

## CONTROLLED ATMOSPHERE GRAIN STORAGE IN CHINA

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### INTRODUCTION

During October–November 1979, FAO conducted a UNDP financed study tour/workshop, hosted by the Chinese Government, on Storage Structure Design for 20 participants from different Asian countries. The information in this article is based on observations made during the study tour.

### 1. BACKGROUND

The annual grain harvest in China is about 320 million tons and it is estimated that about 80 million tons are kept in central stores.

About 11 million tons are kept in locally built silos with clay/straw walls (see Fig. 1). Traditional warehouses (see Fig. 2), where the grain is normally stored in bulk, and outdoor stacks (usually with about 200 tons of grain each 2,000 bags x 100 kgs/bag, and covered by 5–7 layers of reed mats) are commonly used facilities at central stores.

The grains stored are wheat (in the North) and paddy (in the Centre and South). Near big consumer centres, milled rice for consumption is stored in bags.

The areas referred to in this article are located between 40°N (Beijing) and 30°N (Shanghai), with a humid continental to humid sub-tropical climate.

### 2. FACILITIES FOR CONTROLLED ATMOSPHERE STORAGE

Special structures for controlled atmosphere storage are rarely used in China except for low temperature stores and underground stores. Means of controlling the atmosphere for stored grain are usually applied in the normal standard warehouses and in the clay/straw walled silos.

### 3. NATURAL COOLING

In the North, natural cooling is used. If grain is not cool when put into storage, it is later ventilated naturally by means of doors and ventilation openings or, if necessary, taken out of the warehouse or silo for cooling and then brought back in again. Small suction fans are used in some stores to cool the grain. In some cases, the grain is covered with plastic (see Fig. 3) and a layer of sand after cooling to prevent reheating when the warm season arrives.

It should be noted that most warehouses have a ceiling limiting the heat exchange between the interior and the ambient air.

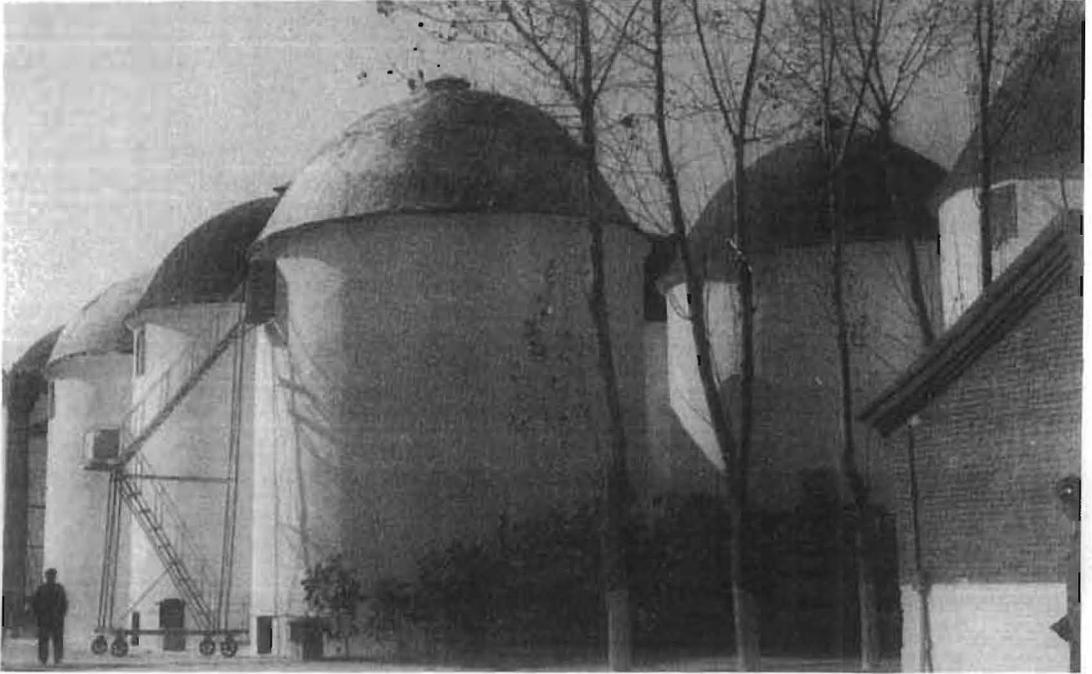


Fig. 1. Clay-straw silo near Beijing  $\varnothing$  8 m, height 8.5 m, holding capacity about 250 tons of wheat.



Fig. 2. Traditional warehouse in brick near Wuxi. In this warehouse, ventilation openings are mechanically adjusted by the small motor seen to the right.



Fig. 3. Interior of clay/straw walled silo with the grain covered with polyethylene (to prevent air exchange and prevent the grain from warming up).

Temperature control is a normal routine in most grain stores. When the ambient temperature is below  $15^{\circ}\text{C}$ , readings are made every month and when above  $15^{\circ}\text{C}$  every week.

