Rice Drying and Rice Dries in Japan

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Present status of rice drying

The annual yield of husked rice in Japan now reaches up to as much as 14 million tons, and about half of the paddy rice is dried by machine (artificial drying) and the rest is dried without machine (natural drying). Even if rice is dried by machine, in most cases it is sun-dried first to bring the moisture content of rice down to 16 to 18 per cent. Although the moisture content of paddy rice varies considerably ranging from 30 to 16 per cent when harvested, it is usually 20 to 24 per cent. However, labor has recently been so scant that rice of high moisture content has become to be fed into the machine directly without natural drying. The wider use of combine harvester has also strengthened this tendency. Generally speaking, in Japan, rice is dried on paddy field by farmers and is sold in husked form to the government except the rice consumed by the farmers themselves. The government has established the standard level of moisture content and the farmers are requested to decrease the moisture content of rice to this level (Table 2).

Table 1. Treatment of rice it in most cases

Treatment before threshing			
Natural Drying	Drying on rack	52%	
	Windrowing	21	
	Drying on pole	10	
	Drying in standing bundle	9	
	Other methods of natural drying	3	
Without drying (Threshing immediately after harvesting)		5	
Treatment after threshing			
Natural Drying on mat		18%	51%
Without drying		33	
Artificial drying		49	4

Note: 1) Above figures are percentage of area by each drying method to the total area of rice field.
2) This table was arranged by the author from the 1967 investigation results of the Food Agency of Ministry of Agriculture and Forestry.

Natural Drying

Rice drying methods without machine vary from place to place in Japan. Some of them are illustrated in Fig. 1 and their popularity is presented in Table 1. "Drying on rack" is

Table 2. Inspection standard of rice for moisture content (permitted max. moisture content %)

Grade / rice	1	2	3	4	5	off-grade	Remarks
Paddy	13.5	14	—	—	—	—	Value by air oven method, 105°C, +0.5% over this value for San-in and Hokuriku districts +1.0% for Tohoku and Hokkaido
Husked rice	14	14.5	15	15	15	15	

most popular throughout Japan, while paddy rice is dried on multiple racks (drying on multiple racks) in the central district facing the Japan Sea (Hokuriku district), and in the northeastern district (Tohoku district) poles are used for drying (drying on pole).

Paddy rice is left of field for 1 to 30 days in such ways as shown in Fig. 1. Although the

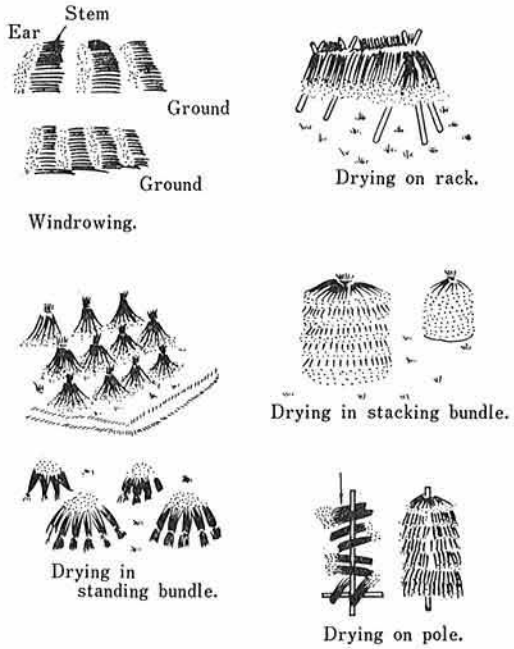

Fig. 1. Examples of field drying methods.

duration of the drying period depends on the weather and also regional conditions, it usually requires 7 to 10 days for the rice to be dried on the rack. Sometimes rice is dried on the mat supplementarily after threshing when its moisture content does not drop to the acceptable level within the predetermined period through natural drying before threshing. Artificial drying is replacing such an additional drying.

Artificial Drying

Most of the rice, when dried by machine, is processed by smaller machines owned by individual farmers (on farm drying). Such driers on farm drying are still popular and increasing in number every year. In 1955, its number was less than 10,000. In 1969 it was estimated to reach up to as many as 1.5 million. It is an increase at the rate of 200,000 annually. Here is a brief description given about the features of machines used by the farmers.

