Seed and grain imaging Vs subjective inspection methods

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Plant breeders, seed producers and grain traders use subjective inspection methods, i.e., visual inspection, separation and counting to determine quality aspects of grains and oil seeds. Depending on the sample and the inspection standards, subjective inspection can take 15 minutes per sample or more. On the other hand, machine vision inspection offers a rapid and more reproducible method of inspecting grains and oil seeds at a fraction of the cost of manual inspection.

Subjective Vs Objective measurements

The human eye and brain have an amazing ability to pick between two objects and decide differences in size, color, defects and other physical parameters, however the brain cannot retain the exact image and provide a quantitative evaluation of these parameters. Not to mention, humans have different perceptions of color and defects.

An Image Analyzer does not have the differentiation capability of a human, however an Image Analyzer can quantify the parameters, i.e., assign numbers to the parameter, which can be stored and compared to a set of standards for that parameter.

Subjective measurement is how humans measure physical parameters, where as an Image Analyzer makes an objective measurement.

Another aspect of Image Analysis is that the lighting is kept constant from machine to machine where as lighting used in subjective measurements can vary. A fluorescent lamp will show an image with more blue hues than red, as compared to a halogen lamp. Daylight is another light source but it changes depending on the time of the year, time of the day and whether it is overcast or sunny.

The image that is collected from the Image Analyzer provides a permanent record of the sample that was analysed. A subjective measurement of a sample on the other hand has no record other than the count that was made by the inspector. If the same image is re-analysed by the SeedCount software, the results will be same. If a sample that has been subjectively assessed by a human is given to another human, then the results will probably be different.

There is one major problem with Image Analysis in that it is never going to be the same as the subjective measurement. The human eye can look at a seed, which has several colored sections, and compare it with a printed standard and a subjective measurement can be made. It may not be 100 percent correct, however the eye and brain can make an assessment. An Image Analyzer often cannot differentiate between subtle color differences or complex shapes etc.

As such, the decision to change from subjective measurements to objective measurements should not be based on the objective measurement producing the same results as the subjective measurement, which will change from person to person, but rather based on the ability of the machine to reproducibly assess samples no matter who is performing the test.

Where the machine cannot make the assessment due to the differences being too subtle or too complex, then the machine should be used to make the measurements that it can do well and to combine it with a user option to classify the seed shown on the screen using a pull down options menu.

Figure 1: SeedCount scanner, touch screen PC and tray

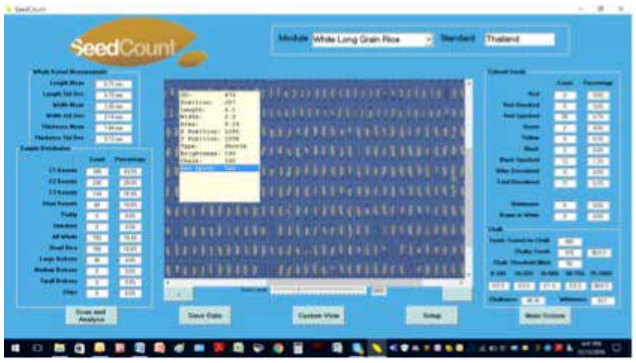


Figure 2: Screen shot of SeedCount Long Grain Rice Analysis

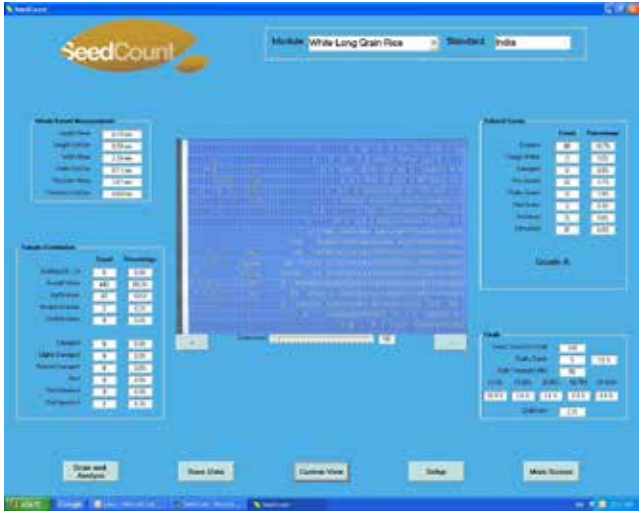


Figure 3: Typical results screen showing the analysis of long grain rice using the Indian Standard.

