<table>
<thead>
<tr>
<th>Title of Project :</th>
<th>Grain Quality in the Pre-Milling Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Reference number :</td>
<td>4101</td>
</tr>
<tr>
<td>Research Organisation Name :</td>
<td>SunRice</td>
</tr>
<tr>
<td>Principal Investigator Details :</td>
<td></td>
</tr>
<tr>
<td>Name :</td>
<td>Bronwyn Sigmund</td>
</tr>
<tr>
<td>Address :</td>
<td>Yanco Avenue, Leeton, NSW 2705</td>
</tr>
<tr>
<td>Telephone contact :</td>
<td>0269530075</td>
</tr>
</tbody>
</table>
SUMMARY

The rice processing sector has become more globally competitive in recent years. It has been an important part of SunRice’s business goals to raise our quality practices to a world leading standard. Quality assurance measurement and maintenance is a vital part of all operations, at every stage of rice production, from farm to consumer. Grain quality in the pre-milling phase has looked at many facets pertaining to improvements and optimisation of operations in the post-harvest phase of rice receival. Over the past few years these studies have allowed an understanding and adoption of best practice within SunRice operations. Of the many areas trialed, SunRice has adapted practices to accommodate those that have shown the ability to optimise cost benefits, enhance quality of grain and improve point of receival testing practices. Additionally, many projects have led to expansion in trials as have the learnings been adopted in other projects.

The aims of the projects that have spanned the past seven years have provided growers with a better indication of crop quality during harvest and have allowed more effective segregation of paddy rice within SunRice storages.

At point of receival, studies in crop quality such as trash, storage aeration, green grains, image analysis, and moisture variance have been explored resulting in improved testing methods and the ability to capture a greater understanding for segregation purposes. This allows SunRice to optimize the use of higher quality grain by reducing chances of contamination with lower quality grain. Additionally these studies have benefited the grower by providing a greater indication of their crop quality thought the harvesting process. Combined, a greater bearing on best practice has resulted, for the growing, storage and production of rice.

More recent studies have concentrated on similar improvements in point of receival testing and storage quality optimization by grasping fresh advances in grain handling and technology. This has ensured stored rice is kept at the best possible standard. Overall, the greater understanding captured throughout these trials has largely benefited the sustainability of rice production.
I Sub-Project Name: Trash determination at point of receival (1997-2002)

Background
‘Trash’ consists of rice hulls void of grain, rice straw, pinheads (small fragments of rice), and other impurities in rice grain samples. The presence of these within a sample of rice has no economic benefit.

Objectives
It is important to separate trash from and correctly measure the trash level in commercially valuable grain. The knowledge of a sample’s trash content is an important factor for correct management of newly received paddy rice. Segregation of grain to minimise storage costs, is facilitated through the knowledge of trash content in grain samples.

With relevance to growers, trash indication at point of receival allows them to make any necessary adjustments to headers, to ensure a cleaner harvest. Trash determination for grower payments is performed at the Quality Appraisals Centre, where results generally would not be available until October. This early indication can assist growers to ensure trash penalties are kept to a minimum.

Past Observations
Trials to find a reliable or indicative measurement of trash content at the point of receival begun in 1997.

The original method of trash determination was performed using the Carter Day machine located at the Quality Appraisals Centre.

Initially studies comparing the Kice instrument with the Carter day resulted in a poor correlation of results. Subsequently, the trial expanded to compare the Rakoraf Model S grain-cleaner from Denmark. The model S instrument utilises sieving and aspiration to provide an indication of trash levels.

In the early stages it was indicated that no correlation resulted between the Model S and the Carter Day. Additional examination identified a need to optimise the Model S grain-cleaner adjustable settings for operation with specific grain. An extensive set of trials were conducted for the purpose of elucidating the optimal instrument settings for use in rice. The optimal feed-rate, aspiration and seive sizes were identified by testing 10 varieties of rice with known trash contents over a range of moisture contents.

Technical Information
An initial attempt was made during the 2000-01 season to conduct this trial. However, grain samples with the true amount of trash unknown were used, so the accuracy of the trash measurement for each machine could not be measured. It appeared from the results of the 2000-01 trial that in general the Carter Day machine returned a significantly lower reading for the trash component than the Model S.
**Methodology**

The trial was run according to a block design, with nine commercial rice varieties used and three target trash levels. The nine varieties were the long grain varieties Langi, Kyeema and Doongara, the medium grain varieties Millin, Illabong, Amaroo and Jarrah, and the short grain varieties Opus and Koshihikari. It was not expected that there would be any major difference between long, small and medium grain varieties in terms of trash content, and despite the fact the settings on the machines needed to be altered very slightly when changing from a long grain to a medium or short grain variety, but not enough to be considered a big enough inconvenience, there was considered to be no need to segregate the rice samples on grain length. The 9 varieties were randomised within each replicate.

There were three Model S machines available, located at the Wamoon Avenue RCL site in Leeton, while a Carter Day machine was located at the Leeton Quality Appraisal Centre. The design assumed that there were three Model S machines and three Carter Day machines, so the one Carter Day machine had to be treated as three separate machines. On occasions, the samples for the Carter Day machine may not have been done for all three ‘machines’, but only two or even one. The order each machine was used was randomised within each variety.

The three target trash levels chosen by the researchers to be most practical and relevant to the real world were 2%, 4% and 10%. These trash levels were always randomised differently within each of the three machines within a variety within a rep.

It was not expected that the moisture content was likely to affect the trash readings, but nevertheless each of the samples for each replicate for each variety were of a different moisture level. The moisture levels were also different across varieties within a replicate. This meant that moisture was confounded with the interaction of rep and variety, and the effect of moisture could be accounted for as such. Grain The treatment randomisation orders were the same for both machine types to provide the best possible comparison. Grain from the same sample, was used for both machine types in the corresponding runs.

In summary, there were three replications of 9 varieties by 3 machines of each type by 3 trash levels by 2 machine types, giving a total of $3 \times 9 \times 3 \times 3 \times 2 = 486$ measurements overall.

Machine type was thus randomised within trash level, within machine (1, 2 or 3 for each type), within variety, within replicate.

A mixed model was fitted to the difference between the observed trash level and the target trash level. The terms of interest, the overall machine type, the variety by machine type interaction, the trash level by machine type interaction and the variety by trash level by machine type interaction, were all fitted as fixed terms as the model, with random error stratum terms based on the design, to ensure all fixed terms are evaluated at the correct error level. The full ANOVA table, complete with Wald statistics indicating the significance level of the fixed terms, is presented in Table 1. The error term for the rep.variety term is fairly substantial (34% of the total error variance), which may be due to the fact that this term was completely confounded
with grain moisture, so this term is soaking up the variation that may be caused by the
different moisture levels in the grain.

Fortunately, there was not a great deal of variation (only 3% overall) between
machines of the same machine type. This may be due to there being only one Carter
Day machine, but is a good sign nonetheless.

From Table 1, we also see that there were significant differences overall between the
two machine types as expected, as well as there being highly significant interactions
between variety and machine type, trash and machine type, and variety by trash by
machine type.

Table 1: ANOVA table for mixed model for difference between observed trash level and target trash
level

<table>
<thead>
<tr>
<th>Source</th>
<th>Term</th>
<th>F/ R</th>
<th>Wald/Var. Comp.</th>
<th>Model syntax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rep</td>
<td>Residual</td>
<td>R 0</td>
<td></td>
<td>rep</td>
</tr>
<tr>
<td>Rep.Variety</td>
<td>Residual</td>
<td>R 0.0289</td>
<td></td>
<td>rep.variety</td>
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<td>Machine Type</td>
<td>variety. machine type</td>
<td>F 519.15**</td>
<td></td>
<td>variety.mtype</td>
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<tr>
<td></td>
<td>trash. machine type</td>
<td>F 2155.81**</td>
<td></td>
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<tr>
<td></td>
<td>variety.trash. machine type</td>
<td>F 480.23**</td>
<td></td>
<td>variety.trash.mtype</td>
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<tr>
<td></td>
<td>Residual</td>
<td>R 0.0529</td>
<td></td>
<td>[units]</td>
</tr>
</tbody>
</table>
Results

![Figure 1](image)

*Plot of difference between observed trash percentage level and the true trash percentage level for each trash level within each variety. The measurements for the Carter Day machine are in blue, the measurements for the Model S machine are in red.*

<table>
<thead>
<tr>
<th>Variety</th>
<th>Machine</th>
<th>2% trash</th>
<th>4% trash</th>
<th>10% trash</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Millin</td>
<td>Carter Day</td>
<td>-0.01</td>
<td>-0.25</td>
<td>-1.27</td>
<td>-0.51</td>
</tr>
<tr>
<td></td>
<td>Model S</td>
<td>0.44</td>
<td>0.61</td>
<td>0.99</td>
<td>0.68</td>
</tr>
<tr>
<td>Kyeema</td>
<td>Carter Day</td>
<td>-0.01</td>
<td>-0.23</td>
<td>-1.34</td>
<td>-0.53</td>
</tr>
<tr>
<td></td>
<td>Model S</td>
<td>0.58</td>
<td>0.69</td>
<td>1.09</td>
<td>0.79</td>
</tr>
<tr>
<td>Langi</td>
<td>Carter Day</td>
<td>-0.31</td>
<td>-1.02</td>
<td>-3.57</td>
<td>-1.64</td>
</tr>
<tr>
<td></td>
<td>Model S</td>
<td>0.55</td>
<td>0.69</td>
<td>1.07</td>
<td>0.77</td>
</tr>
<tr>
<td>Doongara</td>
<td>Carter Day</td>
<td>-0.42</td>
<td>-1.04</td>
<td>-3.01</td>
<td>-1.49</td>
</tr>
<tr>
<td></td>
<td>Model S</td>
<td>0.24</td>
<td>0.25</td>
<td>0.30</td>
<td>0.26</td>
</tr>
<tr>
<td>Illabong</td>
<td>Carter Day</td>
<td>-0.03</td>
<td>-0.14</td>
<td>-0.77</td>
<td>-0.32</td>
</tr>
<tr>
<td></td>
<td>Model S</td>
<td>0.48</td>
<td>0.69</td>
<td>0.99</td>
<td>0.72</td>
</tr>
<tr>
<td>Amaroo</td>
<td>Carter Day</td>
<td>-0.05</td>
<td>-0.20</td>
<td>-1.34</td>
<td>-0.53</td>
</tr>
<tr>
<td></td>
<td>Model S</td>
<td>0.32</td>
<td>0.29</td>
<td>0.38</td>
<td>0.33</td>
</tr>
<tr>
<td>Opus</td>
<td>Carter Day</td>
<td>0.00</td>
<td>-0.30</td>
<td>-1.28</td>
<td>-0.52</td>
</tr>
<tr>
<td></td>
<td>Model S</td>
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<td>0.46</td>
<td>0.59</td>
<td>0.49</td>
</tr>
<tr>
<td>Koshihikari</td>
<td>Carter Day</td>
<td>0.01</td>
<td>-0.20</td>
<td>-1.18</td>
<td>-0.45</td>
</tr>
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<td></td>
<td>Model S</td>
<td>0.53</td>
<td>0.70</td>
<td>0.88</td>
<td>0.70</td>
</tr>
<tr>
<td>Jarrah</td>
<td>Carter Day</td>
<td>0.01</td>
<td>-0.26</td>
<td>-1.32</td>
<td>-0.52</td>
</tr>
<tr>
<td></td>
<td>Model S</td>
<td>0.39</td>
<td>0.44</td>
<td>0.68</td>
<td>0.50</td>
</tr>
</tbody>
</table>

A plot of the difference between the raw trash percentage measurements and the target percentages versus the target percentages for each variety is shown in Figure 1.
A table of the mean differences between the observed trash level and the true trash levels for the two machines for each trash level for each variety is presented in Table 2. In general the Carter Day machine underestimates the trash percentage (i.e. negative differences) and the Model S overestimates the trash percentage.

