AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523
BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY
BATCH #28

1. SUBJECT CLASSIFICATION	A. PRIMARY Agriculture	AQ10-0150-0000
	B. SECONDARY Food processing--Cereals--Rice	

2. TITLE AND SUBTITLE
Drying paradox: wet is better

3. AUTHOR(S)
(101) IRRI

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1970	2p.	ARC 633.18.I61q v.6,no.2

7. REFERENCE ORGANIZATION NAME AND ADDRESS
IRRI

8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability)
(In The IRRI reporter,v.6,no.2)

9. ABSTRACT

10. CONTROL NUMBER PN-RAB-570	11. PRICE OF DOCUMENT
12. DESCRIPTORS Drying Rice	13. PROJECT NUMBER
	14. CONTRACT NUMBER CSD-2541 Res.
	15. TYPE OF DOCUMENT

AID 590-1 (4-74)

7

THE IRRI REPORTER
Published bi-monthly by the International Rice Research Institute, P.O. Box 583, Manila, The Philippines
March-April 1970 Volume 6 Number 2

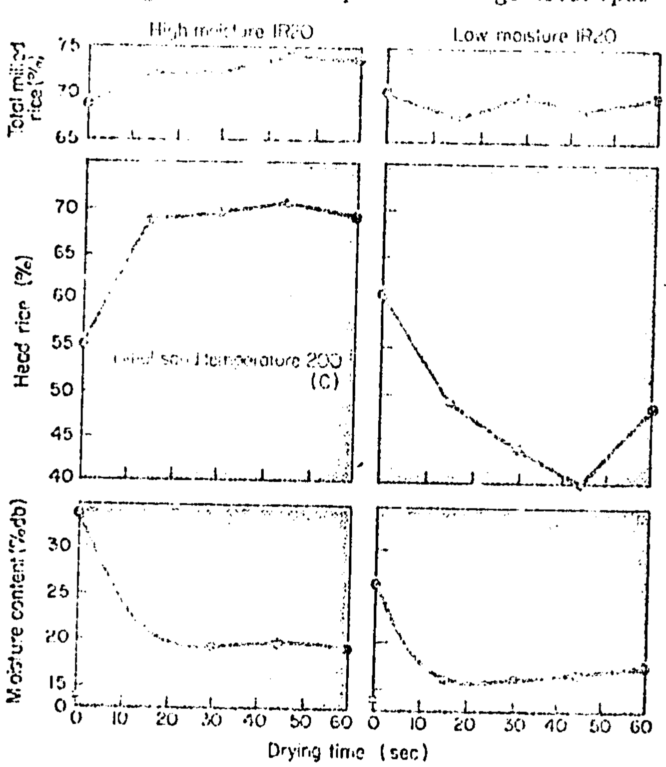
[illegible]

In the search for better rice driers for use at the village level, IRRI researchers have found two fast ways to dry rice that work better with wet rice than with relatively dry rice. The research has also led to the promise of an unexpected bonus: a fast way to produce parboiled rice.

Rice is usually harvested at about 20 to 35 percent moisture and then dried to 14 to 16 percent so it can be stored safely. In developing countries the rice is usually dried in the sun. This method is slow. Some of the rice may spoil if wet weather occurs while the rice is drying, or the rice may be lost to mice or rats.

Conventional driers blow hot air through the paddy rice. The temperature of the air must be carefully controlled. If it is higher than about 40 C the yield of head rice (unbroken grains) will be lowered. In addition, to get maximum head rice yields, the rice must be passed through the drier several times with tempering periods in between.

Developing countries need fast driers that do not require large amounts of capital so village-level operators can afford them. Farmers are reluctant to travel many kilometers to get their rice dried at large centrally located driers. With inadequate transportation and since farmers consume 50 to 70 percent of their own production, farmers prefer to dry the rice in the sun.



In 15 seconds, the heated sand method dries rice to a level almost low enough for safe storage. If the initial moisture content of the paddy rice was high before drying, the ultimate head rice yield will be sharply improved. But if the initial moisture content of the paddy was low before drying, the head rice yield drops.