Figure 2 shows an example of where the operator selects a seed from the screen image and a table shows the machine assigned parameters. By clicking on a parameter, the operator can change the assessment. This hybrid system at least provides a permanent record of the assessment that can be emailed to the buyer or end user to validate the analysis.

SeedCount Image Analyzer

This following describes the SeedCount Image Analyzer system for measuring corn and rice for physical parameters including length, width and thickness as well as color, broken seeds, discolored seeds, and corn specific attributes such as Horneous Endosperm count.

So what exactly is it?

SeedCount is a purpose built system for objective measurements of a wide range of cereal and oil seeds including wheat, barley, rice, oats, sorghum, corn, soybean, lentils, canola (rape seed) and coffee beans. Other seeds can also be assessed using a generic module and a seed specific tray. SeedCount uses a flat bed scanner that is setup for either reflectance images or reflectance and transmission images of the seeds.

A tray is used to present the seeds to the scanner and the inbuilt PC with a large touch screen controls the scanning process and computes the parameters specific to the seed. Figure 1 shows the SeedCount scanner and touch screen PC with a tray filled with long grain rice seeds.

The process of loading the seeds into the tray is simple but effective. A volumetric cup is filled and leveled, then weighed. The contents are poured onto one side of the tray. The tray is gently shaken back and forth to allow the seeds to spread over the tray and drop into the specifically designed holes. A quick manual manipulation can be performed to move the seeds around to

reduce the number of instances where two seeds are in the same hole. However the software will detect doubles and triples and exclude them from the analysis.

The tray is inserted into the scanner and the scan initiated from the touch screen. After pressing the Scan and Analyse button, the software asks for the weight of the sample. Type in the weight and press OK. The weight is used to calculate the parameters such as Test Weight and 1000 Kernel Weight. After 15-30 seconds the results are displayed on the screen. Figure 2 shows the analysis of long grain rice samples using the Indian Standard of inspecting long grain rice.

Recognising that there are several different international and region standards for inspection of rice, the SeedCount software offers standards for India, Thailand, Malaysia, USA, ISO and Australia.

How does SeedCount work?

The SeedCount software is a Parametric type system rather than a learned or Neural Network system. The first step in the process is to marquee each seed. A line is drawn around each seed. The length, width, thickness and color of each seed are then determined by the software. Using these four measurements, a linear decision process is created to then determine the other parameters.

For example, to measure blacktip in barley, the next step is to identify those seeds that have the crease showing upwards to the scanner. Since Blacktip is visible on seeds with the crease facing down, then all the up facing seeds are ignored. The next step is to identify the narrow end of the seed. The software then compares the color of the middle of the seed to the other end. If the color gradient is more that the set point, then the software considers the seed to exhibit Blacktip. The severity of the Blacktip is determined by the area of the end of the seed that is black and how many dark pixels are within the seed outline.

This linear sequence of decisions to determine the state and specifics of the parameter is known as Parametric Analysis. It should be noted that there are no training sets required for Parametric Analysis, although there is some method development required to establish the decision sequence and then to test and fine tune the process.

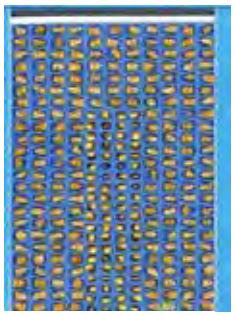
SeedCount analysis for rice

There are several application modules available for different rice types and preparations, including small, medium and arborio: White and Brown, Paddy Medium and Arborio, long grain: white and brown, parboiled long grain, paddy long grain.

Different trays are designed to hold different seeds. The length and width of the whole are designed to fit a certain type of seed. Broken seeds need to be placed into individual holes otherwise the software detects them as doubles or triples and excludes them from the analysis.