For the 2% trash samples the Carter Day machine actually estimates the trash level better than the Model S for all varieties bar Doongara. At the 4% level the Carter Day is still more accurate for all varieties bar Langi and Doongara.

However at the 10% level the Carter Day machine badly underestimates the trash level by more than 3% on average for Langi and Doongara and by more than 1% on average for all other varieties bar Illabong, which is the only variety it remains more accurate for. In contrast, while the Model S still overestimates the trash component, it does so by an average of only 0.3-1.1% across all varieties.

On an overall basis across the three trash percentage levels, the Carter Day is better for Millin, Kyeema, Illabong and Koshihikari while the Model S is better for Langi, Doongara, Amaroo, Opus and Jarrah. However the differences are marginal for Opus and Jarrah, and the overall estimates are biased towards the lower trash percentage levels (two of these to one high level) and hence the Carter Day machine.

**Implications and recommendations**

For the low trash levels, the Carter Day machine did better in estimating the trash component. However for the 10% trash level the Model S machine did much better in estimating the trash component, and the Carter Day badly underestimated the trash component, by more than 1%, for 8 or the 9 varieties. It would seem that the Carter Day machine did not estimate the Doongara, Langi trash components well in general, while the Model S did not do well with Kyeema, Koshihikari or Illabong samples.

The Model-S grain cleaner was used in all 19 receival site testing platforms from the 2001 harvest period. Frequent quality assurance tests were made to ensure that all grain cleaners provided results within a (0.5%) threshold of the standard laboratory instrument. The instrument was used to measure the trash content of growers’ paddy as the rice was delivered. The results of the test were provided to the grower, allowing for adjustments to the harvesting equipment as a means of reduce the level of trash brought to the point of receival in subsequent loads.

The Model S has proven a valuable addition to the receival testing process as it continues to provide trash indication to growers and allow segregation of high trash loads into a dockage area. This collective study is believed to have improved this area dramatically with major benefits to both SunRice and its growers.

**Project Intellectual Property**

No IP
References

Acknowledgements
Mr Nathan Cutter
Ms Nicole McQuillan
Mr Ben Braysher
Mrs Tanya Bauer
Ms Sue Meline
II Sub-Project Name: Pneumatic Probe V Manual Probe (1999)

Background
The necessity for an automatic sampling system at RICEGROWERS CO-OP LTD receive sites was highlighted initially as an Occupational Health and Safety (OHS) issue prior to the 1997 harvest. Consistency in sampling technique was also of major concern.

A trial was undertaken on an American designed automatic probe at Leeton in 1997, to determine its correlation with samples extracted using the manual probe technique. Poor results instigated another trial at Leeton in the following year that allowed for adjustments in airflow. Equally poor results were obtained from the 1998 trial, and the American designed probe was disregarded as an unsuitable sampling method.

Following further investigations by RCL staff, the Rakoraf probe was determined to be the most suitable system for future testing. This was due to its particular design where no air-flow adjustments are required. Two Rakoraf probes were installed at the Deniliquin site (the testing platform and weighbridge) while the automatic probe already situated at the Leeton testing platform was modified to incorporate the Rakoraf system.

If the Rakoraf pneumatic probe were to be applied across the entire industry, it would be a gradual implementation therefore, testing was required to determine if the Rakoraf pneumatic probe extracts the same quality sample from a truckload as the manual probe. Comparative trials were undertaken during the 1999 harvest at the Deniliquin testing platform.

Objectives
To assess the Rakoraf pneumatic probes ability to remove a consistent sample from a load of paddy and to draw a comparison to the manual probe currently in operation as an industry standard.

The Rakoraf Probe
The telescopic arm with the core tube can be extended, retracted, be turned horizontally 350 degrees and can also be raised or lowered vertically. This system is operated via a compact, handheld joystick, which allows 5 samples to be taken in 40 seconds.

When the core tube is forced downward into the load, the grain, due to the downward pressure is pushed upwards into the inner chamber of the core tube and carried to the receiving chamber in the testing platform. In the receiving chamber the air is separated from the sample and the clean air is circulated back through the air motor and discharged through the outside chamber of the core tube. This air circulation system eliminates the “vacuum cleaner effect”.

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The issues underlying the trial will include tests to determine the following.
- Compare samples drawn from a truck using the Rakoraf probe and the current manual method.
- Variables to be analysed include dockage, whole grain yield, mill out total and brown rice weight.
- Determine if variables such as moisture trash content and grain variety affect the accuracy of the pneumatic probe.
- Establish degree of user friendliness.

**Methodology**
Each load is to be probed using the manual and pneumatic probes obtaining 3kg of sample and sent to the Quality Appraisals Centre (QAC) for drying and analysis.

The following indicates an aim of the variety and number of samples to be collected. Statistics of 1998 season receivals was used to determine these figures, to ensure a representative collection.

**Table 1. Variety and number of samples required for collection.**

<table>
<thead>
<tr>
<th>Variety</th>
<th>Number of Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amaroo</td>
<td>80 samples</td>
</tr>
<tr>
<td>Langi</td>
<td>30 samples</td>
</tr>
<tr>
<td>Namaga</td>
<td>50 samples</td>
</tr>
<tr>
<td>Jarrah</td>
<td>20 samples</td>
</tr>
<tr>
<td>Illabong</td>
<td>20 samples</td>
</tr>
<tr>
<td>Koshi</td>
<td>20 samples</td>
</tr>
<tr>
<td><strong>Total 220 samples</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Tester Methodology**
Step 1: Ensure that the truckload is a variety required.
Step 2: Pneumatically probe the truck in 4 or 5 places (a minimum of 3kg for each sample).
Step 3: Manually probe the truck around the areas which were pneumatically probed (enough for a 3kg sample = approx 5-6 probes).

Step 4: Allow the traditional tester to manually attain samples for grower and bin appraisal.

Step 5: Bag samples and mark on the chit the sample identification.

Step 6: Send both samples marked for Paul Roninson’s attention at the QAC via the courier.

Quality Appraisal Centre Methodology

Step 1: Dry sample to storage moisture of approximately 14%.


Step 3: Hull 1000 grams of clean paddy.

Step 4: Weigh brown rice.


Step 6: Establish whole grain yield value using the Indent Cylinder.

Data analysed for correlation between manually and pneumatically probed samples.

Results

Unfortunately the expected number of samples (220) was not attained due to various reasons. Instead 99 samples were collected and used to devise the following statistics. The data, summarised in table 2, indicates that there is an acceptable correlation between the manually and pneumatically probed samples in all instances.

This indicates that the automatic probe would successfully replace the current manual method. The White Rice Total has produced a relatively lower RSQ value, however this variable is not a constituent used for grower deduction, therefore is not as imperative as the Trash and Whole Grain Yield readings.

Table 2: Summary of Results.

<table>
<thead>
<tr>
<th>Constituent</th>
<th>RSQ value</th>
<th>Average Variance (Grams)</th>
<th>Average Variance (%)</th>
<th>Graph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trash</td>
<td>0.934316</td>
<td>0.216327</td>
<td>0.878661</td>
<td>1</td>
</tr>
<tr>
<td>Whole Grain Yield</td>
<td>0.949448</td>
<td>0.7</td>
<td>0.112346</td>
<td>2</td>
</tr>
<tr>
<td>White Rice Total</td>
<td>0.876668</td>
<td>1.134694</td>
<td>0.1574923</td>
<td>3</td>
</tr>
<tr>
<td>Brown Rice Total</td>
<td>0.969228</td>
<td>0.6</td>
<td>0.0722117</td>
<td>4</td>
</tr>
</tbody>
</table>

These figures are represented graphically in the appendices and the raw data indicates the moisture and variety of each individual sample.

The pneumatic probe extracts a sample similar to the manual probe despite changes in trash levels, variety and initial moisture. The first graph in appendix ten highlights that despite varying levels of trash, (ranging from six to sixty grams) the pneumatic probe maintains accuracy compared to the manual probe. Similarly, the variety of grain was found to have no bearing on the level of trash removed from the load. Finally, graph 3 indicates that the grain moisture at receival (ranging from 12 to 21 percent) has no impact on the pneumatic probes ability to replicate the manual probe sampling technique.
User Friendliness
All users of the Rakoraf probe have spoken favourably about its ease of operation. It was the general consensus that the sampling method would not be any slower than manually probing. Rather in most scenarios pneumatic probing would be quicker, depending on the truck bin design and operator expertise. Furthermore, the benefits from an occupational and safety perspective was highlighted by all users.

The only concern raised was the fact that the tester was no longer able to make a good visual assessment of the load by walking across the grain.

Added Benefits
Additional knowledge concerning the set-up and operation of the pneumatic probe was gained over the 1999-harvest trial at the Deniliquin site. After consultation with Knud Klit suitable operating instructions have been devised (see Appendix 1). Technical expertise has been gained concerning the construction and installation of the Rakoraf probe. Mr Shane Dryburgh (RCL) and Mr Jack Peacock in particular have gained extensive knowledge in these areas.

Implications and recommendations
Ideally, a greater number of samples should have been obtained to reflect the entire spectrum of receivals, however the statistics attained highlight that the pneumatic Rakoraf probe can replicate the readings of the manual probe with a high degree of accuracy.

Furthermore, this method of sampling complies with the Australian grain industries acceptable primary method of sample extraction from a bulk load. (Ronalds 19811). It is recommended that the Rakoraf Probe gradually be introduced to all RCL receival sites in order to attain sample consistency and safe work place practices across the industry, particularly at sites where long queues often prevail during harvest.

At the time of implementation it is imperative that an education program is devised for all testers and growers. For example pre harvest meetings with growers to explain the changes to testing procedure at their receival facilities.

Cost of Implementation
Expenditure for industry wide application is as follows:

<table>
<thead>
<tr>
<th>Table 3. Expenditure for Industry Wide Application of Rakoraf Probe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probe (Model CHE)</td>
</tr>
<tr>
<td>Installation*</td>
</tr>
<tr>
<td>TOTAL per instrument</td>
</tr>
<tr>
<td>Installed at 20 sites</td>
</tr>
</tbody>
</table>

* Subject to power supply.

Acknowledgments

The authors gratefully acknowledge the skilled technical assistance of Paul Robinson and the appraisal employees, the Deniliquin staff, Scott and Vanezzia Whitmore and testers Tom Dawson and Megan Basset for additional labour required during the harvest season and engineer, Shane Dryburgh.

Appendix 1 - Operating Instructions for the Pneumatic Probe (Based on a setting of 165mm-water pressure)

Ensure that the system is continually running and that the vacuum is maintained whilst probing the load. If it does stop during the probing of a truck, allow the sample to fall out of the load before continuing the probe.

Whilst operating the probe allow the probe to go to bottom of load then straight away lift probe out of the load.

Figure 1 Diagram showing the operation of the probe (straight down and straight back up again).

![Diagram of probe operation]

Probe truck 5-7 times in random locations across the load.
Background
Currently payment for all paddy rice delivered to the Ricegrowers Co-operative is based on the dry weight of each delivery. This includes trash and non-millable products that are of no value to the Co-operative and furthermore are an expense to the company in storage costs and extraction during milling. To overcome paying for non-value product a theory has been devised to pay growers based on the brown rice weight percentage of their product. At the testing station the grower’s sample is representatively sampled. The probed sample is weighed and the result recorded. Next the sample is hulled with a centrifugal huller which removes the husk from the rice. The huller also removes most other typical extraneous items from the sample. The brown rice can be weighed and a value recorded for the brown rice weight percentage of the original sample. The hulling process excludes trash and hulls, the parts of the delivery that are of no value to the Co-operative.

Objectives
The objective of this project is to determine the efficiency of the huller and consequently whether variability in moisture of paddy at time of receival is less when analysed in brown rice form.

Past Observations
Measuring moisture in paddy rice is problematic during periods of wet weather or heavy dews. The accurate detection of moisture with the Grainspec Near Infrared Transmission instrument is hampered when there is an uneven distribution of moisture throughout the grain. However by removing the grain husk, the grain moisture can be measured in the brown rice form. It is expected that moisture variation will be much lower in brown rice than in paddy when tested using the Grainspec.

