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## BULK SEED STORAGE, DRYING AND AERATION

A.H. Boyd<sup>1/</sup>

To meet the demands of the ever-increasing market for quality seed, many seedsmen have found it necessary to expand and modify their operations. To keep a seed processing plant operating, it is necessary to have adequate seeds in storage either on the premises or on the farm where they were produced.

However, our storage, drying and aeration problems do not necessarily begin when we load the seed into the storage facility. Quite often we "store" seed in the fields when weather conditions prevent a timely harvest. It has been demonstrated that soybeans which have been damaged, mechanically or by weather, deteriorate much faster in storage than those which were harvested early with little or no weather damage. Part of this effect is the presence of more fungi on weather damaged seeds. Mechanically damaged seeds are more susceptible to storage fungi than undamaged seeds.

As harvesting equipment gets larger, farms get larger, and the harvest season shorter, there is more and more pressure on the drying and storage facilities. This creates a greater tendency for farmers to have storage on their own farms. The presence of storage and drying bins on the farm give the farmer-seedsmen more flexibility in his choice at the market, but at the same time create management problems and add the risk of seed losing value because of improper handling.

Adaptations of existing equipment may be as varied as the mechanical drying and storage ingenuity of the seedsmen and the dictates of his existing equipment. In some cases batch drying has been used in combination with dryer bins quite effectively. Since most of these dryers are designed for grain, a temperature rise of 90 to as much as 150F is common. With a limitation of 110F air temperature for drying seed, the farmers must be limited to a 30-50F temperature rise to effectively dry seeds. The drying rate will be slower at the lower temperature than it would have been under grain drying conditions.

The most common farm installations are large flat bottom bins. Generally, the greatest problem with such installations is the tendency of the seedsmen to fill the bin completely rather than fill it to the level where effective drying can take place. Such bins almost always can store much more than they can effectively dry. Figure 1 shows the relation of horse power to depth of seed and air flow in a typical soybean storage and drying bin. Note that as the depth of seed increases, the air flow in cubic feet per minute per bushel decreases rapidly until a point is reached where the air flow approaches zero. Bin drying can

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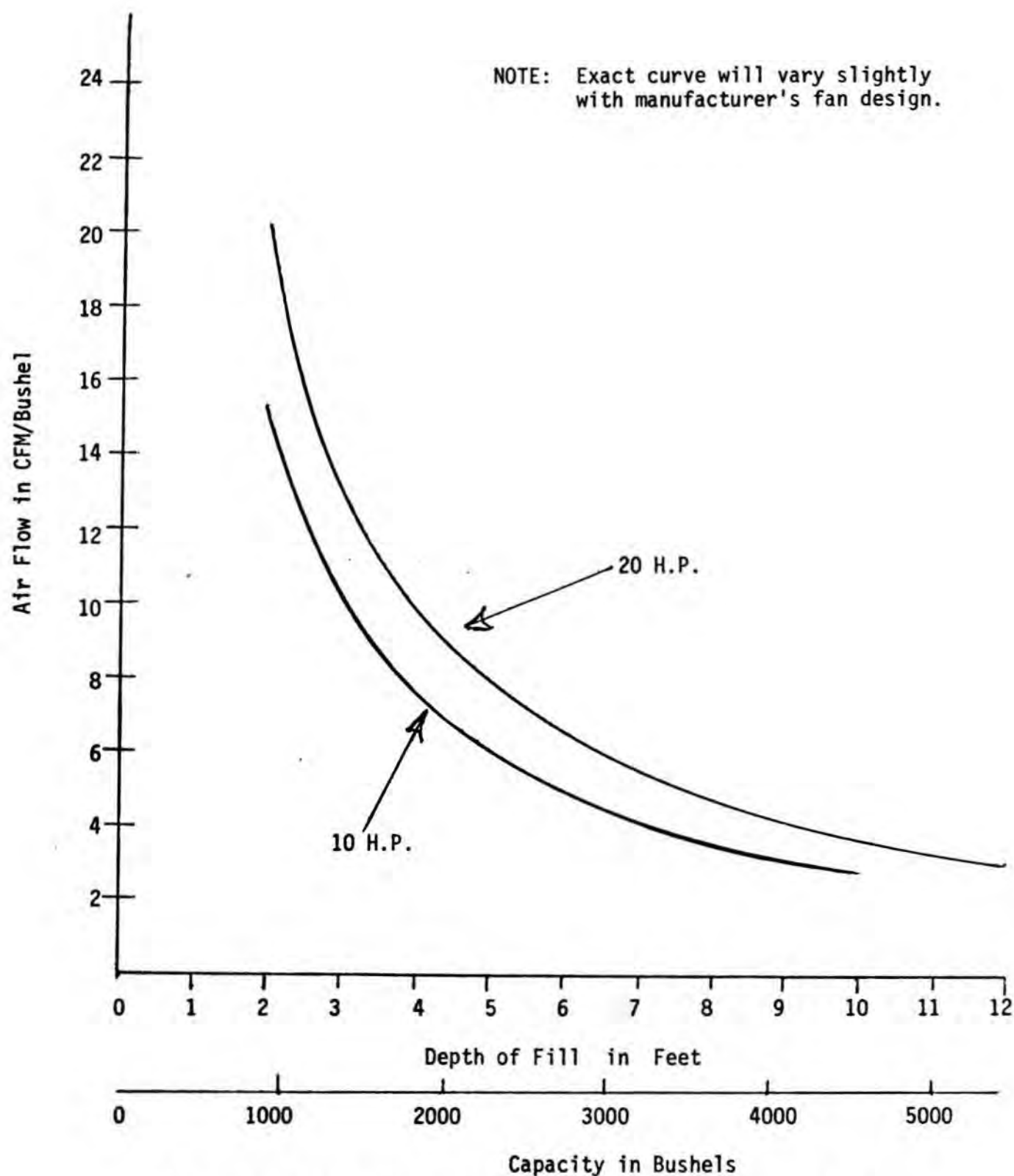


