	:	Nakhon Sawan, Phitsanulok
Upper North	:	Lampang, Chiang Mai, Chiang Rai
Northeast	:	Nakhon Ratchasima, Khon Kean, Udon Thani, Udon Ratchathani, Surin
South	:	Surat Thani

It is proposed that a further necessary survey on this issue be carried out in the Feasibility Study Phase II.

10-4 Improvement of Technology Application for Rice Storage

As mentioned before, existing grain storage facilities in Thailand are inadequate for safety storage in terms of structure and function. Rice loading facilities at wharves are old-fashioned and hold the same problems as grain storage facilities, despite the rapid increase in export rice in recent years. When the PWO plans for new facilities, following technical matters should be considered.

a) The technology should be based on the actual grain marketing condition in Thailand. It mustn't estrange from the existing technical and economic conditions. Improved technology should have conformity with the marketing system.

b) The equipment of storage facilities should be excellent not only in individual performance but also in hermonization as a whole. Such equipment should have good operational efficiency collectively.

c) Generally, the adaptability to new technology is relatively high in Thailand, but some problems remain in maintenance work. Especially in case of the PWO, enhancement of technical staff is indispensable to smooth operation of the storage facilities.

d) Though modernization of shipping facilities has been attemped by the rice exporter, it has not progressed well because of economic and technical restrictions. Economic as well as technical evaluation is important in order to maintain international competitiveness of Thai rice and to let the new facilities function as a pilot plant for the private sector.

e) It is necessary to recognize that the storage technology which has been improved in developed countries in temperate zone can not be always adopted to the storage condition like Thailand where temperature and humidity are high all the year round.

f) The problems of storage should be overcome progressively. It is important to evade a risk caused by radical changes.

10-4-1 Technological Improvements in Milled Rice Storage

The following methods to improve the milled rice storage has been developed to put into practical use.

1) Complete removal of attached bran

Conditions of materials stored and the natural environment are the two major factors affecting the rice storage. One of methods to improve the material condition is to completely remove the rice bran from milled rice. The deterioration of rice quality is caused primarily by changes in quality in the bran layer and embryo. They tend to oxidize naturally because of their fat content. Intermediate organisms produced by the oxidization is assumed to cause a chain reaction that brings about the deterioration of quality. The absence

of bran may permit rice to keep its whiteness by restricting the change in rice components like acidity of fats. The degradation of rice whiteness results fromt the decomposition of the bran components and their movement into the startch layer of a rice kernel. Experiments indicate that insects breed easily in milled rice with residual bran, brown rice and paddy, but hardly so in white rice with the bran completely removed, and this white rice is more palatable.

Rice becomes ready to store for a long period of time by reducing the moisture content to a low level, elevating the milling degree and completely removing attached bran by polishing. The milling degree for high quality Thai rice is set "extra well milled" by the rice quality standards of Thailand. This means that the bran should be completely removed. Thai milled rice can be improved condition for storage by removing the attached bran with a polisher. The wet polishing method for milled rice is particularly effective to improve the storage condition due to the smooth surface of milled rice.

2) Reduction of moisture content of milled rice

The quality of rice will hardly deteriorate, even under poor storage conditions, if the rice has a low moisture content. Humidity in the air has a close relation with the moisture content of rice under the natural equilibration. Therefore, it is very important for the storage of milled rice to reduce the initial moisture content to a safe level, and to control the relative humidity in the environment air in a warehouse. It is particularly important to control the relative humidity during the tropical rainy season.

It is possible to reduce the moisture content of milled rice by reducing the relative humidity in the warehouse. When a large volume of bagged rice is stored, it will require about one month to achieve an equilibrium between the moisture content of the rice kernel and the humidity in the air. To save energy, it is advisable for Thailand to adjust the moisture content of rice to an appropriate level by controlling the relative humidity in the warehouse rather than controlling the temperature at appropriate low level in the warehouse.

The temperature of rice is closely related to the moisture content of rice for rice storage. While it is true that low temperature is a favorable for the storage, the temperature does not have to be so low if the rice has a low moisture content. It is vital to maintain a low moisture content of rice for storage in the tropical areas.

3) Prevention of quality deterioration and insect damage by the new packing materials

As previously mentioned, damage to gunny bags caused by rats is rare in Thailand. However, it has been observed that insects make holes in plastic film bags that have been used recently. There will be an urgent need for preventive measures. In addition to the problems concerning the packing materials themselves, presence of insects (i.e. their eggs and larvae) with milled rice before packing, and intrusion of insects due to an incomplete heat seal are major subjects to be concerned. These matters should be improved first before considering insect control by adopt new packing materials.

Factors of intercepting insects by packing materials include mechanical strengthening, repellents, and adoption of hard packing materials. The resistance of packing materials against insects can be expressed by pricking and wearing tolerance.

4) New packing materials

Plastic film bags are commonly used to contain the amount (2 kg, 10 kg) of milled rice in Japan, and the following special film bags are used for milled rice with embryo and retort-pouch rice.

i) Low density polyethylene laminate film (for sealing CO_2)

Low density polyethylene film (thickness of 100 μu) is coated inside the 2 layers (37 μu per layer) of nylon film by the dry laminated method. (Material expenses for 10kg bag; ¥90 to 130)

ii) Aluminum evaporated film

Aluminum evaporated film in hardly penetrated by gases and not easily penetrated by humidity and light.