Methodology
Samples that have been de-hulled at the testing platforms using the Satake hullers were collected and analysed using the Grain Check Image Analyzer. The Grain Check instrument determines the percentage of paddy in the brown rice sample, which is an indication of the huller efficiency. The variety, moisture content and percentage of paddy in brown was recorded for assessment.

The Graincheck Image Analyzer was not calibrated for testing long grain rice in the brown form, therefore these samples were handpicked for paddy percentages. The moisture content of each sample was accurately determined using the 2 stage oven method of moisture determination.

Results of moisture as measured using the Grainspec are to be compared to the results of generic samples tested by the air-oven method.
Results

Figure 1 describes the efficiency of the Satake centrifugal huller when dehulling long grain paddy rice. At low moistures, below 15%, the huller is quite efficient and almost all of the paddy rice is de-husked to produce brown rice. When the moisture content of the grain rises above 15% the huller starts to become less efficient. As the moisture content of the paddy rises from 15% to 25% the efficiency of the huller at removing the husk steadily becomes worse. In this trial, the Satake huller was approximately 94% (average) efficient at dehusking long grain paddy rice in the moisture range 14.32% to 26%.

Figure 2 describes the efficiency of the Satake centrifugal huller when dehulling medium grain paddy rice. The graph shows the same general response of efficiency to increasing moisture content that is seen with long grain rice. However the huller is much better at de-husking medium grain rice than...
long grain. The huller is approximately 98% (average result) efficient at dehusking medium grain paddy rice in the moisture range 14.32% to 26%.

Figure 3 describes the variation in paddy moisture when compared to the air-oven result. On average 3 out of every 11 results shows an increase in paddy moisture as measured by the Grainspec than the result for the air-oven method. Some of these increases are in excess of a 1.5% variation.
Figure 4 describes the variation in brown moisture when compared to the air-oven result. On average only 1 out of every 11 results shows an increase in paddy moisture as measured by the Grainspec than the result for the air-oven method. Of these increases none are more than 1%.

This trial was conducted to determine how well the hullers worked in the testing station environment and to understand any limitations that the hullers had. Additionally the actual variation in moisture between paddy form and brown rice form when compared to the air-oven result was important.

The hullers worked more effectively at removing the husk from rice when the rice was at low moisture content. Even when the rice had a 25% moisture content the huller proved to be approximately 96% efficient at removing the hull from medium grain. The ability of the huller to dehusk long grain rice markedly declines after the rice moisture content reaches over 15%. Regularly up to 10% of a sample remained un-hulled in long grain samples over 15% in moisture.

The brown rice form of moisture determination proved less variable and more accurate when compared to the air-oven result. In the paddy form high variations were experienced.

**Implications and recommendations**
The Satake centrifugal hullers were purchased for their ability to quickly dehull high moisture rice.

Tests have proven that measurement of moisture in brown rice with the Grainspec is more accurate than testing paddy rice compared to the standard air oven moisture test.

**Project Intellectual Property**
No IP

**References**
N/A

**Acknowledgements**
Mr. Nathan Cutter
Ms Kellie Close
Mrs Tanya Bauer
IV Sub-Project Name: Portable Drying Trials (2000)

Background
In March 2000 RICEGROWER’S purchased on consignment a 1.2 tonne Satake Batch Dryer (Model No: RMDR 12SD). This dryer was used to simulate rapid drying that occurs in Ricegrowers facilities over the harvest period. Four trials (Trials 2-5) were initially conducted investigating the various Dryer settings on drying temperature, moisture removal, burner operation, moisture contents effect on grain quality and time after drying before a sample should be milled.

Past Observations
Following the collection of results from the initial four trials it was discovered that the moisture removal %/hour was not rapid enough to accurately simulate the rates achieved in the field. Therefore two further trials were conducted (Trials 6 & 7) using significantly higher drying rates.

Objectives
To apply this drying information to the column drier located at Deniliquin.

Methodology
1. Take a sample of paddy to the Appraisals lab for conventional drying and milling.
2. Place 1 tonne of wet paddy (20-25%) into the dryer.
3. Record time and initial moisture content of paddy (Grainspec and drier display).
4. Dry paddy to the recommended target moisture taking moisture and milling samples, drier moisture and temperature readings and ambient temperature readings every hour.
5. Once the bin has been dried collect four samples: The first to be milled within 6 hours of drying, the second to be milled 2 days after drying, the third 2 weeks after drying and the fourth four weeks after drying.

Results

Table 1: Average Drying Temperature and Moisture Removal for each drying trial

<table>
<thead>
<tr>
<th>DRYING TRIAL NO:</th>
<th>AVE TEMPERATURE</th>
<th>MOISTURE REMOVAL</th>
<th>HOURS OF OPERATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>37</td>
<td>0.69</td>
<td>8</td>
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<td>3</td>
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<td>4</td>
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<td>5</td>
<td>33</td>
<td>0.57</td>
<td>11</td>
</tr>
<tr>
<td>6</td>
<td>42</td>
<td>1.1</td>
<td>6 ¼</td>
</tr>
<tr>
<td>7</td>
<td>42</td>
<td>1.1</td>
<td>6 ½</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>37</td>
<td>0.78</td>
<td>8.6</td>
</tr>
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</table>

Table 2: Appraisal analysis of the dried paddy samples from drying trials 2 to 7

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<tr>
<th>Drying Trial No:</th>
<th>Conventional Drying</th>
<th>Milled Initially</th>
<th>Milled 2 Days</th>
<th>Milled 2 Weeks</th>
<th>Milled 4 Weeks</th>
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<tbody>
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<td>61.3</td>
<td>59.8</td>
<td>60.1</td>
<td>58.7</td>
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<td>62</td>
<td>61.3</td>
<td>60.7</td>
</tr>
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<td>4</td>
<td>67.51</td>
<td>66.4</td>
<td>68.5</td>
<td>68.2</td>
<td>69.2</td>
</tr>
<tr>
<td>5</td>
<td>68.3</td>
<td>68.5</td>
<td>68.6</td>
<td>68.7</td>
<td>68.4</td>
</tr>
</tbody>
</table>

1 Samples milled at different times to the other drying trials (initially after drying, two weeks, three weeks then four weeks.)
### Implications and recommendations

These trials highlighted the difficulties in maintaining the quality of paddy during rapid drying. As average moisture removal increased, whole grain yields were found to significantly decrease.

Operating burners either continuously versus intermittently indicated no advantage in either improved whole grain yields or fuel efficiency. Drying efficiency however could be improved by operating the burner at lower temperatures for high moisture paddy.³

Rapid drying of paddy below 18% will cause significant reductions in whole grain yield. Therefore rapid drying using high moisture rice is recommended. Allowing samples a tempering time of 2 weeks after rapid drying provides some benefit in the form of improved whole grain yields.

It was concluded that the above findings should be applied to improve the operation of the Deniliquin drier for the 2001 harvest and that an automatic controller be also installed.

### Project Intellectual Property

N/A

### References

N/A

### Acknowledgements

Darryl Hill
Ricegrower’s Appraisal Laboratory –processing of samples and quality data.
Ms Jan Salmond - technical expertise and assistance.
Rice Research Australia –providing paddy and funding support.
Mr Chiaki Ono Satake Australia – Installation and commissioning of dryer.

**Figure 1:** Chiaki Ono (Satake Australia) with the RMDR 12 SD portable dryer

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³ Samples four trials 6 and 7 milled initially after drying, one week, three weeks and four weeks.

³ High moisture rice is defined as paddy with receival moisture contents of above 18%.
V Sub-Project Name: Impacts of extended on-farm storage on grain quality, in particular stackburn grain (2001)

Background
The 2001 rice harvest has been forecast as the largest on record. Due to limited storage capacities, Ricegrowers’ have outlined a plan during peak periods at several depots to receive grain for five days and close for two days to allow time out load any dried grain.

This however poses a number of problems and concerns for farmers who may have harvested grain or potentially will want to harvest grain will not be able to deliver for several days.

The consequence of keeping harvested rice at high moisture in storage bins for extended periods of time is not fully understood. Therefore it is necessary to investigate the impact that this has on reducing rice quality in particular the occurrence of stackburn.

Stackburn is the heating of wet grain due to microbial respiration resulting in yellow to tan, translucent grains that have not been gelatinized completely.

Objectives
The aim of this trial is to explore the impact the prolonged storage on farm has on grain quality, in particular the likelihood of stackburn.

Past Observations
N/A

Methodology
This trial was conducted at the Rice Research Australia, Jerilderie with the assistance of Russell Ford and Chris Quirk. Trial commenced on the 7th March and was terminated on the 16th March, 2001.

Materials
- 8 x 1 tonne storage bins
- Approx. 8 tonnes medium/short grain rice at moisture levels 18, 20, 22% dried to 14%.
- Manual probe
- 4 Tinytalk and 4 Hobo data loggers and sensors (to detect and monitor temperature)
- Grainspec (to measure moisture at harvest and during storage)

Methods
- Six 1 tonne storage bins were positioned in direct sunlight in order to simulate conditions similar to those a rice grower would store grain post harvest prior to delivery to paddy storage.
- Two 1 tonne bins were placed in shed to simulate normal drying practices of paddy storage. These bins were used as control or reference stacks.
- Three varieties of rice were harvested in order to gain the range of moistures required to conduct the trial (Opus, Koshihikari and Jarrah). Moisture levels (18, 20, 22%) used for the trial, with replicates for each moisture (Appendix 1).
Tinytalk and Hobo data loggers were re-set and inserted into the centre of each bin or stack at depth of 30cm. The time of resetting loggers noted and recorded.

Stacks were monitored daily during the warmest period of the day, 1:00 to 4:00pm. Samples were taken from each stack using a conventional grain probe. Two probe samples were taken, one from the outer edge approximately 15cm from the bin wall and the other from the centre of the bin. The two probe samples were combined and immediately grain moisture was tested and recorded using the Grainspec instrument (Appendix 2). Visual observations and assessments were made of the condition of the rice, including smell.

Ambient temperature was recorded inside the shed at the time of sampling. In addition to solar radiation and daily temperature records from the Rice Research Australia weather station.

Samples taken from each stack were then dehulled using an Otake Centrifugal Huller™. Brown samples then were visually appraised for any obvious signs of stackburn (Appendix 3).

Using a Minolta Chroma Meter CR-310™ brown rice samples were analyzed, control samples from a control bin (Stack 8) used as were as a colour reference. The ΔE valued calculated represents the colour ‘difference’ between the ‘target’ or reference colour and the tested sample.

In order to further analyse for evidence of stackburn the samples were dried in a Zip Fully Automatic Soft Dry™ Clothes Dryer, for periods of 1 hour at 53°C on the ‘Summer Soft’ setting. Moisture re-tested in Grainspec. When moisture of 14.5% was recorded, samples were milled using the Yamamoto Whitener™.

Polished samples were then visually assessed for evidence of stackburn and again the colour measured using the Minolta Chroma Meter CR-310™, referenced against the initial grain sample colour for that moisture.

**Results Moisture**

<table>
<thead>
<tr>
<th>Date</th>
<th>Grain Moisture (%)</th>
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</thead>
<tbody>
<tr>
<td>7/03/2001</td>
<td>22%</td>
</tr>
<tr>
<td>8/03/2001</td>
<td>20%</td>
</tr>
<tr>
<td>9/03/2001</td>
<td>18%</td>
</tr>
<tr>
<td>10/03/2001</td>
<td>17%</td>
</tr>
<tr>
<td>11/03/2001</td>
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<tr>
<td>13/03/2001</td>
<td>11%</td>
</tr>
<tr>
<td>14/03/2001</td>
<td>9%</td>
</tr>
<tr>
<td>15/03/2001</td>
<td>7%</td>
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</table>

**Figure 1**

Figure 1 shows the moisture of the grain generally decreased as the trial progressed. The control sample had initial moisture of 18.1% and at the conclusion of the trial was 11.4%. The bins placed in
direct sunlight showed slower decline in moisture with the 22%, 20% and 18% moisture bins declining by 1.8, 0.7 and 3.1% respectively from the start to the conclusion of the trial.