Figure 1. Estimated air flow in cfm/bu. vs. seed depth for a 27 foot diameter drying bin of soybeans with 10 hp and 20 hp centrifugal fans.

be an economical and effective method of drying but when a high side-wall bin is almost completely full, about all you can expect out of drying fans of any practical size is a good job of aeration or temperature adjustment but not a good job of drying.

As we can easily observe as we travel, almost anything is mechanically possible in the way of modification or construction of drying, storage and aeration facilities. Facilities are only limited by the imagination of the designers and the economics of construction. If one will carefully observe seed drying facilities, it soon becomes obvious that facilities are not the ultimate answer to the question. The man operating the drying facility and making the decisions must understand the problem; he must understand the principles of drying and storage, the relationships of drying fronts, air flow, temperature, moisture evaporation and heat transfer as well as the mechanics of air movement and seed conveying.

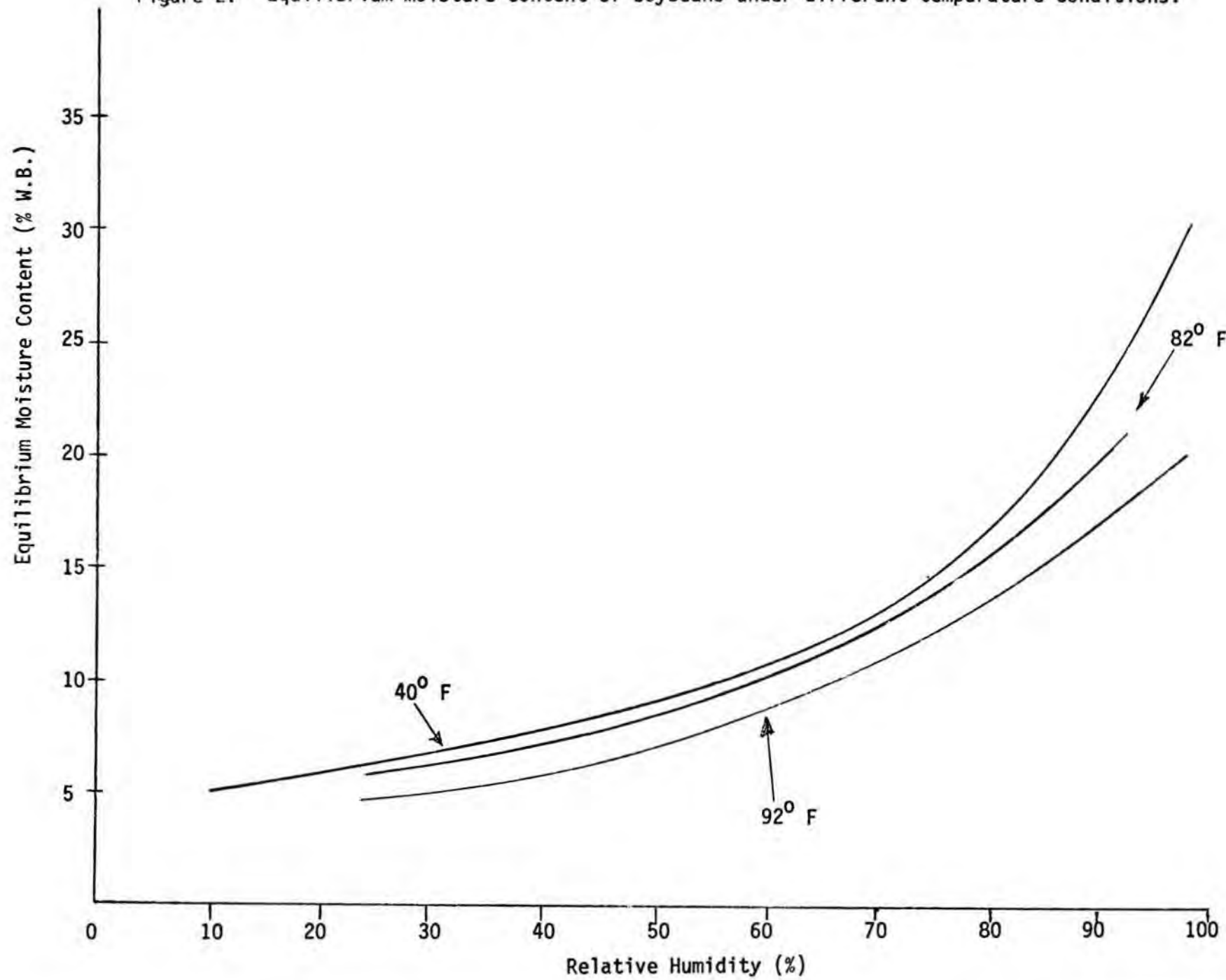
One important point to remember is that there is no magic moisture content for bulk storage of seed. The equilibrium moisture content of a seed at a given relative humidity changes somewhat with change in temperature. Seed reach a lower moisture content at a given relative humidity at a higher temperature, but the same seed will reach a higher moisture content at the same relative humidity at a lower temperature. Figure 2 gives an example of the equilibrium moisture content of soybeans at 40, 82, and 92 F.