Due to the low winter temperatures in the North, grain temperatures can be kept below  $15^{\circ}\text{C}$ . The water content of stored grain is of the order of 13-14%.

#### 4. LOW TEMPERATURE STORES

In the Centre and South, low temperature stores are used for milled rice in bags. Traditional warehouses have been insulated (K value = 0.5) and sealed, and cooling units installed (see Fig. 4). The photograph shows a  $1,000\text{ m}^2$  store in Shanghai for about 2,000 tons of bagged milled rice. A 22 kW cooling unit is installed and is reported to work for about 800 hours per year, or 3-6 hours per day depending on the season. The temperature in the store is kept at  $15^{\circ}\text{C} \pm 1^{\circ}\text{C}$  and the relative humidity at about 50%. The air distribution unit in the low temperature store is shown in Fig. 5.

#### 5. NITROGEN ATMOSPHERE STORAGE

Low temperature stores are as yet comparatively few but storage in nitrogen atmosphere is quite common. In fact, it is assumed that about one-third of the grain kept in the Shanghai area is stored in a nitrogen atmosphere.

Arrangements are simple and can be applied in any normal warehouse. Stacks of about 100 tons are covered with polyethylene (0.23 mm) and sealed (see Fig. 6). Air is evacuated and replaced by nitrogen. This method is considered suitable only in the temperature range  $+5^{\circ}\text{C} - +30^{\circ}\text{C}$ . Even if low temperature stores are considered technically better, nitrogen atmosphere storage is going to be used a lot because of the simplicity of the method.

#### 6. UNDERGROUND STORAGE

Underground storage is used to a fair extent in Henan Province where topography and soil conditions are suitable for the construction of this type of storage.

Underground bins are usually bell shaped with a diameter of 8-18 m and a depth of 8-12 m. The bins are entirely covered and therefore maintain a low, nearly constant temperature. Usually grain with about 13% moisture content is put into these bins at a temperature of  $10^{\circ}\text{C}$  or lower. This type of storage is reported to cost only 40% of the cost of normal storage and in some cases grain has been kept for twelve years in such underground bins without deterioration.

#### 7. CONCLUSIONS

It was impressive to see in China how, with very simple means and low cost methods, controlled atmosphere storage was applied in normal warehouses. Extremely good management and hygiene and minute control of the grain reduced losses to

an absolute minimum. Chemicals were used sparingly and only a small part of the stored grain was treated or fumigated.

Development of storage structures and methods is empirical but long experience on large quantities of grain has proved the merit of the techniques in use.