Temperature

Figure 2 shows the temperature of each stack was recorded at 1 or 5 minute intervals on Hobo and Tinytalk data loggers. The general trend over the experimental period was an increase temperature (Figure 2). The temperature for the 22% and 20% moisture sample reach 50°C after three days and four days respectively. The control samples did not reach temperature beyond 30°C over the entire trial period.

Figure 3 shows the average mean maximum and minimum temperatures were recorded at McCaughey Institute, as well as the solar radiation readings for the duration of the trial (Figure 3). The daily maximum temperature for seven of the nine days exceeded 30°C. The solar radiation readings ranged from 22.1 to 25.8MJ/m.

21
Brown Rice

Figure 4

Figure 4 shows the average ΔE value for the two replicates for each initial moisture level in the trial (18, 20, 22% and Control-18%). From the initial reference colour of the control the ‘difference’ increased for all moisture levels.

White Rice

Figure 5

Figure 5 shows the average ΔE value for the two replicates for each initial moisture level in the trial (18, 20, 22% and Control-18%). The initial ‘target’ was set as the first sample taken for each moisture level. There is a general trend that indicates an increase in the ‘difference’ between samples tested. Visually when samples were milled obvious signs of stackburn were observed as being slightly golden or yellowed grains. This visual difference was observed only after three days in the highest moisture paddy rice (22%) and both the 20% and 18% moisture samples after four days. As the trial progressed
the intensity of the colouration of the grain increased, which is supported by the general trends observed in Figure 5.

Mould

Figure 6
Mould growth appeared in high moisture samples on day 4 and progressively developed throughout the remainder of the trial. By day 6 mold growth had developed to a lesser degree in the mid-moisture samples (Plate 1).

Moisture
Grain moisture decreased slowly over the trial period. The effects of moisture variation may have been more severe if the bins had been covered or tarped. However from these results it can be seen that high moisture paddy (22%) developed detectable signs and symptoms of stackburn than lower moisture bins (20% and 18%). Variation in the moistures recorded is most likely due to difference in sampling sites within the bin.

Brown Rice
Visually and using the Minolta Chroma Meter CR-310™ the colouration of the brown rice increased over the trial period. With the greatest ‘difference’ in colour being observed in the highest moisture bins (22%).

Variation in the general upward trend is noted and potentially explained due varying green grain contents of samples or varietal differences between the ‘target’ sample and tested sample.
White Rice

White colour meter readings did not indicate as strongly the trends observed in the brown rice. However, visually as the trial progressed a general yellowing of the white rice was noted. Variation in the results from the Chroma meter can be potentially explained by varietal differences, logistical and practical constraints prevented a single variety from being used.

Mould growth

Mould growth developed after a relatively short period of time in the higher moisture bins of 22 and 20%. The effects of the mould growth were both visual and odor. The mould contributed to the brown colour of the dehulled rice and potentially the finished white rice product.

Appendix 1 - Stackburn trial design

Appendix 2 - Grainspec moisture readings

<table>
<thead>
<tr>
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<td>12.1</td>
<td>12.8</td>
<td>11.9</td>
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</table>

Appendix 3- Minimum and Maximum temperatures and solar radiation at McCaughey, Jerilderie (7/3/01-16/3/01)

<table>
<thead>
<tr>
<th>Date</th>
<th>Max Temp</th>
<th>Min Temp</th>
<th>MJ/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/03/2001</td>
<td>33</td>
<td>17.1</td>
<td>25.762</td>
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<td>8/03/2001</td>
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<td>16/03/2001</td>
<td>34.1</td>
<td>19.6</td>
<td>23.165</td>
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</table>
Appendix 4- Bin design for trial at McCaughey, Jerilderie.

Appendix 5- Stackburnt rice and control rice.
**Stackburn**

Stackburn is the heating of wet grain due to microbial respiration, results in yellow to tan, translucent grains that are not gelatinized completely. The phenomena is more severe with unthreshed grains still in the panicle together with wet straw (~80% moisture) than with threshed grain (>20% moisture).

Stackburning generally occurs when the temperature of moist freshly harvested rice rises over 60°C.

Note: In relation to aeration trials conducted by McNeal (1960) that rice with a 24% moisture content suffered damage to its quality when storage temperature was as low as 10°C. Rice at 15-18% moisture content showed damage after only five days when stored between 10 and 30°C.

**Implications and recommendations**
The conclusion of this trial highlights the need to conduct further of research into stackburn and mould growth.

Stackburn was detected after only three days, highlighting the relatively short period time. The high grain moisture of paddy rice and the relatively high daily temperatures at which it is harvested gives rise to both the development of stackburn and mould prior to delivery to aerated paddy storage. Therefore rice growers need to be aware to the consequence of prolonged on farm storage and its effects on quality.

**Project Intellectual Property**
No IP

**References**
N/A

**Acknowledgements**
Mrs Tanya Bauer
Mr Daryl Hill
Russell Ford and Chris Quirk (Rice Research Australia) the use of equipment, their time and rice
Deniliquin Q.A lab for the use of the Yamamoto Whitener
John (Turtle) and Bill (Gogeldrie Paddy Storage Testers) for their assistance in de-hulling samples
VI Sub-Project Name: Impacts of extended on-farm storage on grain quality, in particular stackburn grain - Part 2 (2001)

Background
In light of the results and observations of an initial stackburn trial at McCaughey a second trial was conducted to confirm and consolidate previous work. Results of the previous trial suggest that both stackburn and mould poses a potential problem in the storage of high moisture rice in as little as three days. Therefore it is necessary to alleviate farmer concerns in the delayed delivery of harvested rice to paddy storage.

Objectives
The aim of this trial is to further explore the impact of prolonged on-farm storage of grain post harvest. In this trial a comparison of covered bins and uncovered bins conditions will be made in order to determine the conditions which are most likely to induce stackburn and/or mould growth. Additionally a comparisons between medium and short grain varieties, to determine if medium grain is less likely to develop symptoms of stackburn over a shorter period of time.

Past Observations N/A

Methodology
Materials
- 6 x 1 tonne storage bins
- Grainspec (to measure grain moisture)
- Manual probe
- Approximately 6 tonnes paddy (Amaroo and Koshihikari) @ 20% moisture.
- 6 x Tinytalk data loggers located at 25cm depth (temperature only).
- Temperature probe
- 2 x Tinytag data loggers at 10cm (relative humidity).

Methods
- Four 1 tonne storage bins were positioned in direct sunlight in order to simulate conditions similar to those a rice grower would store grain post harvest prior to delivery to paddy storage, two bins were covered by a tarp (Appendix 1a & 1b).
- Two 1 tonne bins were placed in shed to simulate normal drying practices of paddy storage. These bins were used as control or reference stacks, after two days an uncovered and covered stack was also placed on the drying racks in the shed.
- Two varieties of rice were harvested Koshihikari and Amaroo at 20% moisture.
- Tinytalk data loggers were re-set and inserted into the centre of each bin or stack at depth of 30cm. The time of resetting loggers noted and recorded.
- Tiny tag data loggers placed in the Amaroo covered and uncovered bins to measure the relative humidity at a depth of 10cm. The time of resetting loggers noted and recorded.
- Stacks were monitored daily during the warmest period of the day, 1:00 to 4:00pm. Samples were taken from each stack using a conventional grain probe. Two probe samples were taken, one from the outer edge approximately 15cm from the bin wall and the other from the centre of the bin. The two probe samples were combined and immediately grain moisture was tested and recorded using the Grainspec instrument. Visual observations and assessments were made of the condition of the rice, including smell.
- A temperature probe was used to profile the bin temperature on a daily basis. Readings were taken from the side and centre at 30cm, 60cm and 90cm (Appendix 2).
- Ambient temperature was recorded inside the shed at the time of sampling. In addition to solar radiation and daily temperature records from the Rice Research Australia weather station.
- Samples taken from each stack were then dehulled using an Otake Centrifugal Huller™. Brown samples then were visually appraised for any obvious signs of stackburn.
- Using a Minolta Chroma Meter CR-310™ brown rice samples were analyzed and referenced against the initial grain sample colour for that bin. The ∆E value calculated represents the colour ‘difference’ between the ‘target’ or reference colour and the tested sample.
- In order to further analyse for evidence of stackburn the samples were dried in a Zip Fully Automatic Soft Dry™ Clothes Dryer, for periods of 1 hour at 53°C on the ‘Summer Soft’ setting. Moisture re-tested in Grainspec. When moisture of 14.5% was recorded, samples were milled using the Yamamoto Whitener™.
- Polished samples were then visually assessed for evidence of stackburn and again the colour measured using the Minolta Chroma Meter CR-310™, referenced against the initial grain sample colour for that moisture.

Results

Moisture

![Grain Moisture Graph]

Figure 1

The grain moisture as measured using the Grainspec at RRAPL indicates a steady decrease in moisture for all bins. Generally Stacks A & B, C & D and E & F follow a similar rate on decrease. The moisture in Stacks A & B showed the slowest reduction in moisture decreasing by 0.8 and 2.4 respectively for the entire trial. The most rapid decreases in moisture was seen in Stack E & F, which were placed on the dryers at the commencement of the trial. Stack C & D showed a similar rapid decrease in moisture when placed on the dryer after 2 days.
Data Loggers. The temperature of each stack was recorded at 30-minute intervals on Tiny talk data loggers. The general trend throughout the entire experimental period was a general increase in temperature. The results show Stack A and B recorded the highest temperatures at the conclusion of the trial, and varied only 4°C for the whole trial. The Stacks that were placed on the drying racks show varying temperatures that reflect the operating times of the dryers. Stack C and D show a rapid decrease in temperature when placed on the drying racks after two days.

Temperature Probe. The temperatures as recorded daily using the manual temperature probe showed minimal variation throughout the profile. The results also indicate larger variation between daily records (Appendix 3).
Ambient temperature. The average mean maximum and minimum temperatures were recorded at McCaughey Institute, as well as the solar radiation readings for the duration of the trial (Figure 3). The daily maximum daily temperature recorded for the trial period was 32.2°C and minimum temperature 6.9°C. The solar radiation varied from 11.972 MJ/m on the first day of the trial through to 21.187 MJ/m during the trial.

Relative Humidity

During the trial Tinytalk data loggers were inserted into Stack A (outside and covered) and Stack B (outside and uncovered) to measure relative humidity. The results from this 64 hour period as shown in Figure 4, as the relative humidity of Stack B (outside, uncovered) subtracted from Stack A (outside, covered). This indicates that the relative humidity in the uncovered stack was initially higher than the covered stack however after 14 hours the covered stack (Stack A) was higher.
Brown Rice

Figure 5

Figure 5 shows the average $\Delta E$ value from the initial moisture sample on the 27th March, 2001. The results for the brown rice indicate varying measurements of the colour difference. Individually each stack shows a general increase in the 'difference'. Stack C and D correlate results most closely.

White Rice

Figure 6

Figure 6 shows the average $\Delta E$ value from each initial Stack. The results show significant variability between stacks and days. No visual symptoms of stackburn were observed in the milled white rice.

Mould

Mould growth did not appear throughout the duration of the trial in any stack.
Moisture
The moisture data shows that the most significant decrease in moisture was seen in the bins placed on the drying racks. The stacks that remained outside for the entire length of the trial showed minimal decreases in the grain moisture (Stack A & B). This can be attributed to the relatively low solar radiation and daily ambient temperatures for the duration of the trial. Stack B in the final measurement 1.7% lower than Stack A, which is potentially explained due to Stack A being covered by a tarp, therefore retaining more moisture.

Temperature
Data loggers. The bin temperatures as recorded by the data loggers indicate that that no significant increase in temperature was observed, unlike in previous trials when the temperature recorded in the bin reached in excess of 50°C after only 48 hours. The temperature of each stack indicates a general increase in temperature over the entire trial, with the highest temperatures being recorded in the Stacks that remained outside for the entire trial period. Surprisingly minimal variation between Stack A & Stack B was noted.