1) Flat-bed type forced air drier

As shown in Fig. 2, this type of machine

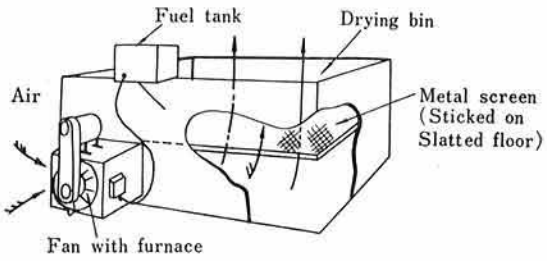

Fig. 2. Flat bed type forced air drier.

dries the paddy placed on a flat by hot air. It is of quite a simple structure. About 1.35 million machines are now in use, and the machines are classified by the size of area of slatted false floor where the paddy is placed. Both 3.3 m^2 and 5 m^2 floor area are most common. The former can process 500 to 800 kg of paddy at one time, while the latter one does 900 to 1,100 kg, at their maximum capacity.

The blowing fan is driven by ¼ to 1 horsepower motor. Hot air generated from the combustion of kerosene fuel for drying paddy (direct heating type). Fuel consumption is usually 1 to 2 kg per hour. Drying speed is about 0.7 per cent per hour, though the weather and other conditions affect it. To avoid the uneveness of drying and also cracking of rice grains, it is recommended to control the hot air temperature at 5 to 15°C higher than the atmospheric temperature. This flat bed type drier cheap in proportion to its performance. The machine with the floor area 3.3 m^2 without the motor costs about 40,000 yen and with the 5.5 m^2-size one 50,000 yen.

2) Upright type forced air drier

Fig. 3 illustrates the upright type forced air drier. Rice grains are sandwiched by screens and hot air moves through rice grains hori-

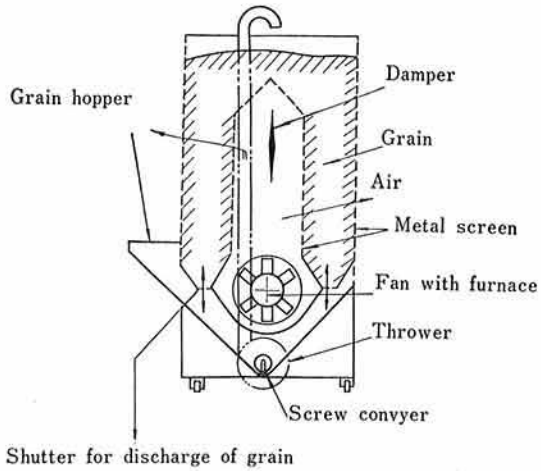

Fig. 3. Upright type forced air dryer.

zontally. There are various forms of the upright type drier which appeared on the market later than the float bed type. About 170,000 of the upright type are now in operation today. The handling of grain is mechanized to alleviate labor shortage, and also it is designed for installation in a smaller area without decreasing its performance. Three types of driers with grain container of 1.3, 1.8 and 2.7 m^3 in volume are now commercially available. They can handle 700, 1,000 and 1,500 kg of paddy at one time respectively. The drying speed is about 0.7 per cent per hour. They require ½ to 2 hp. for operating the fan though the type of the furnace and the fan are the same as the flat bed type drier. When higher moisture content grains are dried by the upright type drier, the grain must be circulated once or more times to prevent them from uneven drying during drying time. The hot air temperature is to be kept at the same degrees as in the case of the flat bed type drier. The price of the machine is rather expensive, compared with the flat bed type drier; that is, 1.3, 1.8 and 2.7 m^3 size costs 60,000, 90,000 and 120,000 yen respectively.

3) Circulation-type heated air drier

In this type of machine, grains are dried by means of automatic circulation. Although only 40,000 to 50,000 driers are now in use, the number is increasing rapidly. Various forms of this machine appeared, but most of them introduced recently share some common features; that is, grains are dried with high flow rate of hot air at the lower part of the machine, a big grain tank is at the upper part, and a bucket elevator is provided in connection with the tank for the circulation of grain. Fig. 4 illustrates this type of drier. The bulk

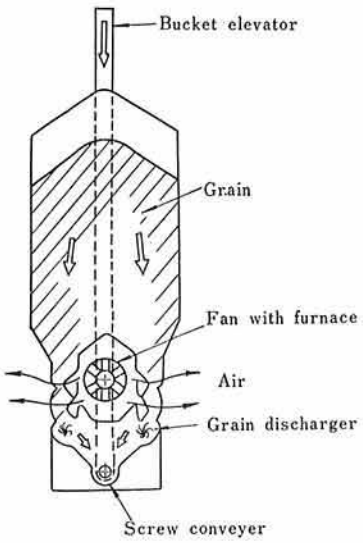

Fig. 4. Circulation type heated air drier.