10-4-2 Cargo-handling Improvement in Warehouse

In advanced countries, computerized commodity physical distribution systems including storage management have been developed to handle general cargoes. As described earlier, the method of loading and unloading bags of milled rice in the warehouses are outdated in Thailand. In contrast to the mechanized handling of cassava products, maize and sorghum in bulk, bag handling seems to be handicapped by technical difficulties. Total palletization system is a practical means of achieving effective distribution of cargoes of rice by taking advantage of existing facilities and structures. Because of the congestion of cargo-handling warehouses at the wharf as described before, it is particularly necessary to improve the efficiency of cargo-handling works.

1) Palletized storage

In order to implement palletized-cargo storage system, it is necessary to consider pallet size, stacking model and number of stacking layers.

Pallet size may be determined by the model of stacking. Table X-2 shows several types of milled rice bags in use in Thailand while different sizes of bags are used to contain the same quantity of milled rice. For the palletization it is quite important to restrict the variety of rice bag sizes not to require various pallet sizes.

The number of layers of rice bags on a pallet should be preferably seven(7) when 50 kg rice bags are arranged in a form called "Tsugaru-5". For 100 kg bags, the number of the layers should be five(5) in either case when the form "Tsugaru-5" or "Square-4" is taken.

Table X-2 Specifications of Gunny Bags

No.	Kind of gunny bag	Size	Weight per piece
1.	Rice gunny bag (100 kgs)	43" x 29"	1.134 kg
2.	Rice gunny bag	45" x 29"	1.19 - 1.225
3.	Sugar gunny bag purple stripe	43" x 29"	1.134
4.	Fertilizer gunny bag or rice bag (50 kgs)	34" x 22"	0.62
5.	Fertilizer gunny bag	35" x 22"	0.68
6.	Corn sack	41" x 23"	1.02
7.	Corn sack	37" x 23"	0.93
8.	B Twill	44-1/2" x 26"	1.02
9.	Castor seed gunny bag	50" x 34"	1.30
10.	Heavy cee stripe gunny bag	36" x 29"	0.95
11.	Heavy cee stripe guuny bag	35" x 29"	0.92
12.	Fertilizer gunny bag (one green stripe inside form selvedge)	40" x 24"	0.81 - 0.84
13.	Japan rice gunny bag	40" x 23-1/2" (101 cm x 60 cm)	0.75 - 0.82
14.	Rice gunny bag (one green stripe inside from selvedge)	37" x 23"	0.70
15.	- do -	41" x 23"	0.775
16.	Rice gunny bag	41" x 23"	0.87
17.	Rice gunny bag	37" x 22"	0.675
18.	Hessian gunny bag	36" x 26"	0.44 - 0.46
19.	Hessian gunny bag	36" x 22"	0.40
20.	Hessian gunny bag	36" x 21"	0.38

Source : Siam Gunny Co., Ltd. (June, 1977)

Typical examples of the arrangement forms are illustrated in Figure X-1, and a suggested relationship among the quantity of bagged rice, available arrangement forms, the number of layers of rice bags on a pallet, and the number of the pallets in each pile of the stacking is shown in Table X-3.

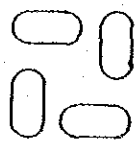
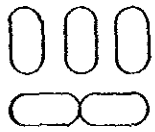
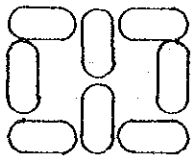
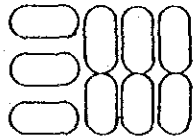
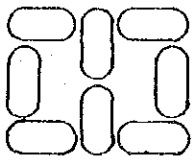
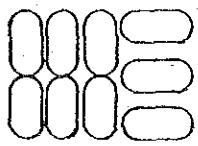
Called in Japan / Layers	Square-Four	Tsugaru-Five	Aizu-Eight	3 x 3 = 9
First-Layer				
Second-Layer				

Fig. X-1 Typical Arrangement Form of Rice Bags

Table X-3 Suggested Palletized Rice Bags Piling

Weight of a Rice bag (kg)	Arrangement form of rice bags for each layer	Number of layers on a pallet	Number of pallet in each pile
50	Tsugaru-5	7	3
100	Tsugaru-5	5	4
100	Square-4	5	4

However, this should be verified by practical application. The higher the pallets are piled, the more easily the stacking of pallets tend to collapse, although the high stacking is desirable for effective use of the space under the beams. In any case practical tests should be conducted for adoption of the proper way of stacking. Consideration should be given first to safety and second to storage efficiency.

In rice warehouses in Thailand, the normal height of stacking is 27 layers. The layers when palletization will become lower than 27 for more safety, as mentioned in Table X-3, accordingly less beam height may be required.

2) Pallet cargo-handling equipment

A forklift or a ceiling crane can be used for handling and pallet cargoes in warehouses. Their operation can involve the problems related to the utilization of space under beams.

Some forklift models can pile cargoes higher than ceiling cranes, and provide the continued operation in- and-outdoors. A ceiling crane requires space above the stacking for the movement of a winch, a hook and slings. It can pile less pallets than a forklift in a warehouse. However, the space for this movement can be considered to meet the technical requirements for preventing radiant heat under the roof. Although a crane can not be used for moving pallets outdoors, it can move them easily within a warehouse. The use of a crane may contribute to the efficiency in floor space utilization by minimizing dead space in the warehouse.

A forklift therefore would be an effective transportation means when a warehouse is located in a short distance from a wharf. And a ceiling crane would be suitable for cargo-handling operation to meet a rather long distance transportation conducted by trucks.

10-4-3 Rice Processing Improvement

1) Mixing facilities

The receptacle bins are made of either wood, steel or concrete.

They can be installed either indoors, or outdoors. Design for bins differs whether or not the bin is to be provided a function for a long time storage of milled rice. Each of these factors needs to be studied carefully before the project is put into implementation. However milled rice is very rarely stored in bulk for a long period of time.