Temperature probe. The results from the daily temperature probing of each bin indicate little trend in the measurements taken. No trend could be observed in the within the bins or between the bins. This could have been due operator error or incorrect calibration of the equipment. The former is being the more likely. The temperature probe requires time to equilibrate to the surrounding temperature before the reading should be taken, in some cases this length of time may have been forfeited.

Ambient temperature. The daily mean maximum and minimum temperatures are relatively low in comparison to earlier trial work. In this trial the minimum temperature being regularly falling below 10°C and the maximum temperature not exceeding 33°C, previous trials were conducted earlier in the season when maximum temperatures consistently 30°C and on some days 35°C (unpublished McNamara, 2001). These lower temperatures potentially explain the increased time before signs of stackburn were observed and thew limited incidence of mould developing throughout the entire trial.

Relative Humidity
Although a difference in the relative humidity was observed between Stack A (covered) and Stack B (uncovered) the difference can not be considered significant, as the maximum variation between stacks at anytime was 5.9%. Should the daily ambient temperatures been higher, consistent with the temperatures of previous trial work, the difference in relative humidity may have been significantly different.

Brown Rice
Although the Colour Meter data being highly variable, there is an overall trend of increasing ‘difference’ in colour from the original sample. There appears to be limited or no correlation within varieties or between varieties, as seen when comparing Stack A, B, E (Amaroo); Stack C, D, F (Koshihikari) or Stack E and F (control). With greater replication of stacks these results maybe more conclusive in proving variation between short and medium grain varieties, between covered and uncovered and their effects on colour variation in brown rice.
White Rice
As seen in the brown rice data the white rice results also indicate significant variability in the colour variation of the sampled white rice and again no correlation between associated stacks can be determined. This therefore highlights the difficulty in trying to quantify colour variation using the Chroma Colour Meter, as generally a bin of rice will naturally have substantial colour variation. Additionally the length of time and the number of replicates make all results subject to challenge.

Mould
No mould was observes throughout the trial period. The relatively low diurnal temperatures, in comparison to earlier stackburn experiments have potentially explained this. Results from earlier trial work demonstrated moistures comparable to those tested in this trial exhibited mould growth after as little as three days.

Appendix 1a – Trial Design

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<th>Stack D</th>
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Appendix 1b - Stack Design (covered and uncovered)
Appendix 2 - Temperature probe

Appendix 3 - Temperature probe data

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### Implications and recommendations

The results both visual and measured indicate that during this trial period negligible stackburn or mould was detected. The daily temperature and the low solar radiation have been attributed for these results.

The conclusion therefore from this trial indicates that temperature is the most significant indicator of the potential or incidence of stackburn and or mould occurring. Previous work in this area suggested that after three days stackburn occurred with daily temperatures above 30°C. This subsequent work indicates that lower temperatures increases the length of time that high moisture rice can remain in on farm storage without suffering a dramatic decline in quality due to stackburn and/or mould.

### Project Intellectual Property

No IP

### References

N/A

### Acknowledgements

Mrs Tanya Bauer  
Mr Daryl Hill  
Russell Ford and Chris Quirk (Rice Research Australia) for the use of equipment, their time and rice.

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VII Sub-Project Name: Determination of Head Rice Yield Using Point of Receival Rice (2001)

Background
The measurement of rice to determine moisture and green grain content is possible at the point of receival using the Grainspec NIRT spectroscope. This trial will attempt to use the Grainspec NIRT spectroscope to predict the head rice yield of sample rice at the point of receival.

Objectives
To evaluate head rice yield at point of receival.

Past Observations
N/A

Methodology
- A 1200g paddy rice sample is collected at the point of rice receival and it is sent to the Paddy Projects office for analysis.
- The paddy sample is split into two equal portions using a Rationel sample divider.
- 200g of paddy rice is taken from one of the equally divided samples.
- The 200g portion is de-hulled using a centrifugal huller.
- The de-hulled (or brown rice sample) is run through a Grainspec instrument to collect the data scan. The data scan is then transferred to a computer via an RS232 cable for storage.
- The portion of the sample with hull still intact is dried down from its initial moisture content to around 14%. The rice is dried down relatively slowly using rice driers borrowed from the Department of Agriculture Yanco.
- Once the rice has been dried down to 14% moisture, the Paddy Rice is stored in airtight tins for 3 months in cold storage.
- The tempered rice is milled using a McGill test mill and the head-rice yield of the sample is determined using an indent cylinder or GrainCheck 310 image analyser.
- The Head-rice yield of the sample is recorded and used as a reference result for the Grainspec data scans.
- By collecting 500 data scans and determining reference results for the scans an NIRT application for predicting the potential head rice yield of rice may be able to be developed.
The correlation appears quite high.

**Implications and recommendations**
An application for the prediction of head-rice yield in brown rice was developed (see figure above). Testing the head-rice application for its ability to accurately predict head rice yield will now take place.

**Project Intellectual Property**
No IP

**References**
N/A

**Acknowledgements**
Mrs Tanya Bauer
Mr Daryl Hill
SunRice Paddy Projects Team
Sub-Project Name: Bunker Aeration Trial (2001)

Background
In the past, Ricegrowers has attempted to avoid storing paddy in bunkers due to the extra labour and material costs associated with the construction, filling and outloading of paddy. As well as the significant quality losses that have been associated with placing paddy in this form of storage. Due to unavoidable circumstances it will be necessary for approximately 200 000 tonnes of rice from the 2000 and 2001 harvest to be stored in bunkers this season. The challenge therefore is to build bunkers where the reduction in the quality of the product is minimised.

The decline in grain quality associated with bunker storage is primarily associated with variances grain temperature and moisture leading to significant moisture migration and insect infestation. This has the effect of downgrading the quality of the paddy for any future end-use.

In order to reduce or avoid declining product quality it has been demonstrated by the other bulk handlers the potential of aerating bunkers. In the previous years Ricegrowers’ had attempted to adapt this technology for the storage of rice, unfortunately past designs at Biocon 1997/98 and Finley 2000/01 have been unsuccessful. However with the acquisition of both experience and knowledge from both CSIRO’s Stored Grains Laboratory and Graincorp, it is hoped to formulate a suitable design for use of the storage of rice.

Objective
To determine a bunker aeration design that maintains grain quality while reduces losses associated with moisture migration and insect infestation.

Past Observations
N/A

Methodology
- 2 Earth Walled Bunker dimensions 127m x 32m (approx. 11500t of rice).
- 2 Aeration Fans that provide an overall aeration rate of 0.4L s-1 t-1.
- 132m x 406mm Aeration ducting (23o open area 1.6mm dia holes @ 3.2mm centres).
- 132m x 354mm Aeration ducting (specs as above).
- Parts associated with the ducting such as joiners, end caps and bends.
- 11 000 tonnes of dried paddy rice
- Grain bunker tarps
- 6 x Tinytag data loggers and sensors
- 6 x 1.2m dowel sticks
- Grey tape/cloth tape
- Two bunker sites prepared by David Grimison & Co. Earthen bunker walls used as retaining walls. A control bunker is used to compare the results of the aerated bunker, grain in-loaded as per normal procedure.
- For the aerated bunker holes cut in the retaining wall for placement of ducting.
- Perforated ducting laid out, in-loading of grain to fill bunker (Plate1).
• 15158 tonnes of Amaroo rice was in-loaded after drying at the Deniliquin paddy storage to a moisture of 12.7%.
• Bunker tarped and seems sealed with silicon to prevent moisture seeping through the stitched seems.
• The sensors taped to 1.2m dowel sticks and inserted into black, 32mm micro-spray irrigation tubing. Silicon then used to seal the ends of the tubing.
• Tinytag data loggers reset to log every 4 hours and then attached to the sensors.

An incision made in tarp and probe pushed in the grain mass. Sensors located at top. Middle and bottom of bunker at the eastern end, on the southern face of the bunker. The sensors and data loggers were secured using grey electrical tape and black cloth tape. Three sensors were placed in identical locations in the ‘control’ bunker located directly next to the aerated bunker on the southern side (Appendix 1).

• Two additional sensors were placed in the aerated bunker at a later stage at a location know as “mid-top”, between the top and sensor placed in the middle of the bunker on the same side as the three existing sensors and one on the northern face (or Deniliquin side) at approximately the same location, this to determine if the temperatures are even across the bunker.
• Fans connected, with fabricated S-bend tube, power supplied from generator.
• Bunker aeration program devised according to temperature records from sensors.
• Sensors regularly downloaded and data recorded.

**Results**

**Aerated Bunker**

*Figure 1: Aerated Bunker at Deniliquin*

In late 2000 predictions were already starting to roll in for the record 2001 harvest, estimates up to and beyond 1.7 million tonnes. This crop size pushing this limits of the RCL storage facilities to an absolute maximum. Temporary storage facilities were required to try and maintain grain quality until milling or more permanent storage facilities were made available. Previously bunkers had been trial in the rice industry, however created some due concerns about quality deterioration, due to moisture migration to the peripheral regions of the bunker, leading to to mould development and thus promoting warm conditions for insect infestations to develop.
Figure 2: Aerated bunker design
Our aerated bunker design has been again developed with the assistance and experience of the SGRL group at CSIRO. The basic design shows the standard measurements for a 12 tonne bunker of 127m long and 33m wide. 354mm perforated ducting was placed against the outer edge of the top side or what we term the 'suction side'. Two further sections of 406mm perforated ducting was place 5 metres from the 'fan side' of the bunker and then connected to fans outside the bunker wall which operate at 0.4Ls-1t-1, drawing the moisture through the bulk of the grain mass. These fans were operated by a diesel generator.

Table 1: Aerated Bunker

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Figure 4: Aerated and control bunker temperatures

The results of our trial showed that grain temperatures can be reduced through aeration in a bunker situation. Sensors located at three points of the bunker were used to monitor and represent grain temperatures. The dark green line indicates the initial temperature 18°C fell over the monitored period to 11°C. The mid point indicates again a fall in temperature to 12°C. Even the top sensor temperature decreased slightly to 18°C, but most importantly, it did rise rapidly like the control sensor.

A control bunker with no aeration was used for comparison. As seen the control bunker after a short period of time rapidly increased to in excess of 40°C, which is of most concern as the peak of the bunker is generally where moisture migration and mould develops.

Aerated Bunker
The aeration was commissioned on the 15 May 2001. The temperature for each of the sensors recorded prior to aeration commencing.

The temperatures recorded on a regular basis through the trial in order to determine and update the aeration program. The aerated bunker was forced to be out-loaded as a result of an irreparable rip in the tarpaulin (28th July 2001).

The temperatures recorded over the monitoring period showed that all locations down the side of the bunker decreased in temperature after aeration. The ‘top’ sensor on the bunker reduced in temperature by 1.4°C. The middle temperature sensor decreased by 7.5°C and the bottom sensor reduced in temperature by 7.0°C. The ‘mid-top’ sensor on the southern side (same side as all other sensors) increased in temperature from 18°C to 18.4°C over the monitored period. The northern side sensor located at the same height on the bunker face remained constant at 19.5°C.

Observations made of the grain on the day that out-loading commenced (31 July) indicated minimal quality deterioration. Additionally, no signs of insects or mould growth were observed (Plate 2 & 3).

Correspondence with Deniliquin Mill and Paddy staff indicated that the grain moisture was 12.5% when delivered to the mill and whole-grain yield was calculated as 52.16% (Mill 1-Deniliquin) and 53.3% (Mill 2-Deniliquin).
Control bunker
The initial temperature of the original control bunker was 14.3°C at the bottom sensor and 19.2°C at the top. This bunker was out-loaded on the 1 June 2001. A second non-aerated bunker was created and subsequently used as the control. The sensors placed in the bunker for temperature monitoring on the 6 July 2001. Result for the control bunker indicated that a rapid increase in temperature was observed over the 4 week monitoring period. The top sensor rising from 25.2°C (16 July) to 53.5°C (31 July), the lower portion of the bunker remaining below 16°C for the four weeks it was observed. The sensors were subsequently removed the same day the aerated bunker was out-loaded and it’s sensors removed on the 31 July 2001.

