Innovations in seed storage methods

*by Tom de Bruin**

Improved seed quality and performance is becoming increasingly important in modern agriculture. High-yield hybrid seeds for rice and corn have become a part of today's agricultural scene and are one of the ways of meeting the ever-increasing need for more food and feed at a time when available land resources are almost fully utilised.

In tropical climates, the ability to store seeds for extended periods is limited due to adverse climatic conditions such as heat and humidity. Seed germ germinates when provided with heat and moisture. The ability to germinate is expressed in percentage of germination.

In addition, an important parameter is "vigour" or "viability", which expresses the ability of a seed to grow and, eventually, to yield grain. Seeds may germinate but still have limited viability, i.e., they do not develop into yielding plants.

Post-harvest practice of seeds

After harvesting, seeds have to be dried properly to 1 or 2 "points" (percentage) below the "equilibrium" moisture content (MC) (figure 1).

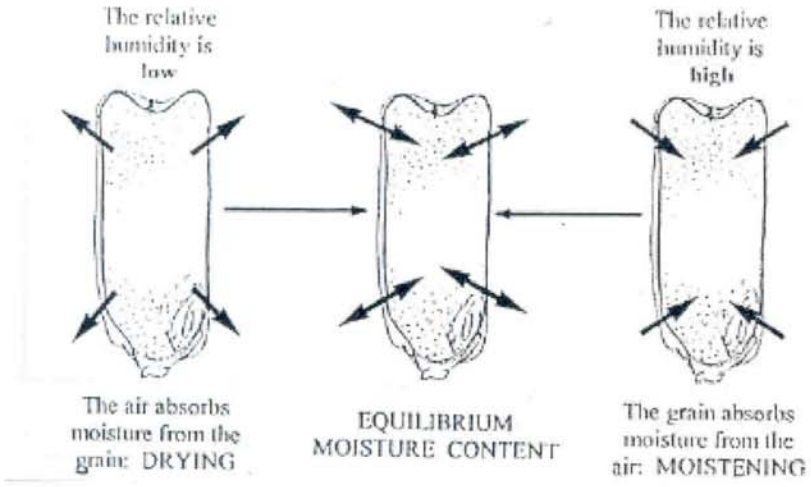

Figure 1. Equilibrium moisture content.

The "equilibrium" moisture content is the MC of a commodity at a given relative humidity (RH), indicating a "balance" between "release" (drying) and "absorption" (becoming more moist) of a commodity. Commonly, a limit of 70 per cent RH is used, since at a higher RH the development of mold (fungus) sets in. For this reason, the official trading standard for rice and corn in the tropics is 14 per cent MC.

However, the reality is that these commodities are stored in environments with, for much of the year, a higher RH that is sometimes above 90 per cent. This occurs especially during the "rainy season", which is six months out of the year.

Under high RH conditions the commodity will "absorb" moisture, raising its MC and causing fungal development (figure 2). This is, of course, a slow but well-known process to those familiar with long-term storage conditions in the tropics. With the increased moisture level, storage insects will also develop rapidly.

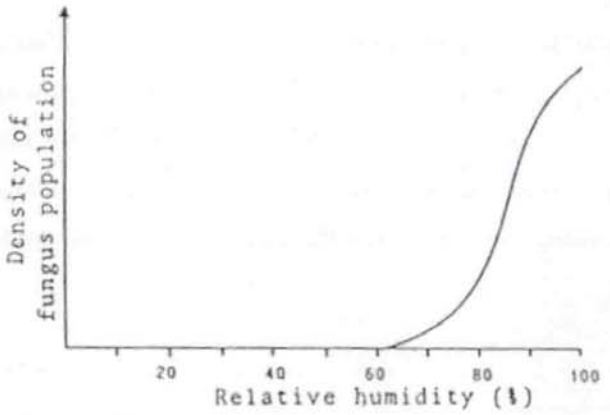

Figure 2. The relationship between fungi and relative humidity

The seed industry tries to cope with these phenomena in various ways:

- A large number of seeds are grown in relatively dry and cool climates such as parts of central India and China;
- Seeds are "over-dried" to about 2 per cent lower than 14 per cent MC to enable moisture absorption without losing quality;
- Varieties that are more expensive are stored in "cold" or "conditioned" refrigerated storage where temperature and humidity are artificially controlled.