Heated sand

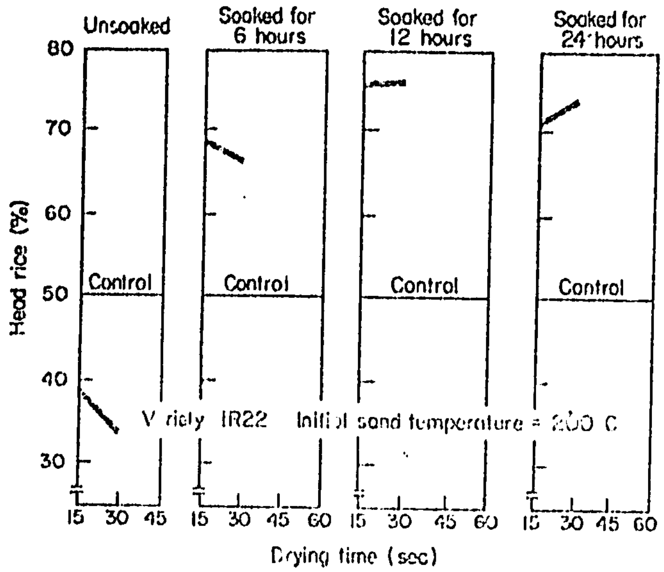
To develop a drier that could be operated efficiently at the village level, IRRI engineers have tested two methods based on conduction of heat. One method involves heating sand and then mixing it with wet rice. Heated sand has been used on the Indian subcontinent to roast or pop rice, wheat, and corn. After numerous tests, using a grain-to-sand ratio of 1:20, the engineers found that the best results were obtained with a sand temperature of 200 C. This combination can reduce the moisture content of paddy rice from 33 percent to 18 percent in about 15 seconds.

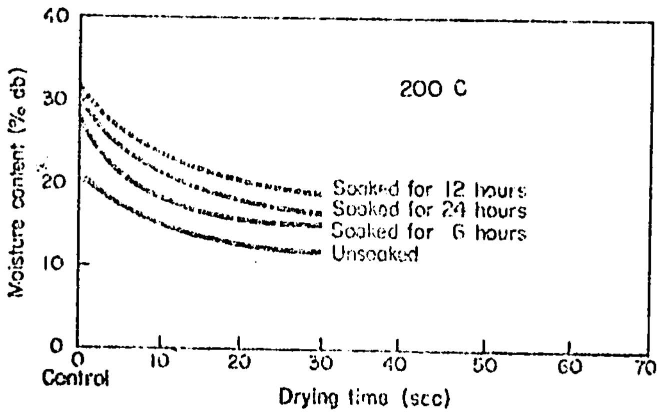
Although 18 percent moisture is still not safe for storage, deterioration occurs slowly at this level. The moisture content can be brought to a safe 16 percent by blowing air through the rice or sun drying.

Surprisingly, the heated sand method of drying dramatically reduced the amount of grains that broke during milling. IR8 with an initial moisture content of 33 percent had a head rice yield of 46 percent for the air-dried control and 67 percent for rice dried with the heated sand method. For IR20 at 30 percent initial moisture content, the control had a head rice yield of 55 percent and the rice dried with heated sand had 68 percent.

With rice of low initial moisture content, say 25 percent, the heated sand method is just as fast -- it drops the moisture content to 16 to 18 percent in 15 seconds. The effect on head rice yield, however, is not the same as in rice with a high initial moisture content. In IR8, rice with an initial moisture content of 25 percent gave a head rice yield of 55 percent, the same as the control. In IR20, the head rice yield actually decreased sharply. IR20 dried with heated sand gave a head rice yield of 50 percent. The air-dried control had 62 percent.

Why did the high moisture rice do so much better than the rice with low moisture content? Apparently, an almost instantaneous parboiling effect occurred. In the high moisture rice, suddenly heated water caused the starch in the rice kernel to gelatinize and cement internal fissures. Parboiling -- a process which normally involves steeping and steaming rice in water for many hours and then drying it in the sun -- is known to increase head rice yields. Rice with low moisture con-





Paddy rice that is too dry can be soaked for 6 to 12 hours to raise its moisture content. After drying, the head rice yield is greatly improved.

ten' did not have enough moisture to allow the parboiling effect.

With a temperature higher than 200 C, the grain became yellow and then brown, depending on the exposure time. Exposing the mixture at 150 C for up to 30 seconds did not decrease the moisture content much and at 30 seconds the rice began to pop. Exposure for 15 seconds at 210 C also caused popping.

The heated sand method clearly is fast enough to be efficient at the village level. It could be useful for large-scale, centrally located driers, too. IRRI engineers have already conducted tests that show that rice that has an initial moisture content that is too low to achieve the parboiling effect can be soaked for 6 to 12 hours to raise the moisture content. Drying with heated sand then results in the same head rice yields as those from rice with high initial moisture content.

After further tests, the heated sand principle will be incorporated in an experimental drier.

Flame exposure

The second method of drying with conducted heat involves placing the wet paddy on a metal screen and shaking it over a flame. The shaking keeps individual grains from being scorched.