Continuing with soybeans as an example, let us relate this difference in equilibrium moisture content at varying temperatures to the conditions as they exist in the field. Figure 3 shows average temperatures at Mississippi State, Mississippi and the maturity date of four varieties of soybeans to indicate the date and average temperature when harvest and storage is likely to begin.

We generally assume that when seed are in equilibrium with 60% relative humidity they are quite safe for short term seed storage and reasonably safe even at equilibrium with 65% relative humidity. Figure 4 shows the equilibrium moisture content at varying temperatures in relation to the varieties and average temperature at harvest. For example the Hill variety soybeans harvested early in September will be quite warm and the 65% relative humidity equilibrium point is about 11%. If we store at the usually assumed safe storage moisture content of 12% with temperatures in this range we may encounter rapid deterioration of seed quality. Couple this situation with the occurrence of green weed seed and plant parts in the early harvested crop and it is easy to understand how farmers often get into trouble with seed that are harvested in warm weather.

Figure 5 shows similar data for corn but with the average temperature at harvest time at various locations throughout the U.S. Notice that the equilibrium moisture content for corn at a given condition is higher than for soybeans. This difference is due primarily to the differences in chemical composition of corn as compared to that of soybeans.

Figure 2. Equilibrium moisture content of soybeans under different temperature conditions.