Seed drying is mostly done by sun drying. It is possible to reduce the moisture level by about 7 points per day, provided the seeds are turned every 30 minutes in order to prevent "sunburn" that will damage the seed germ. If days of full sunshine are available, it takes 2-3 days to dry a stack of paddy or corn seeds.

Most seed producers contend that seeds harvested in the "dry season" are of better quality than those collected in the "wet season". Therefore, the dry season seed harvest often has to provide seeds for wet-season planting in addition to the dry-season planting, meaning a storage time of eight to nine months. For example, in the Philippines, hybrid seeds are harvested in the dry season (March-April) since the results of using wet season harvests proved unsatisfactory.

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Many areas lacking irrigation are cultivated with a crop that is dependant on rainfall and therefore on a seed cycle of once a year (eight to nine months of storage).

Once paddy or corn seed is harvested, it is packed in jute or woven polypropylene bags. After the cleaning process, the seed is stored in ordinary warehouses. Finally, after final testing for germination, it is packaged for shipment to its commercial destination. Meanwhile, warehouses are ventilated, sprayed and fumigated to prevent the insect population increasing too rapidly.

Cold or conditioned storage is usually not feasible for commercial seeds due to the high costs involved and the lack of electricity supply.

Tests performed in several tropical countries with rice seeds have shown that the "predictability" of consistent germination drops after three to six months of storage. Further, a steep drop in germination occurs after six months to drastically below the "certified seed" level of 85-90 per cent.

A direct link can be observed between the increase in RH and the loss in germination, although insects and heat certainly contribute to this loss as well.

Hermetic storage

Hermetic storage (gas tight) is an ancient way of storing grain (seeds) in clay pots, underground pits or mud-plastered structures. Grain stored under hermetic conditions creates an atmosphere high in CO2 and low in O2, thus controlling insect infestation. Researchers in Israel (ARO), at the International Rice Research Institute (IRRI) in Los Banos, the Philippines, and at the Bureau of Post-Harvest Research and Extension, also in the Philippines, have further elaborated on this ancient storage principle. They have developed ways of storing bagged seeds and grain in special bags that have a much better ability to retain the gases produced by the grain than with the ancient methods.

Modern sophisticated plastics can maintain O2 and CO2 levels while preventing change in humidity, and thus build up an atmosphere that prevents insect development and at the same time "blocks" any increase of moisture in the seed.

The "modified atmosphere" (MA) thus created has an extremely beneficial effect on the seeds and, based on tests performed by IRRI, it works as well as cold storage even when measured over a period of more than 12 months (figure 3).

Storage of rice seeds in a 5-mt GrainPro Cocoon™, at

The seeds can be stored in structures with a maximum space from 7.5 m3 up to 430 m3 or in individual bags that are designed for any amount up to 50 kg.