Observations of the grain whilst removing the sensors form the control bunker indicated a severe deterioration in grain quality as the rice was extremely warm and there was obvious signs of condensation at the ‘top’ sensor. The lower sensors located at approximately the middle and bottom (2m above ground level) showed no signs of this type of quality deterioration.

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Discussion
Aerated bunker
Setting up and design
Inserting the probes into the grain mass required piercing the tarpaulin and then attempting to re-seal the hole with the use of grey/cloth tape. In all cases the re-sealing was generally successful, however the piercing of tarpaulins is not advantageous to the longevity of the tarpaulin. In consultation with Graincorp an alternate for method has been recognised using a gauze cloth and sealing with Steamseal™ or Duraflex™ (pers.comm R. Dawson, 23/8/01).

Difficulty was also first experienced in keeping the probes in the grain mass, this was overcome by inserting a length of cable underneath the tarp, to reduce the likelihood of a strong wind pulling out the probe. In order to avoid a repeat of similar difficulties, in future trials the sensors will be placed through the bunker as it is being in-loaded. This gives the advantages of securing the sensors in place within the grain and allowing the monitoring of the temperature deeper into the grain bulk.

Throughout the trial considerable concern was expressed for the likelihood of the “suction” ducting drawing-in moisture, from heavy dew or puddles of water that form around the bunker site as a result of a significant rainfall event (Plate 4). To alleviate these concerns ducting should placed on a higher surface. Also it was been considered that the overall ease of monitoring may be further enhanced by using a concrete bunded bunker in future trials.
Monitoring
Monitoring of the aerated bunker became hazardous to personal safety in gusty weather, as the flapping of the tarpaulin had the potential to cause a person to slip down the side of the bunker, potentially injuring themselves or equipment. Therefore it is considered that if a similar monitoring program is required in future trials that two people be present at on site.

The location of the sensors particularly on the side of the bunker meant that the leads were prone to bird attack, with several sensors being rendered unusable after the trial. Again this issue could be resolved by placing the sensors and leads under the tarpaulin.

Grain temperature
The recorded grain temperature in the aerated bunker decreased over the monitored period. In the case of the middle sensor a decrease of 7.5°C was observed. Due to keeping the majority of the grain mass below the 15°C threshold, considered critical to minimise insect activity no insects were found in the bunker. It has been Ricegrowers’ experience that bunkers due to the difficulty in maintaining and even low temperature and the difficulties in fumigated insects are generally more prevalent and shed storages. In reducing the grain temperature to approximately 12°C for ¾ of the grain mass, the potential of moisture migration to the top and outer edge was reduced. Although failing to evenly cool the entire bunker to a constant 15°C, a temperature of 18.4°C on the top of the bunker and a temperature of 19.5°C on the northern face appear satisfactory in maintaining overall grain quality. With increased monitoring and purchase of an aeration controller, the ability to select the most suitable conditions, in terms of time of day, temperature and relative humidity will enable potentially a more even and temperature throughout the grain mass. It has been the experience of SunRice that bunkers are more prone to insect contamination than shed storage. This has been due to difficulties in monitoring bunkers of even and low temperatures and in fumigation for insect control.

Grain quality
The grain quality of the rice post aeration was observed to be of good satisfactory quality. The grain had no sign of insect infestation, which can be attributed to keeping a majority of the grain mass below 15°C and the relatively short length of time the rice was in the bunker. No sign of mould growth was observed on the peak of the bunker.

The grain moisture when delivered at the mill was an acceptable 12.5%. The whole grain yield was 52.16% (Mill 1-Deniliquin) and 53.3% (Mill 2-Deniliquin) (pers.comm J.Fisher 17/8/01). As no whole grain measurements were taken prior to the commencement of the trial the maintenance or decrease in mill out can not be determined. In the 2001 harvest the average mill out for all medium grain in was 56.0% and Amaroo variety 60.5% mill-out (pers.comm P.Robinson 17/8/01). Compared to the year’s average the aerated bunker storage was of slightly inferior quality, (this again is subject to debate but this is affected by the time of delivery, moisture, area grown and in and out loading conditions that were not recorded.)
Control bunker

Grain temperature

The temperature of the control bunker although only constantly monitored for four consecutive weeks indicated that the bottom portion of the bunker (approx. bottom ¾) remained around and below the 15°C threshold that was aimed at to maintain grain quality. The top sensor in the bunker indicated a rapid rise in temperatures greater than 50°C, with the potential rise higher. The area effected by high and rapid temperature increases potentially due to further moisture migration.

Grain quality

At the time of removing the sensors from the control bunker (31 July 2001) considerable concern was expressed as to the actual quality of the grain. As the temperature of the ‘top’ sensor was 53.3°C the grain surrounding the site where the sensor was located showed obvious signs of grain sweating and condensation build up underneath the tarpaulin.

However at outloading the grain in the control bunker appeared to be in satisfactory condition, with limited quality damage as there was no sign of mould or crusting as anticipated. However it should be noted that this inspection took place when only approximately 2000 tonnes had been outloaded (Plate 5).

The grain moisture when delivered at the mill was an acceptable 12.5%. The whole grain yield was 49.49% (Mill 1-Deniliquin) (pers.comm J.Flisher 31/8/01). These mill-out percentages were lower than the aerated bunker of 52.16% (Mill 1-Deniliquin) and 53.3% (Mill 2-Deniliquin). However no strong conclusions can be drawn from these figures as the length of time in the bunker and the initial grain quality can not be quantified. For more valuable results, measurements of in-loading quality and conditions must be made.

Additional issues and problems

Since the generator was the property of a third part, its availability was at times restricted. This was not a significant problem as the aeration program was not highly regulated and at no time was the grain quality jeopardized. In the event that a controller was purchased the site would require permanent power to allow the automatic turning on and off of the fans when weather and rain conditions are in order for the controller to have automatic control. The purchase of a controller would enable the constant monitoring of ambient temperatures and grain temperatures which will provide superior conditions for maintaining overall grain quality.

The untimely out-loading of the bunker, due to a ripped tarpaulin meant the duration of this trial was reduced. It was anticipated that the bunker would not be out-loaded until mid October, which would have allowed us to determine the effect of long term bunker storage on grain quality, particularly moving into warm weather conditions. For future research it is anticipated that the grain will remain in the bunker for at least 9 months, longer if at all possible.

The process of outloading the aerated bunker was made more challenging due to the ducting. As a consequence several of the ducts were damaged in their removal (Plate 6). The design had allowed room for the bucket to clean between the earthen wall and the ducting. However, due to time pressures, a significant amount of the outloading
was conducted at night and a large number of staff were involved. All staff may not have been aware of the placement of the ducting. In future a larger number of staff will have a detailed design of the bunker’s ducting system to avoid further damage. Graincorp also use a number of posts attached to the top of the ducting to indicate the presence of the ducting.

**Implications and Recommendations**

The duration of this trial was reduced due to a number of unavoidable circumstances. The results from this trial therefore are not entirely conclusive. From observations and measurements taken within this trial it has been shown that the aeration design and system utilized does reduce grain temperature, which in an extended trial should have been vital in reducing moisture migration and insect infestation. The control bunker highlighted the potential of grain temperature to rapidly rise after only a very short time in storage, which will inevitably jeopardize grain quality.

Finally this trial has demonstrated a number of shortcomings in the present design and monitoring techniques that can be amended with further research and consultation with other grains industries. However, it has given strong indications that rice can be stored in bunkers with no significant losses or quality deterioration.

Further research into developing effective aeration systems is required to fully understand the potential that Ricegrowers’ can utilise this technology.

**Project Intellectual Property**

No IP

**References**

N/A

**Acknowledgements**

Mrs Tanya Bauer  
Mr Daryl Hill  
SunRice Paddy Projects Team  
CSIRO  

We would like to thank and acknowledge the assistance of David Grimison and staff for their time, facilities and patience in setting up and monitoring this trial. The assistance of the Deniliquin paddy and maintenance/engineering staff was also appreciated.
IX Sub-Project Name: Analysis of the Infratec as a replacement for the Grainspec for moisture determination (2001-2002)

Background
The use of Near Infrared grain analysis instruments within Ricegrowers’ Cooperative to measure rice quality parameters is important for a number of reasons:
1. The analyses are rapid (40 seconds), replacing the time-honoured, but often slower and expensive reference methods.
2. The analysis methods do not damage the grain and no sample preparation is required.
3. They provide rapid moisture measurement of grain samples at the point of receipt with an accuracy of +/- 0.5%.
4. They allow the segregation of rice at receipt depots based on moisture content.
5. The instruments are also used in RCL manufacturing units to ensure correct steeping moisture for puffed rice products, to optimise milling operations and analyse finished product quality parameters.
6. NIR/T instruments can be calibrated to perform quality analyses such as the measurement of green grain, protein and oil content as well as other parameters.

The Grainspec Instrument:
The Grainspec NIRT instruments were bought by Ricegrowers’ Cooperative in approximately 1995. Ricegrowers’ has 52 instruments currently. These instruments are located right throughout the industry in manufacturing units, quality assurance laboratories, receipt and storage sites. The Grainspec is a multi-component NIRT (near infrared transmission) analyser. The analysis results are shown both on a display and can be transmitted to a computer for data collection. The instrument was manufactured by Multispec in the U.K. and sold by Foss Tecator. However the Grainspec has been superseded by a new type of NIRT instrument called the Infratec.

Infratec 1241 Grain Analyser:
The Infratec 1241 Grain Analyser represents the new instrument generation for quality composition analysis of whole grain. The Infratec 1241 also has the capability to analyse quality parameters in grain such as protein, moisture, starch, oil, etc. with high accuracy. Since it is using NIT (Near Infrared Transmittance) technique, there is no need for sample preparation. The Infratec 1241 Grain Analyser is designed to be used as a stand-alone unit or a network unit. The Infratec grain applications have been developed over a number of years in cooperation with grain companies all over the world. Today it is possible to have ready-to-use applications for several commodities. This becomes possible, thanks to the use of the ANN (Artificial Neural Network) calibration technique. The benefit of using the ANN technique is the capability of handling very large data sets without losing accuracy. As a complement to this calibration technique, PLS (Partial Least Squares) is also used.

Objectives
To evaluate the suitability of the Infratec as a replacement for the Grainspec for moisture determination.

Past Observations
Problems with the Grainspec Instrument:
As with any instrument the Grainspec requires servicing to maintain its accuracy. Occasionally parts have to be replaced. However due to the fact that the Grainspec instrument has been superseded, these parts are quickly becoming expensive. Currently a replacement optics assembly is valued at $8000.00. Since purchasing the original Grainspecs in 1995/6 replacement optics assemblies have been used in the fleet of Grainspecs. The cost of replacement parts for the Grainspec is likely to continue to increase. Therefore a strategy must be developed to ensure the most economical and accurate testing methods are used for the benefit of Ricegrowers’ Cooperative.

Problems with the Infratec 1241 Grain Analyser:
The Infratec 1241 instrument is a scanning spectrophotometer, which uses a different method of calibration than the Grainspec instrument. Therefore the two instruments are not compatible with each other. If it were decided that the Infratec 1241 instrument should be purchased as a replacement for the Grainspec, the initial investment would be very large. This is because at least 52 instruments are needed to service the entire industry.

Other faults with the Infratec are that the keypad is not self-explanatory and would cause difficulty for the layperson operator.

The sample hopper is not as efficient as the Grainspec. The Infratec 1241 often jams up with sample and needs frequent cleaning.

Methodology
During the 2001 harvest, two Infratec 1241 instruments were loaned to Ricegrowers’ Cooperative by the Foss Pacific Company. The Infratec instruments were trialed for their moisture measurement capability and the results were compared to the American Association of Cereal Chemists (AACC): standard method of moisture determination. The Infratec instrument results were also compared to the Grainspec instrument results. In this way the suitability of the Infratec 1241 instrument as a replacement for the Grainspec was evaluated.

