FACTSHEET:

Falling Number

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WHAT IS A FALLING NUMBER TEST?

When it rains just before harvest, grain may start to germinate (sprout) in the head. Germination causes an increase in *alpha*-amylase, an enzyme that breaks down starch. Grain with high levels of *alpha*-amylase produces lower quality flour. The impact of sprout damage is not fully realised until the grain is processed into end products such as bread or Asian noodles.

When visual sprouting is detected, there is a nil tolerance unless a Falling Number is measured. Where the Falling Number is measured, the visual sprouting limit no longer applies and the relevant Falling Number standard is applied. The assessment method used at receival sites depends on the severity of sprouting, grain exhibiting early stages of sprouting may only be detected through the use of the Falling Number test, and is reliant on the availability of testing equipment.

The Falling Number test has been in use in domestic and international wheat trading for over 40 years and has been adopted by key international organisations responsible for standardisation of methods. It is the internationally recognised method used by both traders and their customers who closely monitor wheat deliveries for sprout damage. International grain contracts commonly reference minimum falling number values.

The Falling Number test was designed to mimic the way the flour made from grain would behave in a bakery. It does not directly measure *alpha*-amylase activity but measures changes in the properties of the starch component of the grain caused by *alpha*-amylase activity.

Samples being tested in a Falling Number machine.

The endosperm of grains contains about 65% starch. When starch is heated in water it forms a thick paste (e.g. when you make gravy or custard). If the grain is weather damaged the *alpha*-amylase enzyme has been activated and breaks the starch into sugars. Heated sugar and water makes a sweet liquid rather than a thick paste. The extent of the weather damage can be measured by dropping a plunger into a mixture of ground wheat and water that has been heated. If the wheat is sound it will make a thick paste and it will take the plunger more than 300 seconds to reach the bottom of the test tube, on the other hand, if the wheat is badly weather damaged the plunger will move quickly through the blend. The longer the grain is wet, the greater the amount of *alpha*-amylase present and the lower the Falling Number.

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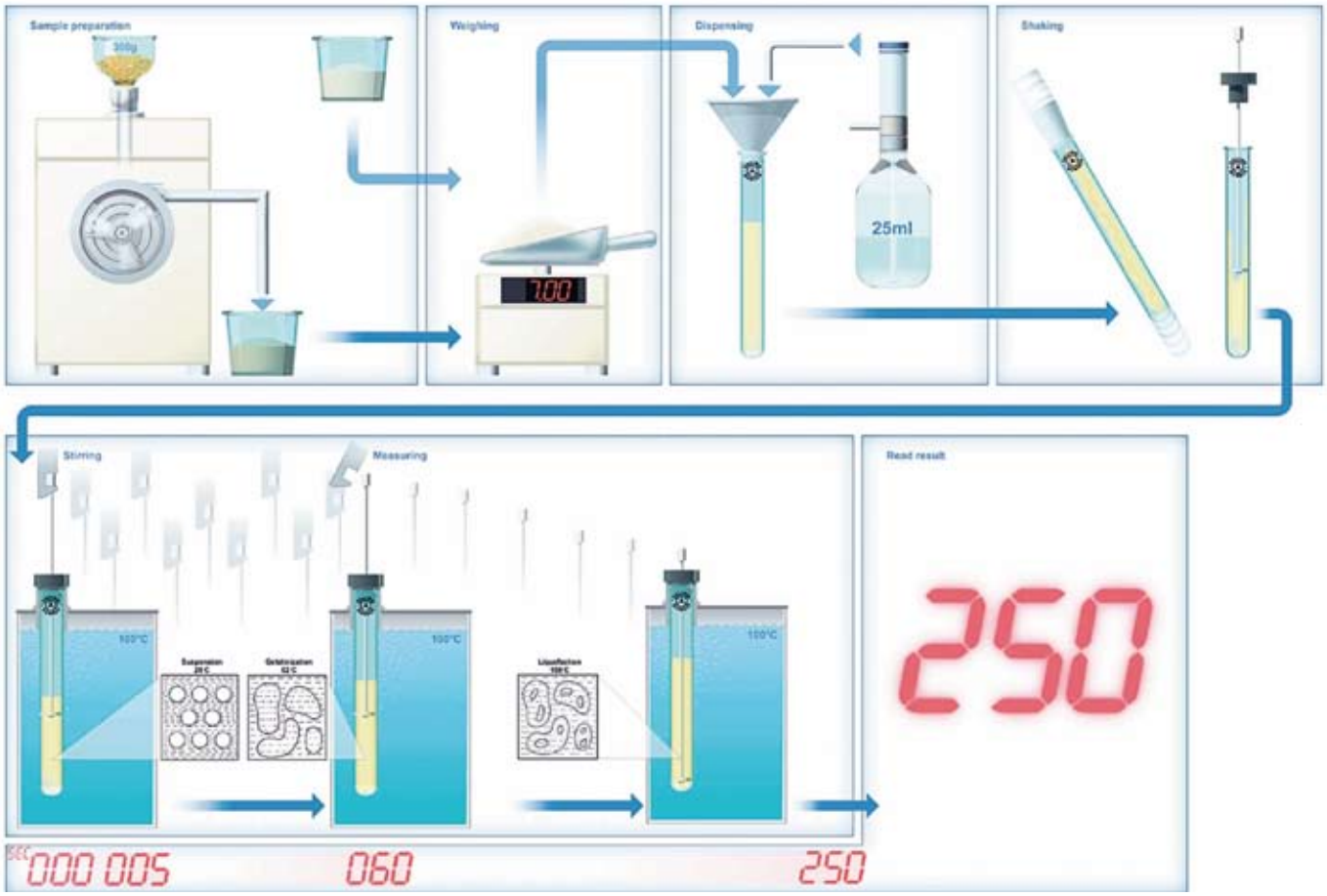
HOW IS THE FALLING NUMBER TEST PERFORMED?

