The construction of farm storage for grain may be one of the largest investments that a farmer ever makes. Because of this, it becomes very important that the grain handling system be completely and thoroughly planned. Constructing the wrong size bin or placing a bin in an awkward location could necessitate very costly remodeling or modification when the facility is expanded or when additional mechanization is desired.

There are several basic schemes commonly used in designing a grain storage facility, each with its own advantages and disadvantages. The University of Kentucky Agricultural Engineering Department generally recommends a centralized layout because of its flexibility, ease of expansion, and relatively low labor requirements. Two plans are available from county Extension offices or from Plan Service, Agricultural Engineering Department, University of Kentucky, Lexington, Kentucky, 40546. The plans are Ky. 11.732-16 (Centralized Grain Storage) and Ky. 11.732-17 (Centralized Grain Storage with Feed Processing). The cost is 25¢ per sheet for blueprints.

ADVANTAGES AND DISADVANTAGES OF THE CENTRALIZED LAYOUT

A major advantage of the centralized layout is that it meets the needs of both the large and small operator. It is easily adapted to include any number of bins and any type of drying method. An orderly expansion can occur with minimum duplication of existing grain handling equipment (this to be discussed in detail later). Labor is kept to a minimum by mechanization, and the system offers several conveniences in that grain may be easily transported to and from a single sending and receiving point.

Disadvantages of this system are that more skill is required in construction and a larger initial investment may be required for handling equipment.

CARDINAL RULES OF GRAIN HANDLING FACILITIES DESIGN

Although there are many guidelines to be followed when designing a grain handling facility, there are two principles that must be applied if the facility is to be utilized efficiently, conveniently, and profitably. These principles are:

1) It must always be possible to easily bring grain back to its point of delivery. This is commonly referred to as a "closed-loop" system; and

2) The system should have the potential for easy expansion to two to four times the original capacity of the facility while not violating the first principle.

The "closed-loop" rule allows a truck or wagon to deliver or receive grain from the same location. It permits the moving of grain from one bin to another or back to the same bin if desired. Any bin to which grain cannot be unloaded and transported easily is not usually included in the facility.

The "expansion" rule allows for additional storage space while keeping to a minimum the equipment required for handling. It should be noted that, many times, the "best" location for a bin in the initial facility layout may block expansion paths when additional bins are added. The "expansion" rule allows the grain storage facility to grow with the farming operation it serves.

SITE SELECTION AND GRAIN HANDLING CONSIDERATIONS

The most important step in laying out a grain storage facility is in selecting the proper site. A well drained,
Figure 3

Figure 4
accessible area with plenty of room to expand should be chosen. Many people make the mistake of locating a single bin in an isolated spot "between the old barn and the pond and out of the way," overlooking the fact that no expansion can occur, with the result that their investment is not utilized efficiently. The key is to "keep all the options open" and this begins with selecting a site large enough to accommodate future as well as present storage needs.

Although the area required for storage will certainly vary with the size of the facility, a minimum space of approximately 100 ft. by 200 ft. should be reserved for the site if at all possible. The ground should be smooth with adequate drainage away from the facility. Other factors to consider are the availability of fuel, electrical power and all-weather roads; the ability to maneuver and park trucks and wagons in and around the receiving and shipping point; the relative location of residential housing (due to noise and dust); and the physical security of the stored grain.

After selecting a site, the next step is to plan the handling system. The location of the center building, the dump pit, and the bucket elevator should be marked (Figure 1). This is not to say that these items are constructed first (or at all) but rather that space will be allotted for them when expansion occurs. If the dump pit and bucket elevator are not constructed the first year, alternate handling methods must be selected. After completing the plans for handling the grain, the location of each bin should be determined. By using wooden pegs and string, the future facility can be completely marked at the site of construction, thus eliminating much of the guesswork with regard to space and arrangement. (Detailed dimensions are shown on Ky. building plans 11, 732-16 and Ky. 11, 732-17).

**LAYOUT AND EXPANSION OF CENTRALIZED FACILITIES**

To illustrate the flexibility of the centralized arrangement, it will be assumed that the facility will begin with one bin, using layer drying, and expand to six bins using a portable dryer.

Where will the first bin be located? If two perpendicular lines were to be drawn through the center of the future building site such that the facility area would be divided into four quadrants, the first bin to be constructed would be in the same quadrant as the proposed bucket elevator, Quadrant 1, as shown in Figure 2. The grain in this bin would be dried using the layer drying technique—that is, drying a 10 to 12 inch layer of grain per day, using a drying air temperature of 15-20 degrees higher than the outside temperature.

Assuming that more storage and additional drying capacity are needed, the next two bins to be built would be located in Quadrants 2 and 3 (Figure 3). Batch-in-bin drying techniques could then be used in Bin 1 instead of layer drying. The batch-in-bin method allows up to four feet of grain to be dried overnight in Bin 1 with a heated air temperature of approximately 140°. An unloading auger could be extended from Bin 1 to a location where it could feed the proposed bucket elevator. At this location a single portable auger can convey the dried grain to either Bin 2 or Bin 3. After Bins 2 and 3 are filled and the bottom 4 feet of Bin 1 is dried, the remaining grain to be placed in Bin 1 is conditioned using the layer drying method.

The decision to expand to four bins generally requires the addition of new handling equipment. However, if planned correctly from the beginning, very little alteration of the existing facility will be needed. The new equipment required will include a bucket elevator with downs毛uting to each bin, a dump pit, and extension of the unloading augers from Bins 2 and 3 to the pit so that the "closed-loop" principle can be applied. Bin 4, located in quadrant 4, also becomes part of the closed loop (Figure 4).

Suppose that the capacity of the batch-in-bin dryer is too small. Because of prior planning, a portable batch or continuous flow dryer may be placed between Bins 1 and 4 (a minimum space of 14 feet between these two bins is recommended). This dryer may also be placed in front of the building near Bin 1 (Figure 5). Selection of a portable batch or continuous flow dryer usually dictates an overhead wet holding bin positioned over the dryer for gravity feeding. In addition, a continuous flow dryer would usually include a surge bin for the dried grain.

What if additional storage space is required? If additional storage is needed, it may be placed in line with Bins 2 and 3 with the "closed-loop" being accomplished through overhead and unloading augers feeding grain to and from the expansion bins (Figure 6). This expansion may continue in several alternate directions, depending primarily on the available space. Note that at this point in facility expansion the cost per bushel of storage decreases because the major materials handling items (bucket elevator, pit, dryer, etc.) have already been purchased.

If sufficient space is allowed for the building, the option of installing feed processing equipment can be taken. Alternate locations include the area to the side of the driveway, overhead above the driveway, or perhaps in one of the quadrants previously reserved for a storage bin.

**CONCLUSION**

The centralized scheme for bin layout offers a number of advantages. But regardless of the layout, the "closed-loop" and "expansion" principles must not be violated if the grain facility is to produce a maximum of profit and convenience. The surest way to fail in designing a grain handling facility is to select a poor site such that there is never sufficient space for expansion and centralization of
storage and equipment. Add to this an inadequate grain handling method (such as moving large quantities of grain by scoop shovel) and the result will be an expensive but poorly functioning system. If one phrase could express the key to designing grain handling facilities, it would be to "keep as many options open as possible."