It is generally advisable to install steel, indoor bins in the beginning, but it is advisable to build concrete bins equipped with the storage function later, as soon as they can be afforded. The concrete bin interiors should be smoothed by paint. Its height should be below 20 m. It should be equipped with device that prevent rice from being broken by the impact of casting and being biased due to the difference of gravity and dimensions of rice, as well as a manhole to ensure the maintenance and inspection of its inner walls.

A bin made of air tight steel and concrete can be useful for both purposes of storage rice and fumigation. However, it is seldom in any country, to store a large quantity of milled rice for a long time in a bin.

It is reported that some private Thai enterprises are planning to construct a bulk storage for milled rice. This plan aims for improvement of handling, processing and fumigating of stored rice but does not intend to store milled rice for a long period.

In Thailand, special caution should be taken into consideration to store milled rice in view of the unfavorable meteorological conditions, even if the storage period is about 6 months. Aeration between the stored milled rice in bulk can not be effective if the aeration is not controlled to adjust to the atmospheric conditions at the place of storage.

Milled rice stored in bulk that is close to the wall of a bin is predicted to reach the dew point when there is a temperature difference of 4°C. This happens if the temperature between grains is 25°C

to 30°C and the humidity between grains is RH 80%. In the case of dry season, if the temperature between grains of 25°C to 30°C and humidity between grains at RH 50% and the temperature difference is 11°C, the similar phenomenon will occur. In bins in Bangkok it is likely to reach the dew point as the annual average humidity is 78%.

The design should be made to minimize the increase of broken rice caused by carriers such as conveyor and elevator. If the amount of broken rice increase more than the standard, the operation would be less profitable. The facility design should minimize the use of bucket elevators and incorporate the functions of necessary processes by arranging them vertically. Mixing, re-milling and packing should not be done in the warehouse, but in an independent building linked closely to the storage bins.

According to the tests conducted by a certain rice mill in Thailand, the amount of broken rice incurred by bucket elevators is 0.1% per one pass. With all other conditions the same, the looser chute angle of the elevator will reduce the increase in the amount of broken rice. 0.1% may seem trivial, but the amount of broken rice will increase proportionately as the bucket elevator is used more frequently. This should not be neglected when the actual design of storage bin is made.

It is also advisable to study the adoption of a "pneumatic low speed conveyor" that can mix rice perfectly with different grades of rice through conveying, in order to make the rice quality to meet the required specifications.

2) Remilling

Remilling equipment is a combination of rice milling and polishing machine. Recent technological changes have developed new types of equipment such as wet polishing and color sorting machine as a part of remilling equipment. These machines came out to be used to satisfy

the needs of rice milling industry to improve quality of its products. It is said that a certain groups of rice exporters are studying the adoption of a large system incorporating the latest equipment for mixing, remilling, packing and loading of rice.

Fig. X-2 is a flow chart of the latest shipping facilities. It include pre-cleaner, de-stoner, scale, rice whitener, wet rice polisher, rotary shifter, length grader, mixing, fumigation, packing, color sorting equipment and accessories, and bins with a storage function. Layout of such equipment should be designed vertically to match storage bins.

The lines of various processes should be designed with separations to avoid the mixing of ordinary rice, parboiled rice and glutinous rice.

10-4-4 Loading Improvement

1) Ship loader

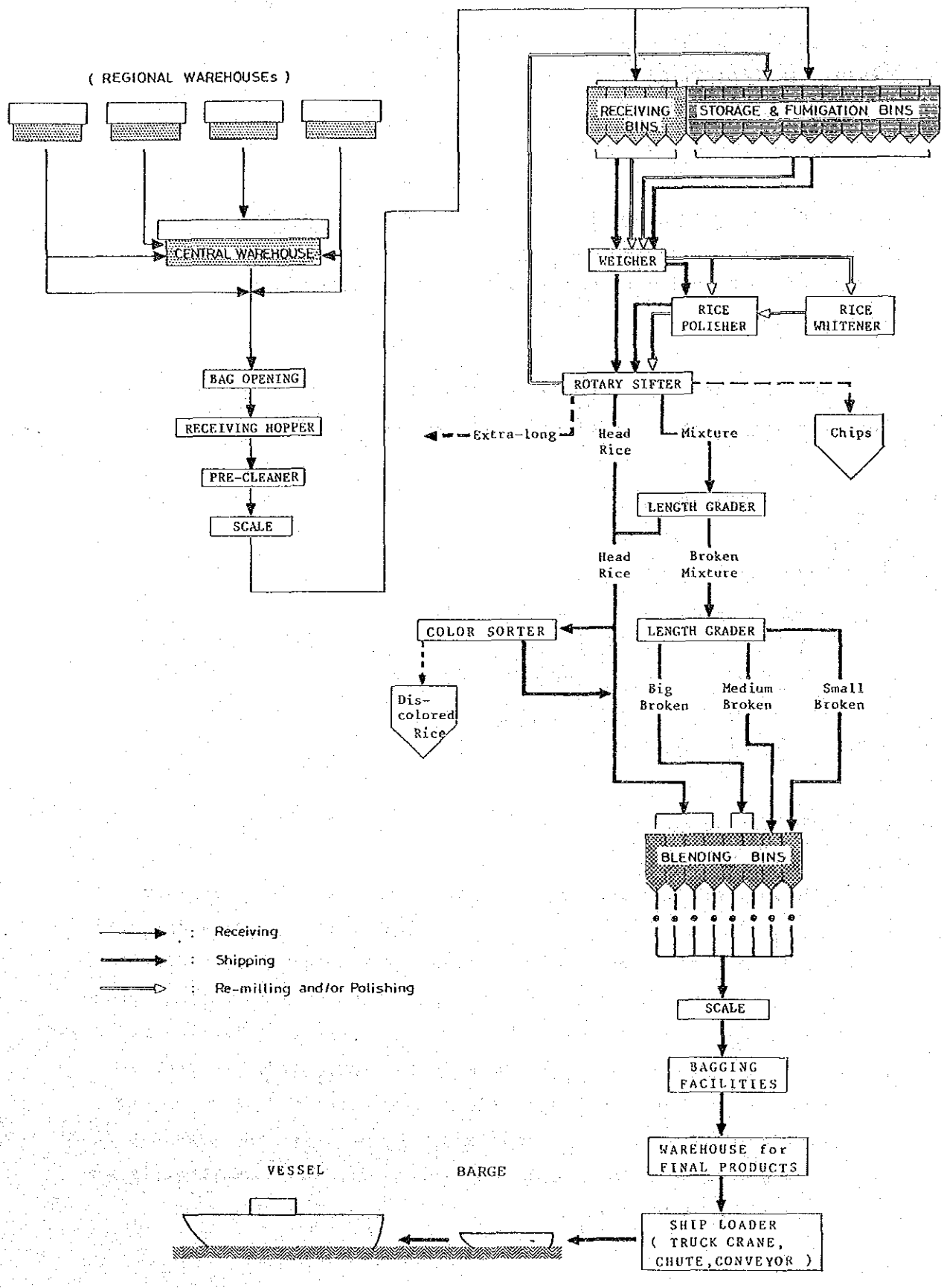
A ship loader is an automatic cargo-worker for loading of packed products onto a vessel. A spiral type chute is one of the typical ship loader, of which main features are explained below, and which is illustrated in Fig. X-3.