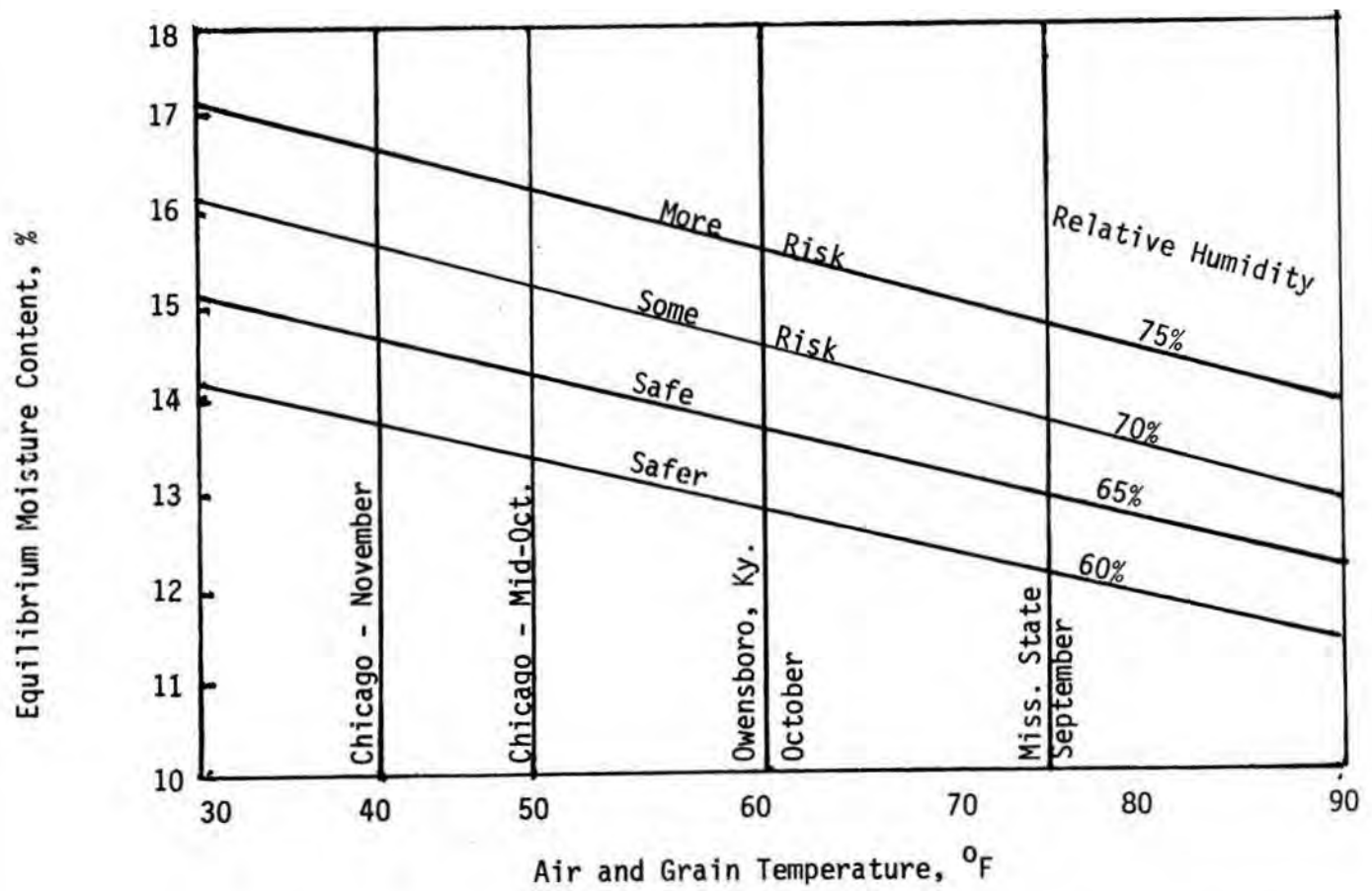


Figure 3. Effect of air and grain temperature and equilibrium relative humidity on the safe storage moisture content of shelled corn.