Results

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Table 2 - Sorted by increase in oven moisture

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Tables 1 and 2 contain the results of moisture analyses performed on recently harvested rice. The samples were analysed using 3 comparative techniques. The oven results refer to the AACC standard method of moisture determination for grain. The Infratec 1 and 2 results refer to the moisture results obtained through analysis using the loaned Infratec 1241 instruments. The Master 5931 and Master 6701 results refer to the results obtained with two Grainspec instruments. By comparing the instrument results and their variability from the standard oven moisture determination, it is possible to determine the accuracy of the instruments.

![Infratec Vs Grainspec](image)

**Figure 1**

*Figure 1 is a graphical representation of the tabulated results. The standard oven moisture determination is plotted in blue and the instrument results are plotted in various other colours. To illustrate the accuracy of the instruments, 0.5% error bars have been added to the oven result. The instrument results can be compared to the oven result and the accuracy of the result (within or outside the 0.5% error margin) can be determined. The bottom row of table 1 contains the number of analysis with less than 0.5% accuracy compared to the oven moisture determination.*

From the tabulated results, it appears that the Infratec 1241 instruments produce more accurate moisture results compared to the oven determination than the Grainspec instruments. The Infratec instruments were capable of accuracy within the 0.5%
threshold in every sample. On the other hand the Grainspec instruments failed several times to achieve the 0.5% accuracy threshold.

This trial was repeated 8 times with rice in various forms ie in the paddy form, in polished form and in the brown rice form. The results of the trials can be found in Appendix 1. The 8 trials produced 46 Infratec analyses that were outside the 0.5% threshold level and 47 Grainspec analyses that were outside the 0.5% threshold level.

**Implications and recommendations**
There was little difference in accuracy between the two NIRT platforms. The only consideration in making a choice for industry is cost.

**Project Intellectual Property**
No IP

**References**
N/A

**Acknowledgements**
Mrs Tanya Bauer  
Mr Daryl Hill  
Mr Nathan Cutter  
SunRice Paddy Projects Team
X Sub Project Name: Green Grain Germination Trials

Background
Rice germination rates are generally in excess of 85%. Lower germination of crops can be attributed to many reasons including crop management and unfavourable weather. Green grain content has also to been suggested to potentially explain poor germination, however to date calculations of the percentage of green grain in seed crops has not been made. Nor has it been established the viability of green grain.

Germination occurs when suitable water and temperature conditions are available. Seed germination is defined when in accordance with the growth of an embryo, part of its tissues breaks the integument’s of an seed and emerges outside. In a broader sense, the germination also includes the period until radical and plumule grow and take root in the medium, during which the young plant is in the so-called hetrotrophic period.

Therefore in conjunction with the green grain trial a series of germination trails have been conducted in order to determine the viability of green grain and influence that green grain has on the germination percentage.

Objectives
The aim of this experiment is to compare the germination of paddy rice, brown rice and green grain.

Methodology
Materials
- 100 grains of paddy rice
- 100 grains of brown rice
- 100 grains of green grain rice
- 6 x Petri dishes, with covers
- Marking pen
- Filter paper
- Water
- Oven

Methods
- Sample 100g of paddy rice. Count out two lots of 50 grains in the paddy form. Dehull the remaining sample. From this sample randomly select two sub samples of 50 brown rice grains and 50 green grains (total of 100 grains of each).
- Place in oven at 30°C for 48 hours to break the dormancy period. Allow cooling.
- Place filter paper on the bottom of the petri dish.
- Moisten the filter paper. Adding enough water to moisten the filter paper.
- Place 50 seeds evenly on the filter paper. Arrange and press the layer of seeds with your hand to ensure that all the seeds are in contact with the filter paper underneath.
- Allow the seeds to germinate. Keep the dish at room temperature one of each treatment e.g. BROWN GREEN PADDY. The remaining three samples should be place in the oven at 25°C.
- Add drops of water 3 times a day to maintain moisture. The seeds will germinate in 4-5 days. Caution: Do not keep in an air-conditioned room. Record temperatures of both oven and room temperature.
- Count the number of germinated seeds each day. Including only those seeds with shoots longer than 1cm.
- Record number of shoots counted is the germination percentage.

**Results**

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The germination of the seeds was monitored for a period of seven days. In figure 1 it can be seen that the green grain in the oven (Green O), germinated first and at the end of the trial 98% of the sample had germinated. The slowest treatment to germinate was the PADDY rice at room temperature (Paddy R), and after 4 days only two seeds were classified as ‘germinated’.

Orange, green, black and pink mould growth was noted on the brown and green oven treatments after 5 days. To a lesser extent mould growth was observed in the brown and green room temperature treatments.

Over all samples germinated at the end of the trial period 80% of the paddy in the oven germinated; 96% and 98% of the brown and green grain respectively germinated. At room temperature the overall germination percentage were 30%, 66% and 90% for paddy, brown and green grains.

![Comparison of Oven and Room Temperature germination percentages](image-url)
Implications and recommendations
An overall comparison of the oven germination and the room temperature germination indicates that the oven is a more effectively means of germinating rice quickly. However the oven germination is not a realistic method of testing germination, as it is unlikely that these conditions replicate field conditions at planting, more realistic soil temperatures is below 18°C.

The results of this experiment showed that dehulled grain rice had a greater germination percentage and germinated more rapidly. However, it also suffered greater mould damage and infestation, therefore removing the feasibility of germinating brown rice on a commercial scale.

Green grain in both treatments germinated exceptionally well e.g. 98% (oven) and 90% (room temperature), therefore indicating that green grain does have the potential to germinate. However the question remains will this occur under normal field conditions. Further work is required to investigate the feasibility of separating out green grain in rice and it’s overall effect on germination percentages.

Project Intellectual Property
No IP

References
N/A

Acknowledgements
Mrs Tanya Bauer
SunRice Paddy Projects Team
Background

In most cases rice is purchased for consumption in the whole grain form. This is a distinction which separates rice from other grain commodities such as wheat and barley etc that are usually converted into consumer products with little resemblance to the original grain. For example wheat is more commonly purchased by the end user as products such as flour and baked goods.

Because the rice grain is consumed primarily as intact kernels, the consumer is often discerning about the physical quality of the grain being purchased. During the processing of rice at SunRice, white or polished rice is graded for quality based on the physical characteristics of importance to various markets.

The degree of milling (DOM) is an important measurement of quality for polished or white rice. The DOM measurement relates to the amount of bran that is retained on grains of rice after the milling process.

To produce white rice, first the hard protective husk is removed, then the germ and bran layers are milled from the grain to expose its white starch centre which is known as white rice.

By removing the bran layers that adhere to the surface of rice the appearance of the milled rice is lightened giving the grain its white appearance. However there are other reasons besides appearance for removing the bran layer from rice. The bran layer has a high oil content. The oil in the bran layer is subject to oxidative rancidity and by removing the bran layer from the grain the product’s shelf life is extended. On the other hand, some of SunRice’s customers have requirements for rice with specific levels of grain surface oil content. Some rice products require specific oil contents to provide value added processing capabilities such as cooking with a puffing process.

These customer requirements put SunRice in the position of needing to measure the DOM in milled rice in order to control the quality of the rice being produced. A lot of studies have been made on the measurement of DOM using Near Infrared Spectroscopy. However this study concentrated on certain colour characteristics of
rice that add emphasis to the importance of using NIR measurement for the rapid measurement of DOM at SunRice.

The Grainspec NIRT transmission instrument was calibrated to measure the fat content of milled rice (reference method: crude fat determination by Fex-Ika (automated Soxhlett extraction)). The measurement of crude fat content by NIRT is not affected by the chalk content of a sample and therefore offers a more robust measurement of DOM.

Objectives
The objective of this project is to determine the correlation of crude fat as measured by the Grainspec and the degree of milling as measured by the Satake milling meter.

Past Observations
A Satake whiteness meter is an instrument used to measure the DOM. The Satake instrument works by measuring the colour of a sample. An inherent problem with the Satake instrument is that ‘chalk’ levels in measured samples produce biased results. The white appearance of the ‘chalk’ confounds the darker colour of the bran. An alternative method of measuring DOM can be inferred through the measurement of sample crude fat content as the bran layers contain a large amount of oil. The Grainspec NIRT transmission instrument was calibrated to measure the fat content of milled rice (reference method: crude fat determination by fex-ika (automated soxhlett extraction)). The measurement of crude fat content by NIRT is not affected by the chalk content of a sample and therefore offers a more robust measurement of DOM.

Methodology
At present, SunRice manufacturing mills use the Satake Milling Meter MM1B to rapidly measure the DOM. The Satake instrument works by measuring the colour of a rice sample. The milling meter specifically measures the white surface area of a sample of grain. The whiteness of a sample increases as the dark coloured bran layer is removed from the outside of the rice kernels. The Satake Meter is calibrated using a white and a brown calibration plate. After calibration a sample of milled rice is packed into a viewing case and the case is inserted into the meter. From the analysis a result is produced for the sample called the Degree of Milling.

A method of measuring DOM can be inferred through the measurement of the sample surface oil content because, as previously mentioned, the bran layers in rice contain a high oil content. The Grainspec NIRT instrument was used to develop a near-infrared calibration to predict surface lipid concentration. The surface lipid calibration was developed with samples of milled grain between 0 and 2.5% oil content. Nine varieties of rice were used to produce the calibration. Each sample was scanned using a Grainspec NIRT instrument for transmission spectra and then the samples were chemically extracted for surface lipid content (reference method: crude fat determination by fex-ika (petroleum ether soxhlett extraction)). This figure illustrates the Grainspec instruments measurement of sample surface oil content with reference results measured by soxhlet extraction. The coefficient of determination (r squared) for the two measurements of oil content is around 0.98.
Results

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</tr>
</thead>
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<tr>
<td>Surface lipid content</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set one calibration</td>
<td>0.98779</td>
<td>0.08</td>
</tr>
<tr>
<td>Set two prediction</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Crude fat content V's DOM (Satake)](chart.png)

A strong correlation was found to exist between the measurement of DOM in non-chalky rice and the measurement of sample fat content.

**Implications and recommendations**

The measurement of sample surface oil content by NIR spectroscopy is a useful practice for SunRice to pursue. The NIR measurement allows rapid prediction of the product oil content. This is useful because certain specialist customers have tight specifications for rice oil content and measurement by Soxhlett extraction is not a fast enough method to control the milling process.

By using NIR, physical characteristics of the grain such as varietal differences, chalk content and grain age are not able to interfere with the DOM measurement.

**Project Intellectual Property**

No IP

**References**

N/A

**Acknowledgements**

Mr Nathan Cutter
Mrs Tanya Bauer
SunRice Paddy Projects Team
XII  Sub-Project Name: Quality assurance of rice products using image analysis (2002)

Background
GrainCheck 2312 Analyzer from FOSS is an automated digital grain inspection system overcoming the traditional subjective, time-consuming as well as labour intensive manual ocular inspection. It gives consistent results, independent of operator using the latest calibration technique – ANN (Artificial Neural Network) – and a CCD video camera.

The design is based on the experience from the grain market. It measures the physical properties from each individual kernel, such as length, width and colour. In a few minutes the results are presented in real time on the screen as well as a printout. The Analyser unit consists of a sample transport device, a colour video camera, a balance and a powerful PC with self-instructive software.

Objectives
The objective measurement of grain quality parameters is desirable to improve product quality and manufacturing efficiency. The Grain Check from Foss Pacific uses image analysis to measure quality parameters in grain and has been used to provide measurements of quality parameters such as whole grain, broken content, chalky kernels, length / width ratio and discolouration in milled rice.

This project aims to standardise the Graincheck equipment, which is located in all SunRice milling sites. The successful standardisation of this equipment will allow for the development of more uniform degree of milling, more uniform segregation of inferior grain and ultimately working to producing more uniform product lines from all mill sites throughout the industry.

Additionally the objective of this project is to understand the limitations and/or adaptability of such an instrument to predicting grain quality.

