Seal of Approval

by **Philippe Villers** and **Martin Gummert**

Hermetic storage of rice is becoming increasingly popular across Asia, and for good reason—as well as being transportable, it is better than air-conditioned storage and almost as good as a cold room, at a fraction of the cost of either

The wax seals found on ancient Greek and Roman jars known as amphoras tell us that hermetic storage has been used to preserve grains for more than 2,500 years. Today, hermetic storage using modern materials has become widely available. In the last 2 years, one of the world's largest seed companies, Bayer CropScience, successfully shifted from traditional warehouse storage to hermetic storage for its hybrid rice seeds. Bayer is now able to eliminate live insects and maintain the full germination potential of hybrid rice seed beyond 9 months. Other organizations have followed Bayer's lead.

How does hermetic storage work? Studies dating back to the 1930s show that properly dried seeds can be preserved for a very long time, regardless of temperatures, as long as the moisture level remains constant and a low oxygen–high carbon dioxide atmosphere is maintained. In a sealed container, such an atmosphere is created through the natural respiration of the seeds and any insects present. The combined effect generally lowers the oxygen level to below 3% within days. Maintaining the modified atmosphere inhibits the generation of molds and their mycotoxin by-products (toxins produced by a fungus). Insects in all life stages die in a matter of days due to a lack of oxygen when stored in hermetic environments at room temperature or above.

For more than 6 years, the International Rice Research Institute (IRRI), through its Grain Quality, Nutrition, and Postharvest Center, has evaluated and disseminated hermetic storage technology in collaboration with national agricultural organizations, farmers, and rice millers. Thanks to these efforts, hermetic storage for smallholder and subsistence farmers is expanding worldwide.

Studies conducted by IRRI confirm and quantify the efficacy of hermetic storage versus alternative methods in maintaining germination potential of rice for periods up to 18 months. Hermetic storage systems rapidly reduce the number of live insects, which are able to survive in nonhermetic air-conditioned storage at 20°C, though not in cold-room storage at 8°C (Table 1). Large commercial hermetic systems and smaller hermetic systems offered similar control.

Similar results were found in Bangladesh, Cambodia, and Vietnam.

Table 1. Number of live insects per 1 kg of grain.

Months	Open storage	Air-con	Cold room	Hermetic (5 tons)
0	3.2	8.4	8.4	8.8
3	135	1.6	0	0
6	114	3	0	0.4
9	54	3.4	0	0.4
12	27	9	0	2.2

Source: DeBruin T, A user's introduction to hermetic storage – how it works. (Unpublished - GrainPro document #SL2322TDB0506-4), GrainPro, Inc., Concord, Mass., USA. Data from Philippines (2002).

In Cambodia, the germination for hermetically stored seeds was 90% after 6 months and 63% after 12 months. In comparison, seed stored in traditional systems had germination of 51% and 8%, respectively. In Vietnam, seeds stored in traditional woven plastic bags had 0% germination after 7 months while the same seed stored in the hermetic systems had 53% germination. In Cambodia, when oxygen levels increased above 9%, insect numbers also increased. The highest number of live insects recorded was a disastrous 332 per kg in an open storage system.

In 2006, the Philippine Bureau of Postharvest Research and Extension (PBPRE) and the Philippine Rice Research Institute (PhilRice) studied storage of the high-performance hybrid rice variety Mestizo 1.

GRAINPRO (3)

Table 2 shows germination rates using different storage technologies. Studies on rice seeds in Bangladesh and Cambodia (100–398 days), on maize seed in Mexico, Thailand, and Bangladesh (90–280 days), and on barley and wheat in Cyprus and Israel (120–900 days) showed hermetic storage seed germination of 81–95% after 90 days.[1,2] Another study from Vietnam on peanut seeds showed 98% germination after 8 months versus 4% when stored unprotected.[3]

It is also important to recall that hybrid seeds not only are more expensive than conventional farmer-grown seeds but also are more delicate and prone to damage. A continuing shift to high-yield hybrid seeds makes effective storage all the more crucial, since without high germination rates and maintenance of vigor, these"high-value" seeds have no value to the farmer. The PBPRE–PhilRice study showed that by month 6 of storage, hermetic methods are economically favorable to the other 3 methods (Table 3).

Table 2. Mean % germination rate of Mestizo 1 hybrid paddy (unmilled) seeds stored using different storage technologies.

	Storage time after harvest (months)			
Storage method	0	3	6	9
Hermetic	96.2	96.5	93.3	86.2
Cold room	96.8	97.6	93.0	89.6
Air-conditioned	94.3	94.8	88.1	85.8
Control (unprotected)	92.9	92.9	76.4	74.7

Source for Tables 2 and 3: Savio GC. Preservation of Mestizo Rice (PSB Rc72H) using hermetic and low temperature storage techniques, presented at the International Working Conference on Stored Products Protection (IWCSPP), São Paulo, Brazil. p 3.