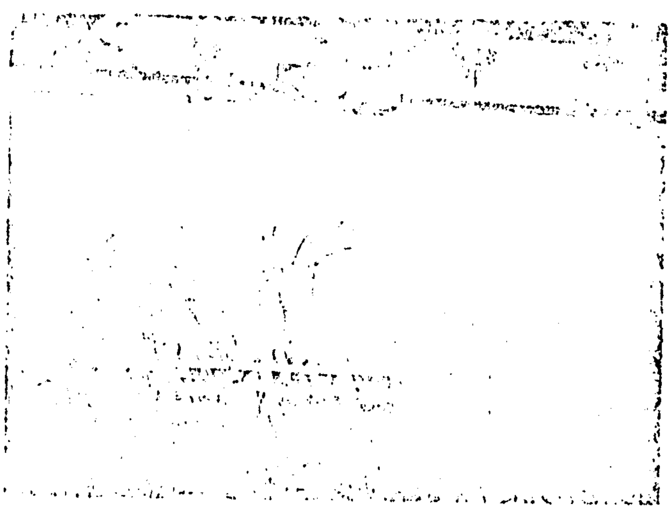
Tests showed that rice with an initial moisture level of 34 percent could be dried to 16 percent in 150 seconds. Although that is fast, it is not comparable to the speed of the heated sand method.

As in the heated sand method, paddy with a high initial moisture content produced a higher head rice yield than the control; paddy with a low initial moisture content produced a lower head rice yield than the control. Here, too, the parboiling effect accounted for the higher head rice yields in the high moisture rice.

Heated sand vs. flame

The heated sand method seems to be a faster way to dry paddy rice than flame exposure. More tests on both are planned. The flame exposure method will be tried with a non-perforated metal surface instead of the screen. Taste tests will also be conducted.

Power weeder for paddies



A lightweight engine operates a three-row rotary weeder. The engine is mounted at the end of a shaft connected to the weeder head and provides a counterbalance when the operator lifts the machine to turn it around at the end of the field. The weeder weighs 19 kg.

Push-type rotary weeders are a big improvement over hand-weeding, but it's still tough work and slow. IRRI engineers have designed a motorized rotary weeder that can be operated easily in small paddy fields.

The three-row model of the power weeder is four to five times faster than push-type weeders and eight times faster than weeding by hand.

Two important aspects of weeding rice shaped the design of the weeder. First, rice paddies have no uncultivated headlands, so it must be possible to lift weeders completely out of the field to make turns at the end of the row. Otherwise, some plants will be destroyed. Second, weeds do not have to be pushed deep into the mud, a few centimeters is sufficient for good weeding.

For these reasons, the small, two-wheeled tractors which farmers use successfully for plowing, harrowing, and puddling soils have not been adapted for weeding. These tractors could not be turned in a planted field without headlands. Also, such tractors would work too deep into the paddy, wasting power and perhaps damaging the rice plants.

The IRRI three-row, rotary weeder uses a lightweight, 32.5 cc, two-stroke engine meant for driving portable chain and rotary saws. The engine is mounted at one end of a shaft which is connected to the weeding rotor. To get high-speed reduction with light weight, the power from the engine is transferred to the rotors through a worm reduction gear box (36:1). A shoulder harness worn by the operator supports the shaft with a sliding hook arrangement. This arrangement lets the engine act as a counterweight to the rotors and makes lifting the weeder easier at the ends of rows.

The entire machine weighs 19 kilograms. When the machine is being used, the operator supports only half the weight.

The three weeding rotors turn at 110 to 130 r.p.m. The blades of the rotors are designed to keep the rotors from sinking too deeply in the mud. They work only the top 2 to 3 cm of the soil. The rotor blades and spokes are self-cleaning so that weeds and mud do not cling to them. Each rotor has six blades.

The rotors are 31 cm in diameter which provides enough axle clearance for the rice plants in the rows to bend and pass under during weeding. In early growth stages rice plants can be safely bent to 8 or 9 cm. In some fields, 45-cm-tall rice plants have been weeded with this machine without harm. Shields are attached to the machine to guide the rice plants between the rotors.

The rotors can be mounted with 9 cm or 16 cm between them to adjust to different row spacings.

A five-row weeder weighing 27 kg was also designed. A 50-cc engine had enough power to operate the weeder, but the machine was too heavy to be handled comfortably.

The machine might also be useful for land preparation in swampy fields that are so deep that even two-wheeled tractors become bogged down.

One manufacturer in Japan has started production of the weeder. Several other manufacturers of portable rotary saws have shown interest and drawings and test reports have been sent to them.