i) Outline

The bagged milled rice is carried from a warehouse to a spiral chute at the wharf by conveyors. A spiral chute is to be designed to slide the bags down to the turntable while maintaining a suitable speed to avoid breaking of the rice bag. Then the turntable feeds the bags onto the telescopic conveyor constantly. It serves to adjust the bags into shape and stack them in the ship hold. An operator at the control room or in the hold controls the direction and the speed of the conveyor as he maintains the position and quantity of bags in the hold. The flexible spiral chute can be adjusted to the tide or height of cargoes.

Fig. X-2

COMPLEX of RICE STORAGE & PROCESSING for SHIPPING



Normal speed of loading by this type of chute is 100 t/hr for loading onto a barge or a small ship (100 - 3,000 tons).

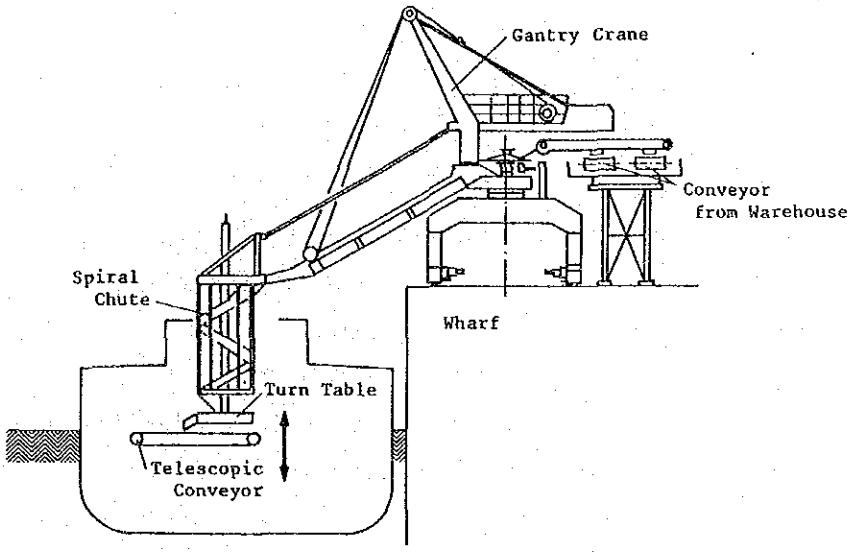


Fig. X-3 Spiral Chute Ship Loader

ii) Development and utilization

Spiral chute ship loaders for bagged rice are not popular yet, but, in Europe, they are used to some extent for other grains.

The followings are some cases of this type of loader employed for bagged rice.

a) Rangoon port

A spiral chute loader of rice was installed at the Port of Rangoon, Burma about 25 years ago, but it is not currently in use. It was reported that there were several technical defects and difficulties to operate it. Some of them were mechanical matters such as;

- many bags were broken
- difficulty of adjustment in the flexible operation (movement, extension or shrinkage) of the chute to match the tides, progress of loading and the working conditions
- workers were hard to handle the volume of bags from the chute smoothly

b) Warehouse in Bangkok

Two sets of spiral chute at Tanakit Warehouses are under construction. They are planned to load cargoes direct from the warehouses into vessels. On completion, the real efficary of this type of loader could be tested.

In short, the spiral chute ship loader for bagged milled rice have not yet reached the stage of practical application according to the information available so far. Their practical application seems to be hindered mainly by systematic problems rather than due to mechanical problems. The problems may be solved with the accumulation of experience before long.

2) Barge for storage-cum-transport of rice

i) Outline

The site for the shipping facilities of this project would be located in an upstream area of the Port of Bangkok according to the original plan of the PWO. Ocean-going large vessels cannot come in to this point due to shallow stream and low bridges. Under these circumstances, more efficient handling of cargo would be required.

