End-Gate Sampling of Grain

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GRAIN SAMPLING

The importance of grain sampling is frequently underestimated. On the farm and at country elevators, grain is sampled with little thought or attention as to sample size and frequency of sample collection per unit volume of grain traded or stored. The sample is considered important, but the means by which it is obtained is often not.

Sampling at the country elevator is necessary in order to determine the level of some factors which determine the price to be paid for the commodity. Sampling should also be done at the farm in order to know the quality of the product going into storage or, at least, to have a representative sample of that product available. Knowledge of stored product quality gives the producer the opportunity to be competitive in the market place. With knowledge of the product quality or having the sample "in hand," the producer can take bids on that product from several buyers prior to actual delivery of the product.

DEFINITION

Sampling is the process of separating a small portion of a substance from a larger portion so that the small portion may be studied and conclusions can then be made about the larger portion. When samples are taken of a uniform material, there are few problems in obtaining a sample that represents the entire quantity. When samples are taken of a nonuniform material, such as grain, there are many problems in obtaining a truly representative sample. This can be due to variation in particle size, stratification, and variation due to particle mass. All sampling involves uncertainty. The degree of uncertainty depends upon the variability in the material, inexactness in carrying out procedures, and the number of samples taken (Bicking, 1967).

STREAM SAMPLING AND THE GRAIN TRADE

The agreement of terms leading to the sale of a load (lot) of grain is partially based upon information about the quality of the grain. There are several factors describing it which have an effect on the price to be offered; dockage, broken corn and foreign material (BCFM), foreign material (FM), test weight, moisture content, and protein. This information is obtained from the sample which represents the lot of grain. Information from the sample leads to price agreement between the buyer and the seller.

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Farmers and country elevator managers are frequently unable to explain wide variations in the values given to grade factors on incoming grain. Some of these differences may be due to errors of measurement, but even when every step in the sampling and grading procedure is correctly performed, there is still one major source of variation in the values assigned to the grade factors, and that is random sampling variation (Bermingham et al., 1976).

The size of a lot of grain being traded at the farm or country elevator prohibits analyzing the entire lot, therefore the sale is based on what is assumed to be a representative sample. Assuming the tests conducted on the sample are performed accurately, the makeup of the sample is considered to be the same as the makeup of the lot of grain. A representative sample is the basis upon which accurate grain evaluation begins. The validity of the testing can be no stronger than the representativeness of the samples tested (Hurburgh et al., 1979). The terms of the transaction are directly affected by the sample taken from the lot of grain. The quality of the sample can have a considerable effect on the amount of money traded for the lot of grain, in favor of either the buyer or the seller. The sample is a critical part of the transaction.

CORRECT SAMPLING

It is well accepted fact that as grain is loaded into a container (truckbox or similar container), some stratification and segregation of the constituents of the grain mass occurs (Watson, 1974; Hurburgh et al., 1979). This stratification is evident when the grain is flowing from the end-gate of a truckbox (Figure 1). When the person collecting the sample has the freedom of selecting the part of the grain stream from which to sample, he has the opportunity to influence how well the sample represents the lot of grain. This freedom to influence the quality of samples cannot be accepted in fair grain trade.

There are certain requirements which must be met if a representative sample is to be taken from a flowing stream. When sampling from a flowing stream, the material should fall free for about 1 foot (Bicking, 1967). The stream of grain must be sampled in such a way that all of the stream is diverted into the sampling device as it passes through the stream. The device must not be allowed to completely fill with grain before it leaves the grain stream; to do otherwise would allow some of the flowing grain to pass around the sampler and not be sampled. A sample of the stream should be taken at periodic intervals so the entire lot of grain is equally represented by the sample. The Federal Grain Inspection Service (FGIS) recommends that a sample be col-

Figure 1. Evidence of segregation and the opportunity to bias the sample.

Figure 2. Typical procedure for sampling.

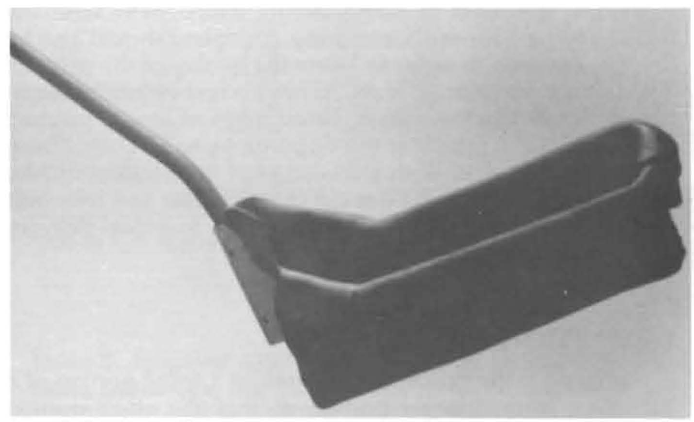

Figure 3. The Pelican sampler.

lected approximately once for each 500 bushels. Truckloads of grain are to be sampled by at least two cuts of the sampler.