Table 3. Cost comparison (Philippines) using four storage methods for preserving Mestizo 1 hybrid paddy seeds (all values in US dollars; $1 = 50 Philippine pesos).

	3 months' storage				6 months' storage			
Costs	Control	Hermetic	Cold room	Air-con	Control	Hermetic	Cold room	Air-con
Investment	82,250	1,744	12,820	16,230	82,250	1,744	12,820	16,230
Operating expenses	24,991	504	3,548	3,820	31,086	504	4,196	3,950
Per 20-kg bag	2.50	2.52	3.55	2.55	3.11	2.52	4.20	2.63

Investment and operating expenses based on: control 10,000 bags; hermetic 200 bags; cold room 1,000 bags; air-conditioned 1,500 bags.

Conventional storage was found adequate only up to 3 months.

Effective hermetic storage requires reasonably priced hermetic containers, now possible with modern specialized materials. Most widely used at the moment is the SuperGrainbag™ liner, a 60-kg-capacity, 0.078-mm-thick co-extruded plastic composed of polyethylene protective layers on the outside and a proprietary gas barrier in the middle (photo, *opposite left*). This plastic has extremely low permeability to water vapor and oxygen (typically 8 grams per square meter per 24 hours for water vapor and as low as 3 cubic cm per square meter per 24 hours for oxygen).

Cocoon™ is another form of hermetic storage (photo, *opposite center*). It is made from a special grade of 0.83-mm polyvinylchloride (PVC) with a permeability to oxygen of 55 cubic centimeters per square meter per 24 hours and to water vapor of 8 grams per square meter per 24 hours. Available in capacities of 5 to 1,000 tons, the Cocoon™ protects seeds in jute or polypropylene bags during storage.

The TransSafeliner™ offers hermetic storage for seeds during transport (photo, *opposite right*). It acts as a hermetic liner for standard 20-feet- or 40-feet-long shipping containers, allowing safe intercontinental transport.

Through the efforts of IRRI and its national partners, hermetic rice seed storage is now being used successfully in Bangladesh, Cambodia, India, Indonesia, Laos, Myanmar, the Philippines, and Thailand.

Hermetic storage of paddy (unmilled) and milled rice is also gaining popularity. IRRI reports that grain quality, as measured by head rice yield and the number of broken kernels, is higher for hermetically stored paddy rice than for traditionally stored rice. In Cambodia, head rice yields for hermetically stored grain were 10% higher than for traditional open storage over 12-months period. (Head rice yields are the percentage of head rice—whole grains and broken kernels that are at least 75–80% whole—obtained from paddy after milling.) In Vietnam in 2003, hermetic storage resulted in a 4.5% reduction in the number of broken kernels after 6 months.

The current revival of hermetic storage, using high-performance plastics, has made possible relatively inexpensive storage of rice seeds, paddy, milled rice, brown rice, maize, wheat, and pulses for both human and animal consumption. As the benefits of hermetic storage become more widely known, use of the technology is likely to grow throughout Asia and beyond. Sometimes it takes a few thousand years for a good idea to take hold.

Dr. Villers is president of U.S.-based postharvest technology company GrainPro, Inc. Mr. Gummert is a postharvest expert at IRRI.

The use of commercial product or company names in this article does not imply endorsement by IRRI.

[1] DeBruin T. 2005. Innovations in seed storage methods. Published in *Asian seed and planting material*. Philippines, January.
[2] Villers P, De Bruin T, Navarro S. 2004 Advances in hermetic storage as a methyl bromide replacement. 4th CAF Conference, Brisbane, Australia, February.
[3] Villers P, De Bruin T, Navarro S. 2006. Development and applications of the hermetic storage technology. Published in Proceedings of the 9th International Working Conference on Stored Products Protections (IWCSPP), São Paulo, Brazil, October.

POSTHARVEST

RICE CONFERENCE AND EXHIBITION

QUEEN SIRIKIT NATIONAL CONVENTION CENTER
15-17 JULY 2009 • BANGKOK THAILAND

An international platform to connect postharvest key players through new technologies, research, and investment opportunities.

CALL FOR ABSTRACTS NOW OPEN!

Take the opportunity to showcase technological advances and research findings to an international audience. Submit abstracts now. Deadline for submission is 15 April 2009.

www.post-harvest.org

Jointly organized by: IRRI, ASIA CONGRESS, pico

Supported by:

For Inquiries:
Postharvest Secretariat
Tel: +66 2 748 7881 I Fax +66 2 748 7880
Email: inquiries@post-harvest.com