Taking into account of practical advantage in handling and transport of bagged rice, a barge for storage-cum-transport of rice would be of use in this case. An outline and expected benefit are described below.

a) The loading capacity of one barge is set at 2,000 tons.

b) Each barge will be provided with two hatches. In addition to the ordinary hatch openings, an opening door on the side wall of hatches will be provided. Through these openings, the cargo can be loaded or unloaded with a crane or a belt conveyor. Installation of a conveyor on the wharf to be used solely for the loading of rice from the warehouse is undoubtedly of great help to facilitate smooth rice shipment.

c) The hold of the barge is airtight, and fumigation of cargo in the hold is possible.

d) Since the barge itself can store rice for some time, space of warehouse on shore can be saved and the ordinary stevedoring work can be reduced considerably.

e) The lower part of the hold is always below the level of river or sea water. Consequently, temperature there, influenced by the water temperature, is low and almost invariable. This provides a favorable conditions to store rice.

ii) Operation

Rice for export, which is processed and packed in bags at the site annexed to a wharf warehouse, is directly loaded onto the barge, and stored on the barge until a cargo vessel gets ready. Fumination of rice is workable during this waiting period. The barge is towed to the vessel by a tugboat and the rice is unloaded through the two hatches by the receiving vessel's deck crane. At present, rice loading in Bangkok is operated inside and outside of the river port in about equal amounts. Since a barge can carry 2,000 tons of rice in a trip, rice loading speed to the vessel anchored off shore would be increased.

Rice barge operation is illustrated in Fig. X-4.

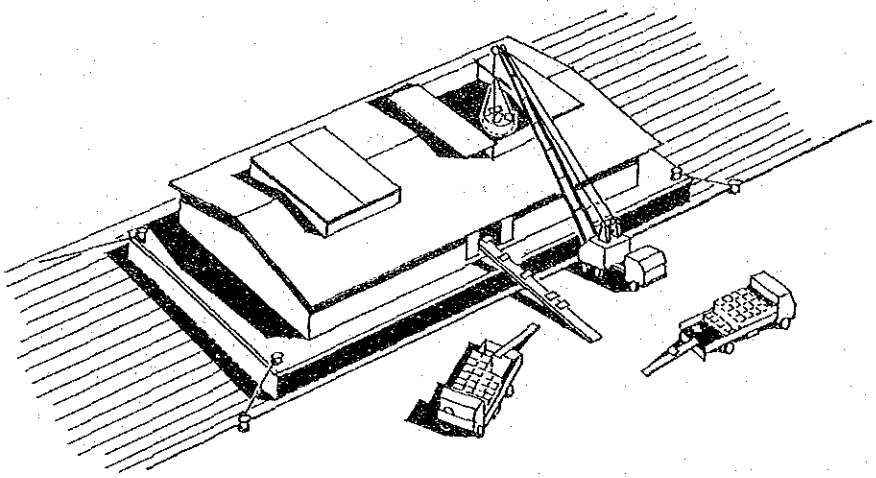


Fig. X-4 Rice Barge Operation

10-5 Description of the Storage Facilities Project

10-5-1 Principal Function, and Criteria of Basic Design

Principal function of each component of the Project should be dicided in accordance with the objectives of the Project which is stated in Chapter IX.

Local conditions at the project site would have influence on the decision of actual design of various facilities of the Project, needless to say. In general, the following points should be taken into consideration when the project site is selected.

a) Convenient traffic condition and easy access by truck.

b) Dry and well drained land.

c) Solid subsoil.

d) There is no dangerous plant or factory that might outbreak fire or any other disaster. It is also important that the facilities must be located far from the area where a flood is common.

e) Location in the shade to avoid exposition to direct sun shine is preferable, if possible.

f) In case of wharf warehouse along the river, proper measure should be taken to avoid the entrance of high humid air.

1) Regional storage facilities in the rice production area

The purpose of these facilities is to safely store bagged milled rice, which has been locally purchased, according to their respective grades. The rice procured is carried in a large quantity in a relatively short period of time after harvest and then is gradually carried out for distribution. Rice is stored for about 6 months at maximum. The purpose of this storage facilities is not the collection of rice but primarily storage in a trading center. It should also be noted that some amount of commodities other than milled rice are handled at some warehouses. The followings are also required for the facilities.

i) Consideration should be given to a long storage period.

ii) Stacking by conveyor loading should be made possible in order to improve storage efficiency.

iii) Arrangements should be made so that fumigation of each partition of warehouse is possible.

2) Regional storage facilities in the consumption area

The purpose of these facilities is to receive the milled rice from the production areas and distribute it smoothly to the areas where rice is in short. And also the followings are required:

i) These facilities are anticipated to be located in the South of Thailand. In fact, there is a great distance from northern part to southern part in the South of Thailand. Almost all movements of marketable rice are carried out on land from north to south in this South region. Therefore, it is necessary to consider the most beneficial way of transport or rice, when the project site is selected.

ii) Under the current transportation situation,the use of the coastal sea route is not practical. Transportation of rice should be done by railway or truck.

iii) As these facilities can also provide cargo handling, point, palletization should be considered to achieve efficient operation.

iv) Pest control measures against insect damage should be included, as harmful insects are more often detected in the South region than in other regions.

v) Other useful equipment, including packing machine, should be studied taking into account of convenience to meet the needs of the consumers.

3) Storage facility in the central consumption area

The main purpose of these facilities is to receive the milled rice from the areas of production and then deliver it timely to retailing

routes. It should also act as a buffer stock of foodstuffs in consumption areas. And:

i) The Bangkok metropolitan area would be considered to be a planning site.

ii) The improvement of cargo handling, palletization in particular, should be considered.

iii) The improvement of equipment to facilitate the operation of the complex should be considered. Especially, equipment to be useful for the needs of consumer, such as packing machine to pack rice in small plastic bag should be studied in view of the recent market requirements.

iv) Measures to prevent fire and flood damages should be taken carefully.