of grains processed at one time is 2.7 m^3 or 4.1 m^3 for ordinary types. The drying speed is commonly 0.7 per cent to 1.0 per cent, though the speed is slower in the bigger size 4.1 m^3-type. The electric power needed for the fan is about 1 kw in most cases, since the power available at many farms limits the capacity of the fan. Kerosene is used for producing hot air and its consumption is around 2 kg per hour. The price is much higher than the former types described above. The 2.7 m^3-size machine costs about 200,000 yen and the 4.1 m^3-size about 250,000 yen. Some of these machines are equipped with a special space for ventilation as illustrated in Fig. 5. Hot air of 40 to 60°C is used, though the volume of air supplied also moisture content in grain affect the optimum temperature for drying.

4) Rice center and country elevator

From late in the 1950's, some part of rice has been processed at the rice centers where

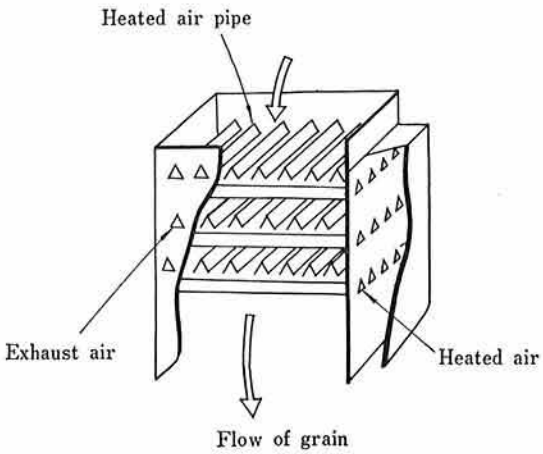

Fig. 5. Circulation type heated air drier.

drying, husking, separating and bagging of rice are done on a comparatively big scale. There are approximately 700 rice centers with the capacity of over 6 tons of husked rice per day throughout Japan and the number is growing every year. An average size rice center handles about 1,000 tons per year, while the biggest ones does more than 2,000 tons. The rice centers sign contracts with the farmers to process paddy rice, from drying to bagging.

The work of the installation fits the usual way of marketing the rice in Japan where, as was mentioned before, farmers sell the rice in the form of husked rice and store it in packages.

However, as storage in the form of paddy seems to be advantageous for longer storage than in husked rice. Besides, as storage in bulk is advantageous for handling, recently large scale storage of paddy in bulk, so-called "Country Elevator", has been established. The facilities have bulk storage silos of upright type and some processing equipment containing one or few driers. There are more than twenty facilities in Japan which are equipped with a bulk storage, in most cases a concrete bins connected with a rice drying system Among them, the biggest one has the capacity of 5,000 tons as drying to storage capacity per year, while facilities of 1,000 to 2,000 tons in capacity are common.

As for the rice drying equipment adopted in such installations, some set many driers which are seen on farm drying in parallel lines, while others adopt a multi-pass drying system in which continuous flow driers are installed in connection with tempering bins. In the country elevator, the bins for paddy rice storage works as the tempering bin and it is connected with the drier.

5) Problems and studies for rice drying

At present, most driers process rice grain whose moisture content is less than 18 per cent. However, as previously mentioned, the more the combine harvesters are distributed, the higher becomes the moisture content of rice fed into the drier. The situation brings about an increase of the drying cost. To dry rice of higher moisture content tends to cause more cracking of rice grains, which, in turn, affects the head rice yield. Besides, rice having a high moisture content is more easily subjected to bacterial damage unless the time from harvest to drying is shortened. Therefore, an economical drying method for rice with higher moisture content should be developed as soon as possible. In this connection, efforts have been made to find some remedy through which 1) the performance of drier is improved so as to prevent rice grains from cracking, 2) bulk of higher moisture contents grains is stored in keeping with its high quality, and 3) the most favorable characters of air flow are found for drying and also for storage, etc. Recently, as the supply of rice surpasses the demand in Japan, the consumers are showing more concern on the taste of rice. Consequently studies on the effect of drying and storage on the taste of rice have been undertaken.