OBSERVED SAMPLING TECHNIQUES AT COUNTRY ELEVATORS

The most commonly observed sampling procedure involves passing a cupped hand through the grain stream and diverting a part of the flow into a container (Figure 2). Typically, this procedure is done approximately three times before the first one-third of the load is removed from the truckbox.

Another common sampling technique involves the use of a home-made sampling tool. The tool is made by fastening a small cup (about 1 pint capacity) to a length of broomstick. This tool is passed through the grain stream from front to back and to the side of the centerline of the grain stream. Not more than four cuts through the grain stream is made during the collection of a sample. The cup usually over-fills before completely passing through the grain stream.

APPROVED SAMPLERS

The Pelican sampler is the only FGIS approved manual diverter-type sampling tool currently available for end-gate sampling of grain (Figure 3) (USDA, 1985). The retail cost is about $80.00 without a handle. The Pelican is somewhat awkward to use for end-gate sampling due to its general configuration. The cost and clumsiness of the tool do not favor its use on farms or at country elevators. Farmers and elevator managers use other sampling methods without knowing about their reliability and limitations. The acceptance of the alternate methods by the buyer and seller is based on good faith and the lack of a better sampling method. There is a need for a more economically priced and easier to use sampling tool that provides a sample as representative as the Pelican sampler.

SAMPLERS FOR COMPARISON

Two sampling tools were developed to compare to the Pelican. The tools were made of low priced, easily worked, and readily available materials. The statistical comparisons were based on test factors common to the grain trade; dockage, foreign material, broken corn and foreign material, test weight, and moisture content. The objectives of the comparisons were:

1. To determine if grain samples collected with two, easily constructed sampling tools differ significantly from grain samples collected with the FGIS approved Pelican sampler.
2. To determine, for each sampling tool, if there are significant differences between grain samples collected at different times during the unloading of grain from a truck.

Crops selected for sampling with the tools were corn, soybeans, durum, hard red spring (HRS) wheat, and barley. Grain properties used as criteria in determining differences between the sampling tools were moisture content, bushel test weight, and dockage for HRS wheat, durum wheat, and barley; broken corn and foreign material (BCFM) for corn; and foreign material (FM) for soybeans.

PROCEDURE

A sampling tool similar to the Pelican sampler was developed. It has a long, narrow opening for grain to enter and a capacity similar to that of the Pelican (Figure 4). The sampling tool is capable of being emptied quickly and cleanly, leaving no residue from one sample to contaminate the next. This sampler will be referred to as the "Pipe" since it is made from polyvinyl chloride (PVC) drain, waste, and vent pipe.

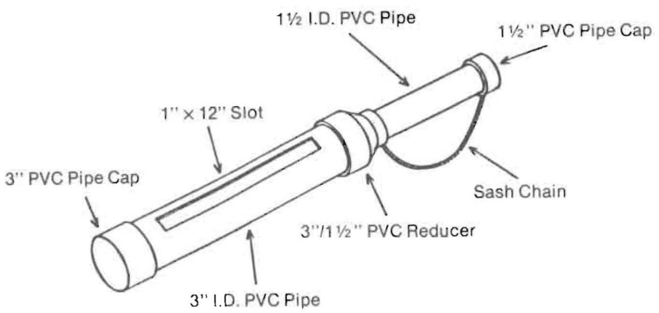

Figure 4. Pipe sampler components.

PVC plumbing components were selected for the construction because of their availability, durability, and ease with which PVC is worked. The system used for joining the parts involves simply using a cleaning agent and then a solvent which welds the parts together. All components are readily available at building supply outlets and hardware stores.

A second sampling tool was made from a coffee can. This sampling tool is referred to as the "Can" (Figure 5). The Can is a somewhat deformed 3 pound coffee can deformed by compressing the sides, changing the basic shape of the opening from round to a very elongated ellipse. The dimensions of the opening were 1.25 inches wide and 9 inches long. A handle made of square steel tubing was brazed to one of the narrow sides to facilitate handling.

Each sampling tool was tested by sampling each type of grain from at least nine truckloads. Samples were taken at three different times in the unloading process; early, middle, and late. Early represents the time period during which the first one-third of the load was unloaded, middle represents the time period during which the second one-third of the load was unloaded, and late represents the time period during which the final one-third of the load was unloaded. Since the capacity and end-gate dimensions of the trucks varied, it was not feasible to assign a more accurate time schedule for sample collection. The number of truckloads and number of samples taken from each load by each sampler yielded a minimum of 27 samples for each crop.

Figure 5. The can sampler.

All sampling tools were used in the same manner. Sampling was done by moving the tool through the grain stream as it flowed from the truck end-gate. The grain stream was cut completely by each sampling tool with a right side to left side movement, which is the FGIS prescribed method of use for the Pelican sampler (Haynes, 1986). The stream was centered in the length of the opening of the sampling tool while moving the tool through the grain stream. The tools were moved through the grain stream quickly enough so they did not overflow before exiting the stream. Truckloads ranging in volume from about 100 bushels to about 600 bushels were sampled. Truckbox end-gates varied in size from approximately 6 inches square to 1 foot by 1.5 foot.