4) Wharf warehouse for export of rice

The purpose of these warehouses is to store safely the milled rice transported from the production areas for a short period of time. They also prepare standard rice to export which meets order specifications and carry out efficient ship loading. Further requirements for the warehouses are as follows.

i) Both banks of the Chaopraya river around the Bangkok port are suitable locations. The PWO possesses three warehouses at Rajburana, Bukkalo and Bankrasor.

ii) Transport of cargo delivered to the port-warehouse is usually done by trucks.

Transport of out-going cargo to the ship or barge is done

mostly by manual labour. It is necessary to improve the efficiency of this loading work by employing mechanical equipment.

iii) It will be necessary for the entire facilities to have multiple functions as well as storage function, which should be systematized. This not only means the systematization of a single wharf warehouse but also integrated control between the warehouses including those currently owned by the PWO at three different locations.

iv) As these warehouses will be able to work as the centers of cargo movement, improvement of efficiency of handling of rice and other cargo is especially important.

v) The modernization of re-milling and mixing processes should be planned so as to produce better quality milled rice to earn more price.

10-5-2 Outline of Main Facilities

1) Regional warehouses at production area

i) Regional warehouses aim at long term safe storage of agricultural products. In planning of these warehouses, the cost estimation taking account of local condition should be studied based on both economical and technical justification.

ii) In designing of warehouse structure, circulation of air is one of the important factors. Outdoor air should be able to take in when the temperature is low and humidity is also low outside of the warehouse. On the contrary, when the outdoor temperature and/or humidity are high, the warehouse must be closed to prevent air from outside. Efficient ventilation

is achieved by the opening and closing of the warehouse in relation to the equilibrium moisture content of the grain.

Cool air condition inside must be kept by reasonable ventilation system.

A ventilation device using temperature and humidity sensors should be installed and heat insulation should be applied as well. Moisture content of milled rice is controlled according to the theory of equilibrium moisture as mentioned already. Moreover, de-humidifier should be planned to install for mechanical reduction of relative humidity inside the warehouse.

iii) The warehouse should be designed for effective fumigation against the insects propagation in long term storage. For this purpose, suitable space of one partition would be $500m^2$.

iv) Belt conveyor should be used mainly for mechanical cargo work inside the warehouse. Storage efficiency can be improved by reducing the width of passages and doors.

v) In some areas, take-in of grain other than milled rice also can be expected for storage. A processing machines, as a subsidiary facility, should be installed to improve their storagebility.

2) Regional warehouses at consumption areas

i) Palletization should be considered for warehouses in consumption areas. This would allow for efficient cargo handling and a high turn-over rate in the same way as a warehouse in a central consumption area.

ii) Operational stock and buffer stock for stable supply are

necessary for warehouses in consumption areas. However, as it is important to practice the "first-in, first-out" policy, the facilities should be designed so that appropriate stacking and cargo handling plans are possible. Proper stacking should be done for the purpose of safe storage and storage volume confirmation.

iii) A pre-packing facility, as a subsidiary facility, should be introduced to meet retailing needs, as the necessity arises.

3) Central warehouses

In the case of the PWO, it is possible for the wharf warehouses for export rice to be located at the same location as the warehouses in central consumption areas. They can act as distribution centers as well as storage points.

The structure of these warehouses should be able to open and air-tight close in common with the planned local warehouses. As they are for short-term storage, a facility to rationalize the cargo work should be planned.

At wharf warehouses, the bags containing milled rice for mixing and re-milling are opened at the time of receipt and pre-treatment for increase in storage ability is sought. The installation of a bin for this purpose will be examined in the future.

4) Rice processing and ship loading facility at wharf

i) Machines for cargo-handling, mixing, re-milling, broken rice separation, color sorting, weighing, packaging and so on will be installed at the newly constructed machinery building. A wet type polisher, giving a smooth surface to the treated rice kernels, will be integrated in to the re-milling section.

ii) The truck-crane, which makes continuous cargo work with pallets possible is most practical as a ship loading device. Though the use of chute or conveyor-type loaders will also be studied for achieving higher efficiency.

iii) Milled rice prepared to meet export standards is stacked in a product warehouse for temporary storage. It is then loaded onto the ship after export inspection. A barge with short-term storage capability is now planned, to remove this stacking process and unnecessary cargo work. This barge will be equipped with a loading and unloading built-in device so that cargo handling inside the hold can be efficient.

Thorough fumigation, as a part of the export inspection procedure, can be done easily inside the hold of a barge. As the timing of this fumigation overlaps the transportation period for offshore delivery, an increase in cargo work can be anticipated.

5) Advice for future measures

Descriptions of the warehouses and shipping facilities which will be developed by the PWO are summarized in Table X-4, X-5. A flow-sheet of the devices for storage facilities, rice processing facilities and the ship loading facilities for export rice, is shown by Figure X-2. They should be systematically connected on the basis of the ship loading program.

This facilities plan outline shows one possible direction as it includes devices which have been unproved and left for further study, such as a warehouse having both opening and air-tight functions, a large bin for milled rice, a ship loader and a rice barge.

The technical and economical question of the practical use and the adaptability of these devices to the local conditions are left open for a future field investigation. The specifications of each device should also be carefully studied in the future.