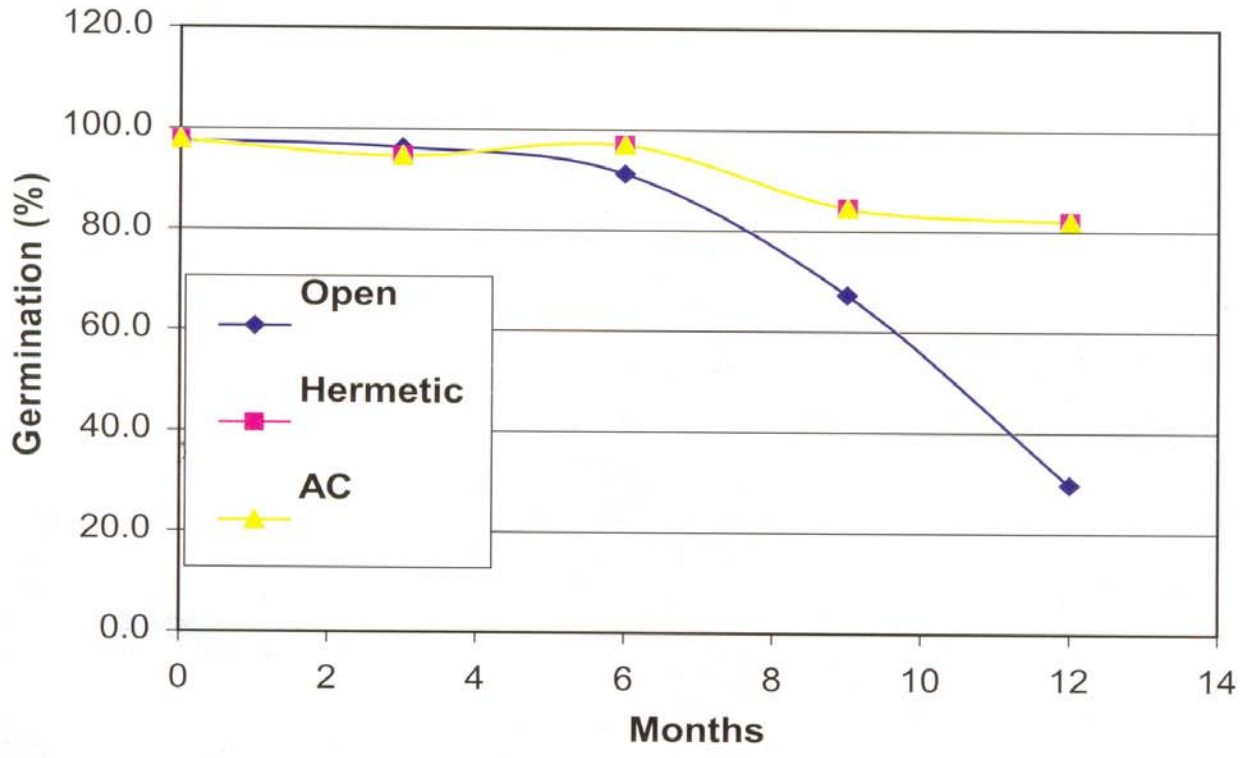

Figure 3. Germination rates in different systems

It is important to emphasise that normal plastic bags (usually made of polyethylene) do not have the desired hermetic properties and, therefore, do not provide the necessary conditions for MA storage. Tests by IRRI have shown special bags containing paddy seeds were able to develop an O2 level of 5 per cent and a drop in infestation to almost zero while maintaining constant humidity levels.

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In Bangladesh, rice seeds that were stored outdoors for 12 months in a type of a special bag showed a drop in the germination rate from 88 to 86 per cent, whereas the rate in a control stack in a warehouse decreased by only 1 per cent.

In Thailand, 10 mt of maize seeds (which were already old at the start of the trial) stored outdoors in a these modernized bags for 12 months kept their germination rate at 81 per cent while the control seeds had close to zero per cent germination at the end of the trial.

IRRI compared seed stored in cold storage, seeds stored in a warehouse and seeds stored in hermetic storage. They found that for 12 months no difference could be observed between the seed in cold storage and the seed in special bags, while seeds stored in an ordinary warehouse went down to 30 per cent germination rate (see figure 2). Various documented trials by Philrice in the Philippines using very sensitive hybrid Mestizzo 1 and 3 seeds, show that germination rates of such seeds stored in this new storage system over a nine-month period showed no significant changes over time.

After almost 10 years of research and tests on food grains and seeds, it has become clear that the modified atmosphere/hermetic storage system has become a legitimate, viable and environmentally-friendly alternative to cold stores or conventional warehousing.

GrainPro, Inc. is a company that offers hermetic storage units that promise better quality seed at lower cost while ensuring improved germination rates and higher yields for farmers throughout the world, particularly in the tropics. Their products include structures called CocoonsTM with a maximum space from 7.5 m3 up to 430 m3 or in individual bags called SuperBagsTM that are designed for any amount up to 50 kg. For more information, please contact GrainPro Inc at salesasia@grainpro.com or visit www.grainpro.com

A GrainPro Cocoon™ containing 10 mt of maize seed at Uniseed, Thailand