The test measures the number of seconds it takes for a plunger to fall through a paste of ground grain and water – hence the name "Falling Number".

The test is performed according to an internationally agreed standard method in the sequence of steps shown in the diagram below.

1. A 300 gram sample of grain is ground in a specified grinder and the ground sample is thoroughly mixed.
2. Distilled water is dispensed into a clean, dry precision bore glass tube.
3. A weighed amount of ground grain is added to the water and the suspension is shaken vigorously so that a uniform suspension is obtained. Any sample adhering to the walls of the tube must be carefully scraped down and incorporated into the mixture.
4. The tube together with its associated plunger is placed into the boiling water bath and the motor starts the stirring after 5 seconds.
5. The plunger is automatically released after 60 seconds in its top position and is free to sink in the heated suspension.
6. When the plunger has fallen the set distance, the total time including mixing time, taken for the stirrer to fall is measured in seconds – This is the Falling Number value and is presented on a display.



Generally a Falling Number of 350 seconds or longer indicates low *alpha*-amylase activity and very sound wheat. As the amount of *alpha*-amylase activity increases the Falling Number decreases. Values below 200 seconds indicate high levels of *alpha*-amylase. The measured time includes a fixed stirring time of 60 seconds which together with the time taken for the plunger to fall through the empty tube makes 62 seconds the minimum value possible even for wheat that is fully sprouted.

As the test has to run for up to six minutes, and time is required to prepare the sample to be tested, it can take up to ten minutes to run a single test. *Diagram provided by Pertan Instruments.*

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WHAT IS THE ACCURACY OF THE FALLING NUMBER TEST?

The Falling Number test often causes frustration and confusion for growers because different test samples can yield very different results making grading based on this test seem unfair.

Under laboratory conditions, the accuracy of the test around a measured value of 300 seconds is ±30 seconds for the same instrument and operator on the same day and the error is greater between instruments. This means that repeated test results on the same ground sample can vary over a range of at least 30 seconds around the 300 seconds receival standard i.e., between 270 and 330 seconds at the very best. The only way to improve on this would be to carry out a number of separate tests on the same sample and average the results. However, this is not a practical solution due to the time that would be involved.

The Falling Number test was designed for use in a laboratory and some of the critical steps in the test procedure are difficult to control adequately under field conditions. These include:

- Cross contamination between samples can potentially occur if the grinder is not thoroughly cleaned between tests. Under the pressure of harvest testing, demanding rapid turn over, the likelihood of cross contamination is greater.
- The weight of the sample used for the test should be adjusted according to the sample moisture content. This is not done because it would add even more time to the testing.
- Distilled water at a constant temperature of 20°C should be used to mix with the ground wheat. This is not feasible in the field.
- The cleanliness of the glass tubes and plungers is critical as minute residues of the previous sample can affect the result. Washing the tubes to the required degree is very difficult in a receival stand.

For these reasons, the accuracy of the test would be expected to be worse at a receival silo than in a laboratory.

Sampling errors (*see Sampling Factsheet*) are very significant for the Falling Number test. This is because the inclusion or exclusion of a few individual sprouted grains in the test sample can have a marked effect on the result. In one example, of a 500 tonne load of wheat 15% was found to have a Falling Number below 85 seconds while 5% of the same load recorded Falling Numbers between 330 and 350 seconds. This is the major cause of wide discrepancies in test results when grain is re-tested at different silos or is re-sampled at the same silo.

WHY IS FALLING NUMBER IMPORTANT?

Wheat with a low Falling Number is unsuited to milling and baking (*see Grading of Weather Damaged Wheat Factsheet*). When mature wheat is wet it begins to germinate. The presence of moisture allows enzymes to function to break down starch (amylases), protein (proteases) and oil (lipases). The enzyme with the greatest effect on wheat and flour quality is *alpha*-amylase. Weather damaged wheat makes poor bread and Asian noodles. Weather damaged barley is unsuitable for malt production.

WHAT ARE MY OPTIONS?

- Avoiding weather damage – sounds good but almost impossible this season!
- Blending – If your wheat is likely to be downgraded due to weather damage it may be worthwhile having an independent Falling Number test conducted. If the Falling Number is close to the GTA receival standard a **high risk option** is to blend the weather damaged wheat with wheat of the same variety with a high Falling Number. This is high risk because it is not easy to predict the Falling Number of a blend from the Falling Numbers of its components. For example, equal portions of grain of Falling Number 200 seconds and Falling Number 400 seconds would result in a blend of Falling Number around 260 seconds at best (not 300 seconds as you might expect). So, attempting to blend to achieve a Falling Number target runs the risk of downgrading the entire parcel. Therefore, this strategy will take trial and error and significantly more sound than weather damaged wheat will be required. Hence a number of Falling Number tests will be needed to guide your blending. Finally, it is vital that the blend is thoroughly mixed.
- Storage – there is anecdotal evidence to suggest that when the Falling Numbers are close to the GTA receival standard (e.g. above 250), storing grain for three to six months could lead to an increase (approx 30 seconds) in the Falling Number. As yet no adequate scientific studies have been conducted on Australian wheat to support these claims.