Table X-4 Tentative Plan for Outline of New Warehouse

Warehouse / Items	Regional Warehouse			Warehouse for shipping facilities	
	Production (surplus) area	Consumption (defecit) area	Central Region (surplus and defecit area)	For export rice for receiving	For export rice for processing
Type of building	one-storied	one-storied	one-storied	one-storied	vertical bin
Open/ close type	open and close	open and close	open	open and close	close
Fumigation	Yes	Yes	No	Yes	Yes
Form of rice for storage	bagged	bagged	bagged	bagged	in bulk
Handling method in warehouse	conveyor	palletization (fork-lift)	palletization (fork-lift)	palletization (ceiling-crane)	bulk conveyor
Cargo receiving	truck . barge	truck · rail · barge	truck · barge	truck · barge	truck · barge
Cargo delivery	truck · rail	truck · rail	truck	-	vessel, lighter
Required equipment	for cleaning in selected site, packing, defumidifier	pre-packing, defumidifier	pre-packing	defumidifier	for processing (mixing, re-milling, grading, packing), ship-loader, (truck crane)
Safety counter-measures	for fire damage	for fire damage	for flood and fire damage	for flood and fire damage	for flood and fire damage

Table X-5 Tentative Plan for The Improvement of PWO's Existing Shipping Facilities

Items \ Site	Rajburana, Thon Buri	Bukkalo, Thon Buri	Bankrasor, Nonta Buri
Storage facilities	(existing warehouse, 58400t to be utilized)	(existing warehouse, 51000t to be utilized)	new one-storied warehouse and small concrete bin
Cargo receiving	(existing truck scale to be used)	truck scale, inspection instruments	truck scale, inspection instruments
Handling in warehouse	palletization (pallet and fork-lift)	palletization (pallet and fork-lift)	palletization (pallet, and fork-lift)
Fumigation	sheet cover	sheet cover	fumigation (closed) warehouse and bin
Installation of rice processing	in existing warehouse	in existing warehouse	in new building for equipment
Wharf	(existing wharf for vessel and barge)	(2 existing wharves for barge)	new wharf for barge
Loading equipment	deck-crane of vessel, truck-crane for barge	truck-crane	truck-crane
expected capacity/day	1000 ton	500 - 1000 ton	1000 - 1500
River transportation	vessel, existing barge	existing barge	existing barge

10-6 Grain Storage Technology Development Facilities

The establishment of a modern management system, introduction of appropriate techniques and employment of competent personnel are indispensable factors for the improvement of the PWO's functions. Without these, modernized storage facilities can not be utilized efficiently.

Therefore, the PWO is advised to take positive measures to strengthen it's functions as follows:

10-6-1 Improvement of the PWO Management

1) Stock control

Improvement in stock control would be one of the most important matter for the PWO. Warehouses located in each region store many kinds of agricultural products with various quantity in different forms, and for a different periods of time. If the stock control of these agricultural products are not properly performed and if the principle of "first-in, first-out" cannot be followed, it would cause a big amount of losses due to quality deterioration and damages in storage, and eventurely cause shipping disordered.

In this view, the followings are advised for the PWO to establish an effective stock control system.

i) Stock control by computer system

The head office should provide with a central computer facility connected to each regional office, which enables to process the up-to-data stock data collected from each warehouse without time-lag.

ii) Development of appropriate form system

The system standardizes formats of the receiving and delivery slips and tags issued in each warehouse to make them suitable for computer input. This enables the terminal devices in each office to print out the control data such as ledger as well as daily, weekly and monthly reports.

iii) Development of control system

Various data of up-to-data stock and handling conditions of agricultural products in each warehouse sent from each terminal device are classified, totaled and processed in the head office, to output data for the PWO to efficiently excute it's plans such as market intervention and export sales.

iv) Computer system for other purposes

This computer system provided with the on-line connection to the regional offices is to be utilized not only for stock control but also for use personnel management, accounting and other operations.

2) Business control

Due to the nature of duties and functions placed on the PWO, it is inevitable that the organization had to confronted with financial defecit when the market conditions become unfaborable. There is no guarantee that the agricultural products procured through the PWO's market intervention can sell the higher price than the buying price and that the interests in the period of stock will be dully paid. Therefore, if the staffs of the PWO do not understand this concept of management which differs from private enterprises, the PWO will encounter more spending and less function than expected.

Based on this understanding, it is recommendable that the PWO should strengthern it's business control system in the fields of collection and analysis of various information and communication between the head office and each department including regional offices.

i) Collection of information by computer

Market prices of agricultural products in each district and region at each level of farmers, local market, wholesale and cental market are to be collected through the terminal devices installed in each regional office. These information is classified, summerized and analyzed by the central computer to produce basic data for making decisions of purchase and sales on timing, quantity and expected effect of the PWO's market intervention.

ii) Data accumulation and utilization

The PWO should accumulate not only the data mentioned above but also their own managerial data such as fixed and variable costs, and compile data to be shown in tables, charts and other required formats.

Such output data can be used for a wide variety of purposes such as long term planning, identification of problems, development of improvement measures. Judging from these data, the PWO could grasp what is needed to enable maximum effect of management with minimum cost for intervention in the market.

iii) Information flow system

It is necessary to develop a system that conveys policy decisions of the head office and important data compiled by the head office to the PWO departments which need them. Therefore,

an appropriate feedback flow system from the head office to the each department is necessary to be established as well as the flow of data collection.

10-6-2 Applied Reserch and Development

Applied research and development concerning quality control and storage techniques are indispensable to technically reinforce the operation of the PWO.

1) Warehouse design

It is necessary to minimize the influence of the tropical temperature and humidity on agricultural products in storage, through improving the design and materials of the roof, wall and floor.

2) Control of environmental condition in warehouse

Safe and economical storage methods that control the high temperature and high humidity inside warehouses under the tropical conditions shall be developed.

3) Pest control

It should be established that countenmeasures to protect the stored agricultural products from insect pest and molds which cause damage and deterioration in them.

4) Research and development of machinery and equipment

Research and development of machinery and equipment installed in the PWO's facilities are necessary to carry out functional and economical operation.