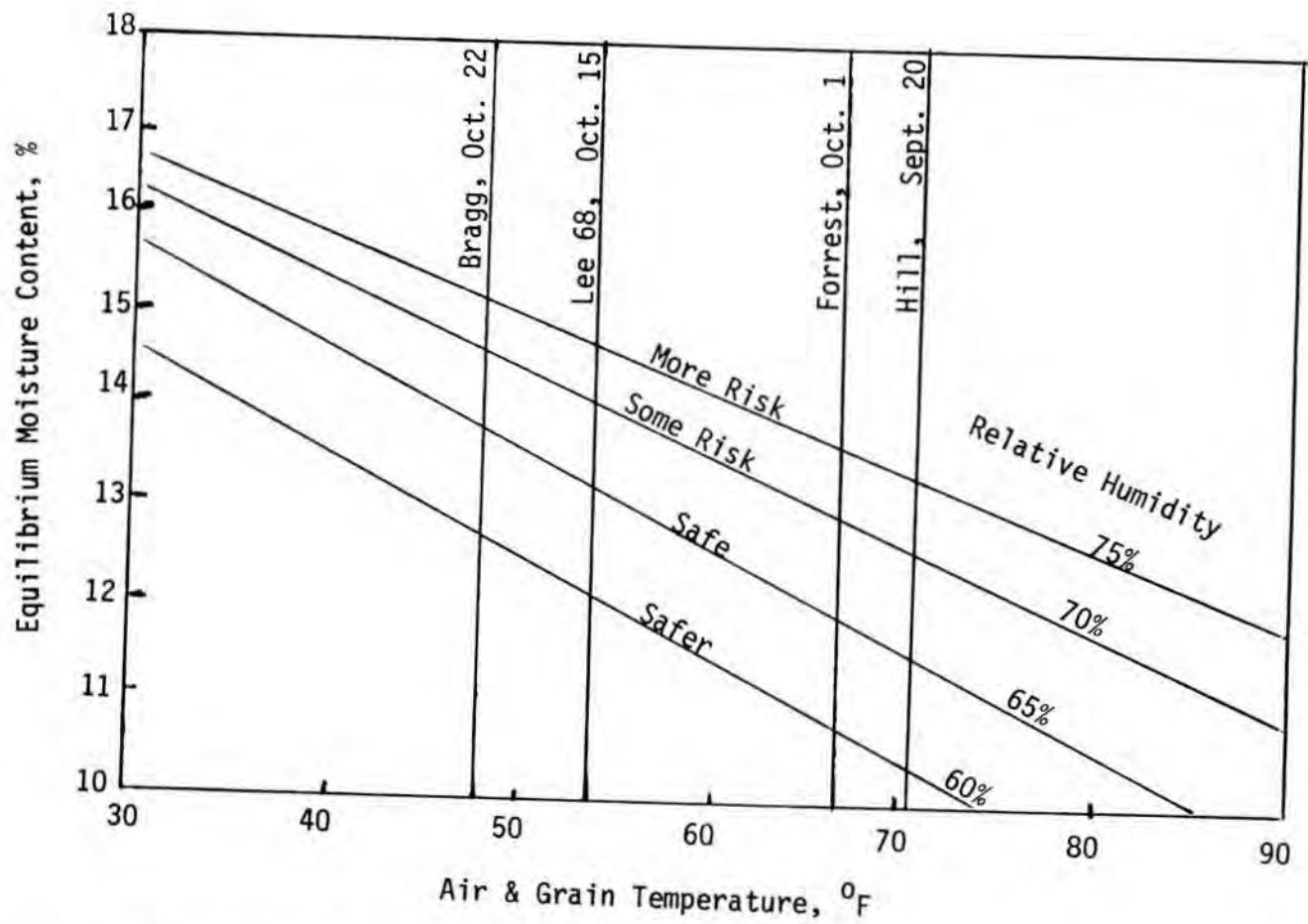


Figure 4. Effect of air and grain temperature and equilibrium relative humidity on the safe storage moisture content of soybeans.

