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Grain moisture problems on the south coast

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In most West Australian grain growing districts high temperatures and dry weather at grain maturation are ideal for harvesting and enable delivery of grain with acceptable moisture levels. Grain from W.A. is known in world markets as a good quality dry product which is unlikely to deteriorate in storage. However, growers in coastal areas and particularly those south of Narrogin sometimes have trouble harvesting grain below the receival limit of 12 per cent moisture.

Standing grain usually absorbs water from the atmosphere at night and loses it during the day. At harvesting time in the cooler, wetter areas of W.A., grain moisture levels at dawn are often above the 12 per cent. limit for safe storage. The problem for farmers in these areas is to determine when the moisture in their grain falls below this critical level so that the crop is safe to harvest.

At receival points the problem is to measure grain moisture quickly, accurately and cheaply. The obvious need for speed at country receival points prevents precise scientific measurement which can take from two hours to two weeks to complete. The methods used must give a de-

The effect of high moisture on stored grain. The sample on the right was stored moist, and mould development has made it unfit for consumption by stock.

The sample on the left was also stored moist but was treated with propionic acid, which has prevented mould growth. Propionic acid-treated grain can be stored for up to a year and fed to stock, which gives farmers an alternative use for the grain in areas where grain moisture is a problem.
termination in minutes and must be as accurate as possible at the cut-off point.

Solutions to these problems could come from better timed harvesting operations, more accurate moisture measuring equipment at receival points, grain drying facilities, and farming systems where grain is fed on the farm and not delivered to the bin.

**Timing harvesting**

One of the most promising approaches to the grain moisture problem appears to be improving the timing of harvesting operations. At present, some of a farmer's decision on whether a crop is dry enough for harvest and safe delivery is based on guess work. Aids such as the graph relating atmospheric relative humidity and grain moisture, which most farmers in problem areas have received, and advice on harvesting in the C.B.H. pamphlet "The Grower and Delivery of Grain to C.B.H. Ltd." cannot cover the whole problem. To these guidelines, farmers must add guesses about grain moisture levels reached in the preceding day and night. These levels are determined by the total moisture environment of the crop—the pattern of relative humidity and rainfall in the days preceding the decision on harvesting.

The relationships between moisture environment and preceding moisture levels, and grain moisture at any given harvesting time are being studied at the Mt. Barker research station where grain is harvested at two hourly intervals. Grain moisture is being measured with several methods and the results are being related to continuous records of humidity and rainfall. The objective of the work is to provide advice to farmers on how to make better use of meteorological records and their own measurements of relative humidity to determine safe times for harvesting.

Working on similar lines, two English scientists were able to obtain an equation which was used to predict grain moisture from weather records. Descriptive and explanatory models for predicting moisture content of wheat in the field in weather which kept the grain at much higher moisture levels than in W.A. were compared by van Elderen and van Hoven. Similar models can be developed for our south coastal areas and should be useful in making daily decisions on when to start harvesting and on predicting the amount of suitable harvesting time in a given period.

At Mt. Barker in the 1972-73 season it was found that moisture in barley grain fluctuated daily between 11 and 17 per cent when there was no rain. Under such conditions it is clearly important to be able to estimate accurately the period of the day during which moisture will be below the 12 per cent limit for receival.

**Accurate moisture measurements**

Standard reliable laboratory methods used internationally involve weighing and oven drying of samples and the fastest method takes about 30 minutes. Even if time was no problem, laboratory facilities at each receival point would be too expensive, so indirect ways of measuring moisture must be used.

The nature of the material being measured also limits the accuracy of measurements. All the indirect methods discussed below give reasonably satisfactory results when used under properly controlled conditions in the laboratory on samples in which the moisture is evenly distributed as when grain is held in an air-tight sample tin for several days. In such a case the moisture in the grain is in equilibrium with the surrounding air. When grain is brought to receival points it has often been subjected to recent sharp changes in its surrounding environment, moisture levels are not steady and levels in individual grains can differ markedly. A further complication early in the season is that grains from late maturing plants will be higher in moisture than the bulk of grain.