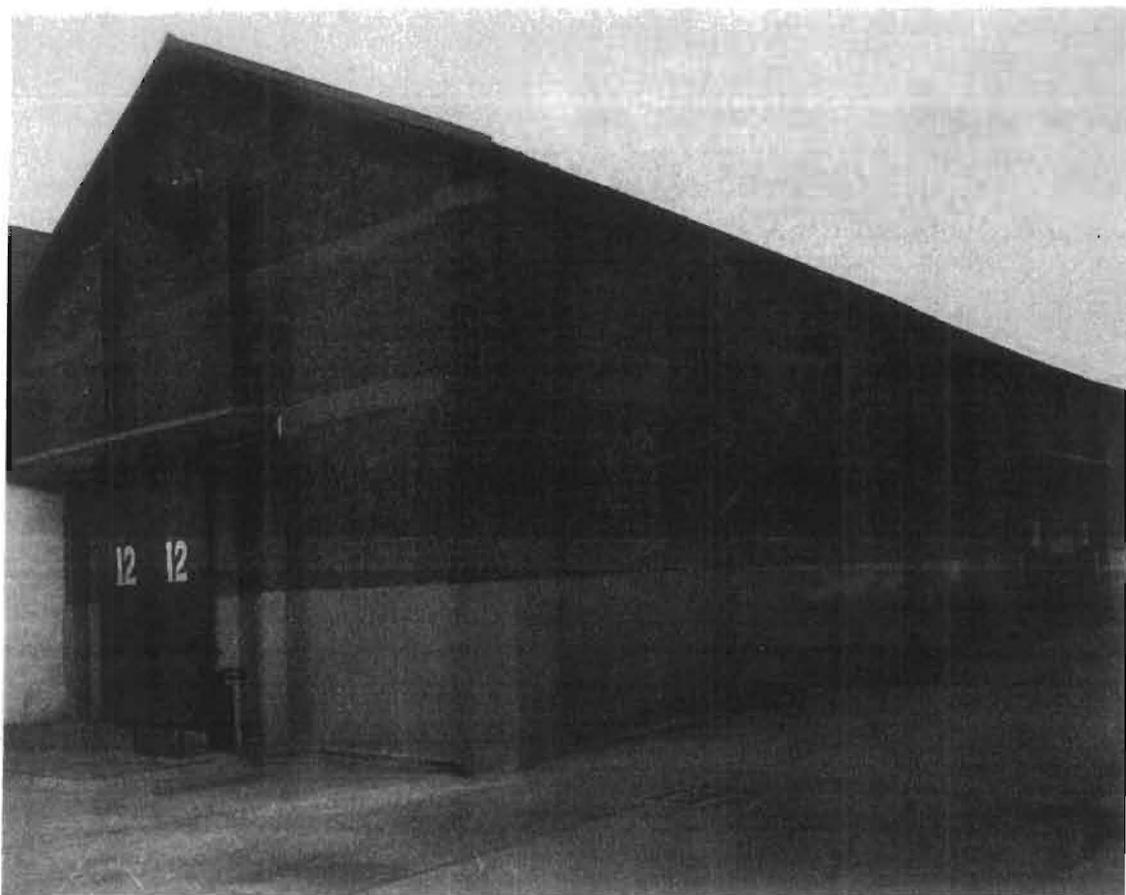


Fig. 4. Traditional warehouse, Shanghai,  $1,000 \text{ m}^2$ , which was remodelled in 1975 for low temperature storage of milled rice in bags.

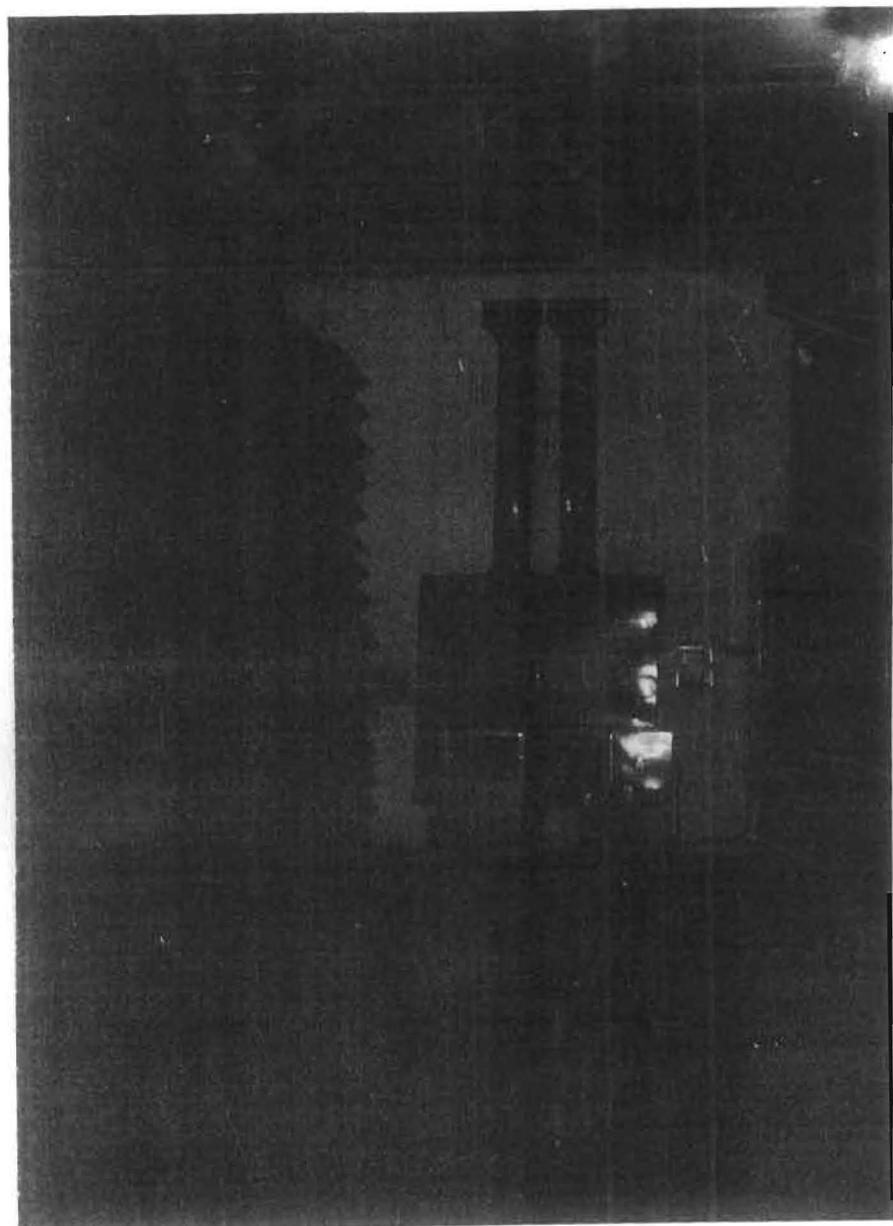


Fig. 5. Interior of warehouse. Air distribution unit. Milled rice stored.  
3.6 m high. Temperature  $+15^{\circ}\text{C} \pm 1^{\circ}\text{C}$ .



Fig. 6. Stack of bags, 13 bags high (= 2.5 m) being covered with polyethylene for nitrogen atmosphere storage.