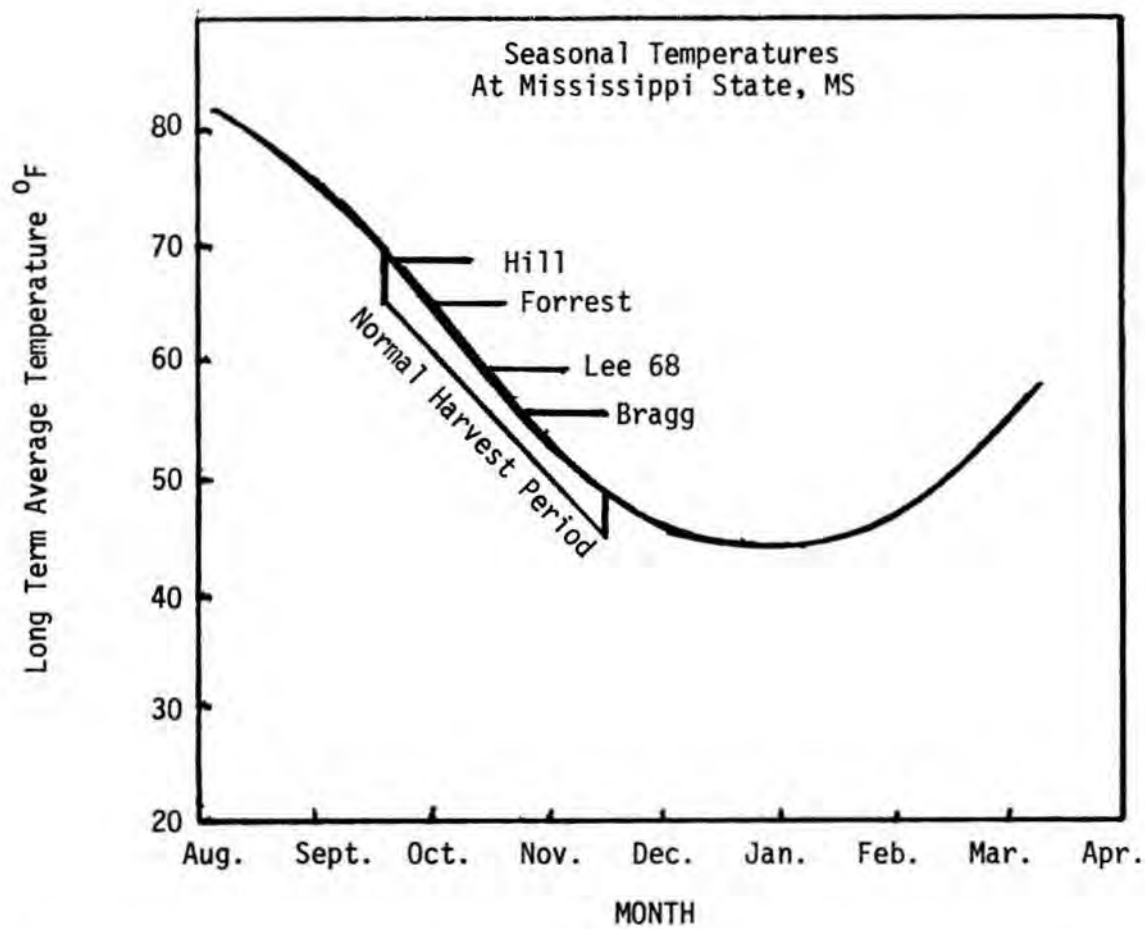


Figure 5. Expected average temperature and harvest dates at Mississippi State, MS.



## Moisture Migration

Another phenomenon that is even more important in bulk seed storage, as compared to grain storage, is moisture migration. Differences in temperature between the outside and inside of a storage bin cause convection currents to flow inside the bin. Even if your seed are within a safe equilibrium moisture content and temperature condition, very cold outside temperatures can cause condensation or "sweating" around the top and sides of the seed mass (Figure 6). After the seed are cool, a subsequent period of warm weather can cause warm air currents to rise alongside the bin with cool air settling through the center thus causing a high moisture zone to form in the center bottom of the seed mass (Figure 7).

Several changes in the weather can create hot spots in the seed which may not be detected until the bin is unloaded. Even more care is necessary to prevent such a condition in seed storage than in grain since it has been shown by several investigators that germination and vigor decreases drastically long before a reduction of one commercial grain grade is noticed.

Moisture migration due to convection currents can be prevented by timely aeration. Some good rules of thumb for aeration are:

1. When the average outside temperature differs more than 20F from the temperature of the seed in the bin, the aeration fans should be turned on and the temperature adjusted.
2. When a temperature rise of 5F at any spot inside a bin is detected, the bin should be aerated regardless of weather conditions.
3. An air flow of about 0.1 cfm/bu is adequate for aeration purposes.

The ultimate key to maintaining high quality in our stored seed is still the man who is responsible for them. The greater his knowledge of the many factors that affect changes in seed quality the more likely he is to recognize the conditions that can cause trouble and have self confidence enough to correct the conditions.