CONCLUSIONS

Three grain sampling tools were compared to each other for their effectiveness to obtain representative samples from which to determine dockage, BCFM or FM, test weight, and moisture content. The comparisons were made on a load by load basis and with all the loads combined by crop. No statistically significant differences were found when the Pipe was compared to the Pelican. When the Can was compared to either the Pipe or the Pelican, 99 percent of the comparisons indicated no significant difference. The ranges of test factors is shown in Table 1.

No statistically significant relationship was found between the time of sampler use and the dockage (or BCFM or FM), test weight, or moisture content of the samples for any of the sampling tools at a significance level of 0.05.

With current standards, the time at which a sample is taken during the process of unloading a truckload of grain

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Table 1. Maximum and Minimum Test Factor Values.

	Dockage, %*		Test Weight, lb/bu		Moisture, $\%_{wb}$	
Crop	Min.	Max.	Min.	Max.	Min.	Max.
Barley	1.0	5.0	44.0	52.0	10.9	13.3
Corn	0.0	4.0	55.0	58.0	12.4	15.2
Durum	0.5	3.5	53.0	62.0	10.1	12.9
Soybean	0.0	0.5	56.0	60.0	9.5	14.6
HRS	0.5	3.0	48.0	61.0	10.1	11.9

*Broken corn and foreign material in corn, foreign material in soybeans.

leadership development opportunities have been available in recent years than 15-20 years ago.

The amount of school completed by respondents made more difference on their perceived leadership ability than any other characteristic studied. The more school completed, the higher the perceived leadership ability. Young rural adults who had completed 16 years of school or more perceived their leadership ability to be higher than those with less schooling. Those who had completed 13-15 years rated their level of leadership higher than those completing 12 years or less. This raises the question: Do persons with higher levels of leadership ability pursue higher levels of education, or do high levels of education contribute to leadership development in that more activities and opportunities are more readily available to those continuing their education?

SUMMARY

The biographical data obtained corresponded closely with the 1980 census data. About three-fourths of the respondents were between the ages of 20 and 36; slightly over one-half were female; and approximately two-thirds were married. Slightly more than one-half the respondents were raised on a farm, whereas the majority currently resides in a town or city. Almost all respondents completed at least a high school education; two-thirds completed some education beyond high school, and about one-fourth completed a college degree.

Young adults residing in rural North Dakota tended to perceive thier leadership abilities to be quite good. Leadership skills in the categories of **General Leadership** and **Work Related Leadership** were perceived to be better than those in the **Group Leadership Skills** and **Speaking Skills**. The **Speaking Skills** category was perceived to be their weakest area of leadership. This would indicate that young people need to be provided more opportunities through activities and their educational experiences to develop their speaking skills.

The greatest difference in perceived leadership ability occurred between sexes (females were higher) and among various levels of school completed (higher leadership among those with higher levels of school completed). A profile of an individual with the highest level of leadership would be: female, single, no children living at home, raised on a farm, not currently living on a farm, 24 years old or less, and has completed 16 or more years of school.

The findings of this study may serve as a basis for developing leadership programs in the state. The leadership skills statements which the young adults perceived themselves to be lowest in should be given the greatest amount of attention in a leadership development program.

REFERENCES

Bureau of the Census (1980). **1980 census of population: General population characteristics** (Vol. I, pt. 36). Washington, DC: US Department of Commerce.

Clarenbach, K.F. (1977). **Educational needs of rural women and girls.** Washington, DC: The National Advisory Council on Women's Educational Programs.

Gordon, Thomas. (1977). **Leader effectiveness training.** New York: Wyden Books.

Howell, R.E., Weier, I.L., & Cook, A.L. (1982). **Development of rural leadership: Problems, procedures and insights.** Battle Creek, MI: the W.K. Kellogg Foundation.

Kreitlow, B.W., Aiton, E.W., & Torrence, A.P. (1982). **Leadership for action in rural communities.** Danville, IL: The Interstate Printers and Publishers, Inc.

Williams, A.S. & Faulkner, L.G. (1979). **The Montana Kellogg-Extension Education Project: An evaluation.** Bozeman, MT: Montana State University Agricultural Experiment Station and Cooperative Extension Service.

Wills, V.L. (1974). A study of leadership. **Adult Leadership, 23,** 116.

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will not have a significant effect on the test factor level in the samples collected with the three tools.

This study indicates that the Pipe and Can will provide samples of a lot of grain that are as representative as those obtained with the Pelican when the sampling instruments are used properly, cutting the full stream and not overflowing before exiting the grain stream.

REFERENCES

Bicking, C.A. 1967. The Sampling of Bulk Materials. Materials Research & Standards, 7(3):95-116.

Hurburgh, C.R., Jr., C.J. Bern, and D.F. Fox. 1979. Evaluating Grain Probing Devices and Procedures. ASAE paper No. 79-3035. American Society of Agricultural Engineers, St. Joseph, MI.

United States Department of Agriculture. 1985. Grain Sampling, Book I, FGIS-20113. Federal Grain Inspection Service. United States Department of Agriculture. Washington, DC.

Watson, C.A. 1974. Sampling Methods Vary, Advantages Are Cited. Grain Age. October. pp. 45.