[illegible]

To avoid the labor and time involved in transplanting rice, farmers in some countries plant pre-germinated seed. Usually this means broadcasting the seeds by hand. In Ceylon, however, a simple seeder consisting of six tubes has been developed to allow the seeds to be sown in rows. The seed is metered by hand: the operator puts one or two germinated seeds in each tube for

A new seeder plants pre-germinated rice [illegible] times faster than a field can be transplanted. The seeder works best in fields that have been drained.

[illegible] Building on this concept, IRRI has developed a seeder with an automatic metering device that can be operated by one man, that can be easily manufactured in developing countries, and that is low in cost.

Seeding in rows has several advantages over broadcast seeding. The stand can be controlled better: broadcast seeding tends to produce stands that are too thick in some areas and too thin in others. Also, broadcast stands cannot be mechanically weeded without destroying some rice plants. And, harvesting machinery for rice generally can only be used in row-seeded crops.

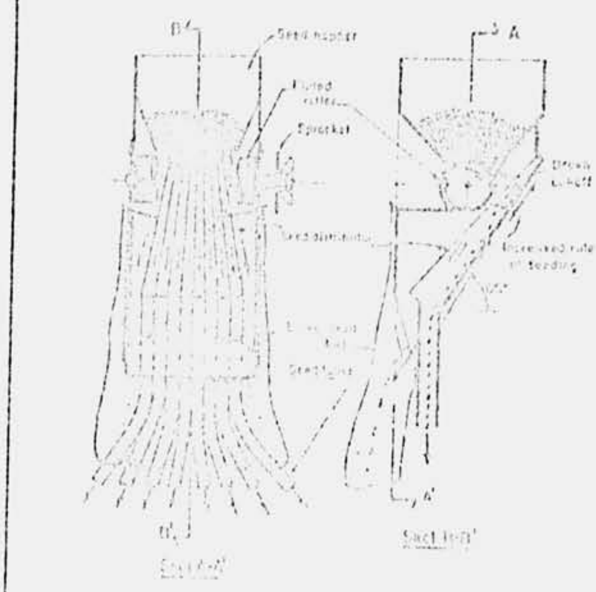
Basically, the seeder consists of a seed hopper, a metering device, eight seed tubes, a skid, and a drive wheel. It weighs 23 kg.

The hopper holds 5 kg of pre-germinated seed which is enough to seed one-tenth of a hectare.

Interlocking seeds

A major problem that had to be overcome before the metering mechanism could work was bridging of the seeds. All crop seeds tend to form bridges over small openings. But bridging is worse in pre-germinated seeds because with their small sprouts they tend to interlock.

Rather than attempting to have one or two seeds drop into individual metering devices for each seed tube, the engineers designed a two-step metering device. In the first step a quantity of seeds fill one notch of a fluted roller. In the second step the roller turns [illegible] the seed into an eight-channeled distributor [illegible] leads to the seed tubes. Seeds which are not in the notch are held back by the bristles of an ordinary paint brush pressed against the roller. Only a few seeds fall into each distribution channel. The rest of the seeds in the notch fall outside the distribution channels and are caught in an overflow bag.



The heart of the seeder is a simple metering device that transfers the pre-germinated seeds from the hopper to the seed tubes.

The metering device is driven by a ground wheel which is 60 cm in diameter.

From the distribution channels, the seeds pass into the seed tubes and drop into the mud. The seed tubes are attached to the skid which holds the openings of the tubes 10 cm above the soil surface so they don't clog up. The skid measures 0.2 m x 2 m. It is equipped with end plates and small furrow openers.

Flotation

In earlier models, a small skid gave insufficient flotation and the planter tended to bulldoze the mud. The mud was pushed out to the side and then flowed back disturbing the rows of planted seeds. The large skid keeps the planter from bulldozing. The end plates lessen the flow of mud.

The earlier model also did not place the seed properly in soil that was either very soft or hard. Because the model lacked adequate flotation it tended to sink in soft soil and as a result seeds were placed too deep. The large skid solved this problem. In hard portions of the field, the seeder tended to leave the seeds on the soil surface where they might be damaged by rats, birds, algae, or pre-emergence herbicides. The furrow openers were the answer, and helped keep the seeds in straight rows, too.

In addition to driving the metering mechanism, the single ground wheel also supports the seeder when it is being transported. If it had more than one wheel, the seeder couldn't be moved on a narrow levee typical of Asia, which is often the only way a farmer can get to his fields. Also, farmers have no land to waste so they plant right up to the levee. At the end of the row, the single wheel permits the farmer to lift and turn seeder without disturbing the seeds in the ground.

With the planter, one man can seed 1 hectare in 5 hours. This is 20 to 25 times faster than transplanting.

The machine is estimated to cost about US$40 to manufacture in the Philippines. Since a machine is not economical to export if shipping charges are a high percentage of its value, it is designed to pack compactly to keep freight costs low.