5) Post-harvest processing technology

Even a efficient warehouse would be useless and loss would occur if the qualities of agricultural products stored is not suitable for it. Therefore, processing techniques such as drying, cleaning, milling, packing of agricultural products also should be improved. This is especially important for the storage of grain such as maize and paddy harvested in rainy-season.

6) Quality improvement

The export of agricultural products is the highest priority of the Thai economy. It is, therefore, inevitably to improve the product quality to meet buyers' requirements.

i) Quality improvement of milled rice

Improvement of facilities for mixing, grading, remilling, polishing and together with fumigating should be carried out to meet buyers' requirements.

ii) Countermeasures against mycotoxin

Contamination with mycotoxin, especially that with afratoxin is the major cause of export restrictions. A study should be carried out to prevent the above.

iii) Quality improvement of cassava pellet

The quality of cassava pellet exported from Thailand is poor in terms of containning foreign materials such as earth, sand and fibers, which always poses a problem in foreign market.

This should be improved and new markets should be exploited for these products to be used as raw material for starch, alcohol, isomeric sugar etc.

iv) Packing improvements

The exported milled rice is usually packed in 100 kg or 50 kg ganny-bags. However, packing method become diversified to meet the foreign buyers' requirements. Recently, a sealed package containing gas (CO_2, N_2 etc) had been developed to prevent deterioration of product quality and pest damage. Basic research is necessary to cope with the problems.

7) Basic data collection .

In order to establish effective, safely and economically storage methods for agricultural products for long period of time.

Basic data including the relationship between interior and exterior conditions of the warehouse and storage products in terms of temperature, humidity, quality of the products, insects and mold etc. shoud be precisely collected.

However, there is little data concerning the storage of agricultural products in the tropics. For practical approach of the study, simulation annexed to the Central Shipping Complex in which various studies such as refrigerated storage could be carried out.

A laboratory for analysis should be provided in this facilities as well as the storage spaces for simulation purpose.

Above research and development study might includes what has already been or is currently being conducted by the Ministry of Agriculture and Cooeratives or research institutes of universities. Reasons which ne-

cessitate the PWO to conduct research and development by themselves are as follows:

a. It shoud deal with outstanding problems related to the storage of agricultural products particularly as a "the Public Warehouse Organization".

b. It should improve the product quality and develop new products in order to maintain existing markets and exploit new ones for various kinds of agricultural products, as an institution attached to the Ministry of Commerce.

Overlapping of the Studies should be avoided when other Ministries or universities are carrying out similar researches, however it might be effective to conduct a joint research with the related institutions of other Ministries or universities.

10-6-3 Personnel Education and Training

Human resources are indispensable for the PWO to exercise it's function efficiently. In improving the PWO operations, the limited number of property trained personnel is the great obstacle. Therefore, personnel education and training are urgently needed under the following subjects.

1) Warehouse control

a. Stock control
b. Environment control
c. Document control
d. Maintenance of machinery and equipment

2) Grading and inspection of agricultural products

a. Sampling and grading theory
b. Sampling and grading practice
c. Laboratory analysis

3) Pest control

a. Species and ecology of insect pest
b. Pest control practice
c. Residual chemical analysis

4) Post-harvest processing techniques

a. Rice; drying, cleaning, milling and packing
b. Maize; drying and silo-storage
c. Cassava; removal of foreign materials and fiber, drying, chipping, pelleting and storage
d. Other agricultural products; drying, cleaning and packing

5) Business practice

a. Market research
b. Transportation arrangement
c. Procurement methods
d. Sale methods
e. Cost calculation
f. Data control

CHAPTER XI BASIC APPROACHES TO THE FEASIBILITY STUDY PHASE II

CHAPTER XI BASIC APPROACHES TO THE FEASIBILITY STUDY PHASE II

The objectives of the Feasibility Study Phase II would be to undertake a study on the Comprehensive Storage Facilities Development Project for the PWO along with the line of the direction and concept agreed upon between the parties concerned in the Feasibility Study Phase I, and to formulate a justified program required for external financing assistance and technical cooperation.

The focus of the study should be placed on the following points to provide the Project with a sound basis.

1) Location and Capacity

Investigations and field survey on the local conditions which facilitate decisions on the most suitable location and the capacities of the warehouses and other necessary facilities should be implemented as soon as possible by taking various account factors involved into. A long-term perspective marketing and the transportation cost of rice and other agricultural products to be handled by the PWO are essential factors in determining the project locations and their capacities.

2) Basic Design

Designing a concrete plan of the Project components: regional warehouses, central shipping facilities equipped with modern handling facilities, and storage, technical development facilities. Improvement in quality as well as the prevention of loss and waste of stored products are also important points to be taken into due consideration.

3) Modernization of the Attached Facilities

The development and the establishment of an efficient inventory and handling systems is urged for the improvement of the functions of the PWO. As stated in this Report, a stock-controlling computer system and a modern floating-loader system should be studied in detail in order to meet the requirements of efficient management, storage, and handling works of the PWO operations.

4) Storage Technology Development

As shown by the results of the Phase I study, it is obvious that the existing technology related to storage, handling, management, quality control, and stock control at the PWO is below the desired level in terms of the efficiency and economical operation. Therefore, an appropriate staff training program for the storage technology development, together with the necessary facilities and equipment, would be a necessary prerequisite.

5) Financial and Economic Evaluation

In order to facilitate the investment decision for the project, estimated benefits and costs of each component should be carefully studied. Financial and economic evaluation should be provided based on the collected data and the proper estimation of the investment cost. In this connection, an estimation of the operation & maintenance costs, price escalation, physical contingency and practical planning of the project duration would be of great significance.