Figure 4 shows a blown up section of a rice tray where the two different sized holes are used. The rice kernels lie flat in the left hand side of the tray where the holes are wider and the rice kernels lie on their sides on the right hand side where the holes are thinner. The Thickness measurement of the seeds is made in one half of the tray where the holes are narrower and the Width measurement is made in the other half of the tray. The Length measurement is made for both sides of the tray.

A common parameter in the assessment of rice is to classify the seeds based on the extent to which they are broken during the milling process. In the Thailand Standard, kernels are classified as C1, C2, C3, Short, Paddy, Immature, Head, Large Broken, Medium Broken, Small Broken and Chips. Color is also used



Corn reflectance tray

Corn transmission tray

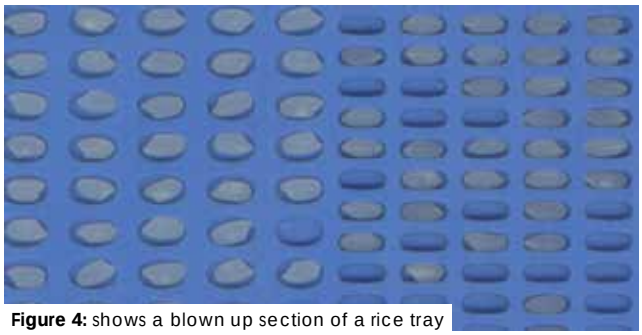


Figure 4: shows a blown up section of a rice tray

to classify seeds including, Red, Red Streaked, Red Speckled, Green, Yellow, Black, Black Specked, and Discolored seeds.

Chalkiness is another key parameter used in many countries. Chalk is the presence of a white mass inside the seed. If the percentage of the white mass exceeds 50 percent then the seed is considered Chalky. The number of seeds exhibiting 50 percent chalk is used to determine the Chalkiness of the sample of seeds. Some plant breeders want a more detailed description of the chalk content by calculating the percentage of seeds that have between 0-10%, 10-25%, 25-50%, 50-75% and 75-100%. Figure 4 shows the results screen from SeedCount used to display the analysis of the parameters in long grain rice using the Thailand Standard.

SeedCount analysis of corn

Maize or corn is traded based on many physical parameters as well as some chemical parameters. Corn that is milled to make flakes is assessed differently from corn used for animal feed. Popping Corn is a different seed variety and is assessed for different parameters.

CornCount is a version of SeedCount that is specifically designed to measure corn kernels in both reflectance and transmission modes. In reflectance mode the parameters including Color (Hue), Dents, Crowns, Red Streak, Length, Width, Perimeter, Area and Sphericity. In transmission mode the parameters are Horneous Endosperm and Stress Cracks.

There are three types of trays available for corn analyses. The reflectance tray has a central section where kernels are placed on the end so that the crowns of the kernels can be examined for Dents. The outer sections are used for measuring the other parameters. The transmission tray has a central section that is transparent. Kernels are loaded on the transparent section so that light can be passed through the seeds and the image detected by the scanner. Kernels can also be scanned in reflectance by loading them into the outer section of the tray. The Popping Corn tray is similar to the transmission tray however the holes are smaller.

Cost savings

It is difficult to place a dollar saving by using an Image Analyzer versus a human assessment. You still require an operator to load the trays and perform the analyses. However it is the speed of analysis using the Image Analyzer that realises a return on investment. Ricetec Inc, Houston, Texas,

Screen shot of the Results Screen from SeedCount

has been using the SeedCount Image Analysis system for several years. The laboratory manager provided the following feedback on their experience with SeedCount for analysing thousands of rice samples each year as part of the plant breeding programs.

"I am very pleased with the SeedCount. It has more than doubled our throughput and has proven to be more accurate and repeatable than any other system we have used in the past. The added benefit of getting three dimensional grain measurements particularly thickness has improved our testing abilities dramatically." Anna Ochoa, Ricetec Houston TX.

CornCount Results Screen

Conclusion

Objective measurement of grains and seeds provides growers, buyers, traders and producers a means of more reliably assessing the physical parameters used to decide on their quality. Once setup, the SeedCount can process approximately 30 samples per hour versus manual inspection that may be as slow as four samples per hour. Not only does the SeedCount improve productivity but it does not suffer from eyestrain or fatigue nor does it require training.