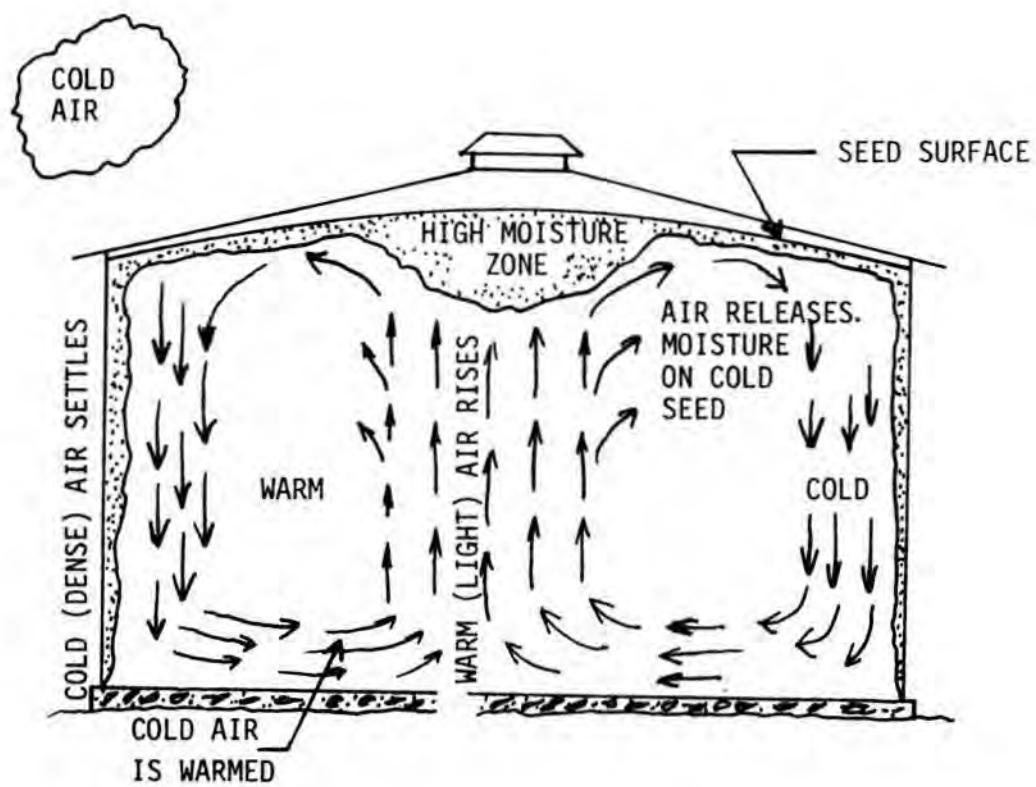


Figure 6. Moisture migration caused by cold outside conditions when the seed mass is warm.

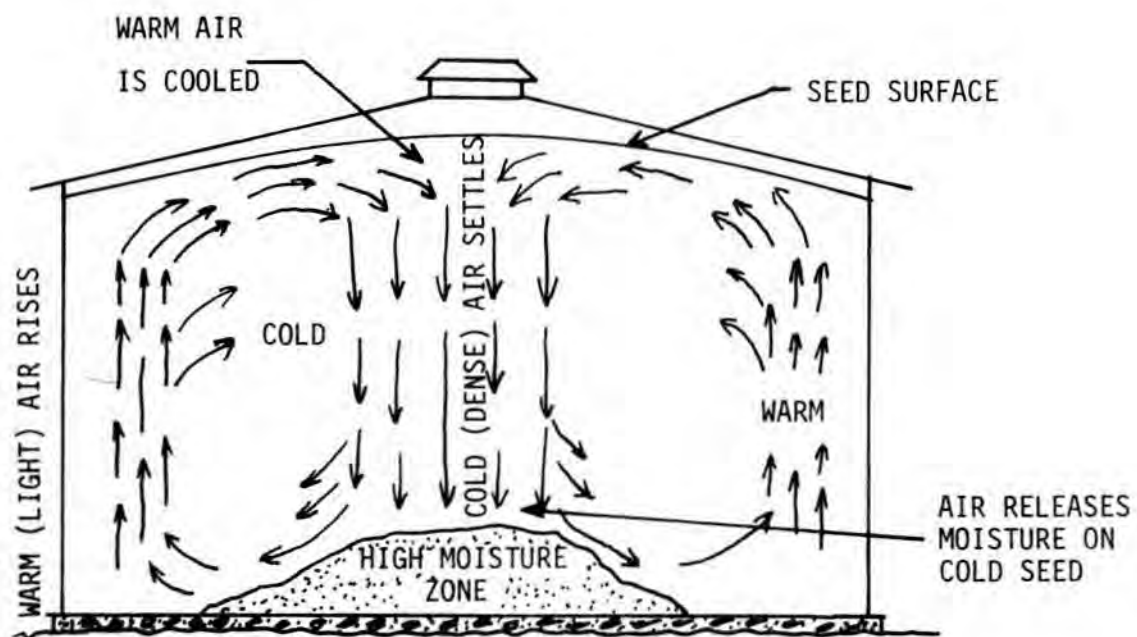


Figure 7. Moisture migration caused by warm outside conditions when the seed mass is cold.