Three basic types of meter are used to measure grain moisture.

**Resistances**

Meters measuring resistance or conductivity of either crushed or whole grain to the passage of an electric current give very satisfactory results in the laboratory and use small samples. Sampling and grinding of the grain into the fine, even particles required is readily done in the laboratory but difficult to achieve at receival points. The number of operations to be done make this method an awkward one to use in the field.

**Capacitance**

Meters measuring the capacity of grain for the passage of an electric current are widely used in other grain producing areas and give results quickly. It is difficult with any indirect method to measure the average level of moisture in material when the moisture is unevenly distributed. Results obtained with capacitance meters have shown them to be less affected by this source of error than other meters. Disadvantages include the relatively high cost and the need for weighing the sample being measured.

**Relative humidity**

Meters measuring relative humidity of air in spaces between kernels of grain can be used to estimate grain moisture levels because grain moisture is the main determinant of the relative humidity of intergranular air. Accuracy with this method relies to a large extent on the attainment of equilibrium between moisture in intergranular air and grain.

One of the weaknesses of using relative humidity of air within a grain sample as an indication of grain moisture level is that there is considerable evidence that temperature affects the relationship. Another is that the relationship is also affected by whether the grain has recently been gaining or losing moisture. A further problem is that at harvest time in some areas there can be considerable gradients in moisture content from the middle to the outside of individual kernels of grain. Under some conditions of grain surface wetness and dryness it can take more than two to three hours to get satisfactory readings.

To those whose job it is to store grain safely the most important matter is to make sure that relative humidity of the intergranular air is below the safe limit. If the relative humidity is too high conditions are favourable for both mould and insect growth. Hence there is a basis for the choice of relative humidity measurement as the means of de-
terminating the suitability of grain for storage.

As much of the investigation on these methods has been done under conditions different from those at W.A. receiveal points, Co-operative Bulk Handling Ltd. and the Department of Agriculture, in collaboration, are comparing the results obtained with these methods under our conditions with the objective of improving the accuracy of the method now in use.

In one of these studies we are harvesting grain at different times of the day and comparing the accuracy of the three methods with the oven method to see how accuracy of measurement varies as grain moisture is rising in the evening and falling in the morning.

C.B.H. began an investigation of the various types of moisture meters at receival points and in the laboratory in 1972-73. Seven different makes were tested against a standard oven method and about 3000 samples were used. The investigation is continuing in 1973-74 with two additional types of meter.

**Grain drying**

Although grain drying could give the farmer a lot of control over his harvesting operation, the main disadvantages are the cost and inconvenience. Another disadvantage is the need for accurate grain moisture measurements from which to determine how much drying is needed. Also, grain drying must be done carefully or the quality of the grain will be impaired. CSIRO is conducting studies of grain drying.

**New farm systems**

An alternative farming system to selling grain is to feed the grain to stock on the farm. This requires storage for periods up to 12 months, and grain protectants can be added to moist grain so that it can be safely kept this long. One disadvantage is that the germ is damaged and treated grain cannot be delivered to the handling authority and sold. To make protectants worthwhile farmers must change their programme and commit themselves to feeding stock over a long period. Such a system lacks the flexibility of simply cropping a variable area and delivering most of the crop to a receiving authority. Small scale trials (in 20 litre drums) have confirmed overseas experience that propionic acid is effective in protecting moist grain from deterioration by moulds.

**Application of results**

By considering results from studies on the prediction of harvesting together with long term weather records, we should be able to give farmers in any particular location reliable estimates of the amount of suitable harvesting time in December and January. This information will help farmers to decide what emphasis to place on cropping where harvesting may be difficult to schedule on account of problems with grain moisture and where alternative farm enterprises are available. An increase in the reliability of decisions that a crop can be safely harvested at a particular time on any specified day should also be possible.

**References**