Past Observations
The objective measurement of grain quality parameters is desirable to improve product quality and manufacturing efficiency. The Grain Check from Foss Pacific uses image analysis to measure quality parameters in grain and has been used to provide measurements of quality parameters such as whole grain, broken content, chalky kernels, length / width ratio and discolouration in milled rice.

Methodology
‘Hand-picked’ samples are tested as per manual method and then processed through the image analyser. Results are recorded and presented graphically. These are a known weight.
Results

Grain Check Measurement of Chalky grains (Millin)

Figure 1 shows the comparison of a known weight of chalky grains, hand-picked and the number of chalky grains detected by the Graincheck analyser.

Measurement of damaged grains (MG Polished)

Figure 2 shows the comparison of a known weight of damaged grains, hand-picked and the number of damaged grains detected by the Graincheck analyser.
Figure 3

Figure 3 shows the comparison of a known weight of green grains, hand-picked and the number of green grains detected by the Graincheck analyser.

All results showed quite a good comparison of data. During the trial however, hurdles were faced whilst attempting to standardise each individual piece of equipment. The light source used in this piece of equipment does not produce consistent light source quality thus creating major variation between composite tests on same samples. An attempt to change the light source in a trial piece of equipment to a halogen globe improved the variation however still provided an unfavourable level. This was unable to be rectified.

Implications and recommendations
This piece of equipment would prove invaluable in streamlining quality analysis of grain both in the pre-milling phase and the milling process. However until the light source can be improved excess variation in light source does not allow this.

Project Intellectual Property
No IP

References
N/A

Acknowledgements
Mr Nathan Cutter
Mrs Tanya Bauer
SunRice Paddy Projects Team
XIII Sub-Project Name: Adaptive Discounting Control in Paddy Storages (2001-2005)

Background
The trial is a demonstration of the performance of the “Adaptive Discounting” aeration control method (ADC) for drying paddy rice within Ricegrowers’ Cooperative Limited (RCL) facilities. This control method has been developed at SGRL over the last 3 years for a broad range of aeration applications; drying, cooling and maintenance. It has been successfully trialled for aeration-drying applications previously using aerated transportable farm silos and the crops sorghum and canola. The new aeration control method offers a series of improvements over existing approaches while specifically tackling a commonly accepted limitation of aeration drying important to RCL, “off spec” moisture contents across the storage bin. The general experience with aeration drying systems (or in store drying) is that the grain is over-dried near the aeration air inlets and insufficiently dried or “marginal” near the air outlets and peripheral zones. In the RCL situation, this results in paddy being supplied to the mills with varying moisture contents and an increased susceptibility to breakage. The aeration control method developed at SGGL can address this limitation.

The new control method also provides a range of more universally applicable benefits. The key benefits are as follows:

- A ‘user friendly’ operator interface
- Maximum thermodynamic efficiency regardless of aeration system size and weather conditions
- Capacity to input target grain moisture contents (and temperatures).
- Controller automatically turns aeration process down as the target is achieved.

In conjunction with CSIRO Stored grains division in Canberra, RCL is required to assist in the weekly moisture sampling of the Gogeldrie Shed 4 Bin 5. The purpose of carrying out direct moisture sampling of the paddy rice undergoing aeration is to provide unambiguous evidence of the drying action carried out by the Adaptive Discounting aeration control method. The direct sampled measurements will support the “on-line” electronic relative humidity and temperature measurements and provide the data required to test if a major aim of the trial was achieved.

Objective
To measure the capacity of the adaptive discounting method to dry paddy rice to a target moisture content within RCL aeration bin without a significant moisture profile across the depth of the bin.

Progress
2001
The trial was conducted over the 2001 harvest in Gogelderie in Shed 4 Bin5. The PC based aeration controller and data acquisition instrument was installed and target moisture of 14% with an over-drying limit of 13% selected.
Figure 1: This is a cross section of Shed 4 Bin 5 where this trial was conducted. Along the bottom are the aeration ducts which run the width of the bins each standing approximately 1.2-1.5m. Sensors were suspended in a ladder like construction from the top of the bin and used to relay data back to PC. These seven points indicate the 7 depths where RCL staff took 500g samples for moisture assessment in the industry standard NIR Grainspec instrument.

Figure 2: Moisture Contents of Paddy Rice at Various Depths Throughout the Aeration Drying Process. This figure here shows the moisture result from this sampling. It can be seen that from the grain moisture the initial grain moisture of 22% – the gradual decline to a final moisture of 14%, at all depths measured.

The final pre-milling moisture contents ranged from 13.0-13.9% without a significant gradient across the bin depth. This demonstrated the ability to use the controller to select ‘best’ conditions for maximum drying efficiency in paddy rice.
Adaptive Discounting Control (bin1).

The initial paddy moistures inloaded into this bin ranged from 13.9 – 18.9. The user inputs 14% moisture as the target. The results of the ADC controlled bin reduced the moisture range to 13.4-14.1, giving a moisture profile of 0.5% across the entire bin. This was achieved in 5-6 weeks.

Sunrice "supervised" control (bin 9).

The final moisture ranged from 13.4 – 14.5 giving a moisture profile of 1.1% across the entire bin. This was achieved in 6-7 weeks.
Past trials have shown the influence of high moisture on defects in grain quality. The results show how the ADC trial better controls the aeration of a bin. This is because the controller is able to determine external environmental conditions over a 24hr period and immediately make suitable changes to the amount of air being pushed through the grain mass. This ensures that on occasions where external conditions are not favorable (e.g. rain), moist air is not pushed through the grain mass.

**Future**
The trial has been ongoing since 2001. Proving both successful and promising, SunRice and CSIRO have negotiated further developments for its application to other storage facilities. Depending on the age of some structures, various functioning equipment (e.g. aeration fans, fan control equipment, aeration introduction systems) are quite different and in some cases not as favorable as those at Shed 4 Gogeldrie. This has moved the studies to understand the adaptability in older, less advanced sheds to give an understanding of how broadly this system may be adopted. We are also interested in the implications of geographical location, and different climates and how ADC will behave.

As this stage of the project is broad and has been ongoing since 2003, there is no data yet available. Further expansion across a broader range of sheds is in progress now. Unfortunately data from the most recent advances will not be available for this report, however SunRice remains positive that ADC will continue to be the most successful and beneficial study within this project.
XIV Sub Project Name: Determination and implementation of a standard paddy aeration strategy across the paddy group, to enable effective drying and aeration of crop, without compromising paddy milling quality (2003-2004)

Background
SunRice had determined the need for a standard aeration strategy. In the past, various aeration strategies had been adopted at paddy sites resulting in a non-uniform standard operating procedure and consequent uneven quality distribution.
In 2003, SunRice decided to adopt, train and implement the ‘Six Sigma’ methodology into the business. Six sigma aims to improve:
- Quality of product and process
- Customer service
- Cost of business
- Profitability

By:
- Setting clear business and functional objectives
- Articulating and defining critically analysed strategies
- Setting up framework for clear communication
- Successful execution of action plans

Aeration was seen as an area requiring improvement, and subsequently was identified to be a ‘Six-Sigma’ pilot project in 2003.

Objectives
To develop and implement a standardised aeration strategy across the paddy group, utilising best available practice procedures, with the aim of ensuring paddy moisture and quality meet customer requirements.

Methodology
Determination of Current Status
An audit of each site was conducted to determine the current operating procedures, operating system within sheds, structure type, fan sizes, moisture probe procedure used, method of data collection and retention, whether temperature probing was performed and who was responsible for signing off on changes. We expected to improve quality standards of rice supplied to mills, reduce loss due to downgrade and shrinkage costs.

In addition we will be sourcing any possibility of the future use of other technology in moisture/temperature analysis (ie. automatic sensor units) and heat imaging by way of research and product trial. We will consult with such organisations as CSIRO and Graincorp to see whether they can suggest any methods that may be useful to our area.

Determination of milling results
For a twelve month period, data from both Leeton and Deniliquin mills were analysed and collated to determine the paddy moisture as delivered to mill, finished product moisture and heat damage (stackburn) for each bin supplying to the mill.
Determination of New Aeration Operating Procedures

Through analysis of the above information and combining the learnings and practices of the ‘SunRice Supervised Bin’ from the Adaptive Discounting trial, determine a set of standard operating procedures, documentation and data recording facilities necessary to ensure uniformity of operation across the industry combining a ‘best practice’ system. Determine the necessity of temperature evaluation within the aeration procedure and source availability of such a product.

Results Determination of Current Status

Overall it was determined that no site had a set operating procedure, some of which were based on operator experience and trial and error. Documentation was rarely retained therefore making it impossible to determine any links between the data and quality levels found at mill level.

Determination of milling results

![Figure 1: Deniliquin dirty paddy moisture results](image)

Average paddy moisture was 12.4% with a major variation in readings across the 12 month period.
In most cases the FP moisture was much lower than the max. moisture specification. This became much worse as time passed indicating overdrying when stored for long periods of time (up to 12 months). The average FP moisture was 13.3%.

**Figure 3: Deniliquin average heat damage per day**
This shows on some occasions major issues with heat damage. These levels show to be unacceptable. It does however show that there must be a cause behind these pockets of high results.

**Figure 4: Leeton dirty paddy moisture results**
Average paddy moisture was 12.1% with a major variation in readings across the 12 month period.
Figure 5: Leeton finished product moisture vs. max. moisture specification per product
In most cases the FP moisture was much lower than the max. moisture specification. This did not become worse as time passed indicating a better strategy used by Leeton operators. This was expected as the most experienced aeration officer was in charge of the aeration at most sheds supplying Leeton mill. The average FP moisture was 12.9%.

Figure 6: Leeton average heat damage per day
This shows a much lower level of heat damage to that experienced at Deniliquin
Figure 7: Leeton average heat damage per day (smaller scale)
This shows on some occasions a higher level than specification.

Table 1: Breakdown of mill data

<table>
<thead>
<tr>
<th></th>
<th>Deniliquin</th>
<th>Leeton</th>
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<tbody>
<tr>
<td>Ave Daily Heat Damage (%)</td>
<td>0.3</td>
<td>0.091</td>
</tr>
<tr>
<td>Ave Paddy Moisture (%)</td>
<td>12.4</td>
<td>11.9</td>
</tr>
<tr>
<td>Current Target (%)</td>
<td>12.5</td>
<td>12.5</td>
</tr>
<tr>
<td>Paddy Variance (%)</td>
<td>0.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Ave FP Moisture (%)</td>
<td>13.3</td>
<td>12.9</td>
</tr>
<tr>
<td>Ave FP Milling Variance</td>
<td>0.9</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Table 2: Average results of combined data

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Weighted Paddy moisture to mill average</td>
<td>12.25%</td>
</tr>
<tr>
<td>Minimum Paddy moisture target</td>
<td>12.50%</td>
</tr>
<tr>
<td>Improvement Target</td>
<td>0.25%</td>
</tr>
<tr>
<td>Improvement Target $ (based on 580kT crop with paddy return $250/tonne)</td>
<td>$362500</td>
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</tbody>
</table>

Table 2 shows a moisture target of 12.5% set for crop year 2004. This is a 0.25% improvement target on the previous year’s average. This is expected to produce savings in excess of $360,000 (based on a 580kT crop) through energy savings and yield efficiency stemming from increased moisture content.

Determination of New Aeration Operating Procedures

From the results of the audit and results of the mill analysis it was clear that a defined direction was needed for aeration activities. The most successful region Leeton was due to the Co-ordinator in that area who has many years of industry experience. This area was also involved heavily in the ADC trial supervising the SunRice bin used in the studies. Some of the procedures used in this area were based on learning experienced with ADC.

A set of standard operating procedures combining recording of data manually and electronically were developed through combining the knowledge and learnings of our experienced operators. This procedure encompassed what is known as the ‘Paddy Operations Aeration Manual’.

Additionally it was seen as important to define a reporting procedure to ensure the continual development and improvement of aeration activities. The introduction of a
complaint and investigation procedure followed allowing complaints to be raised at mill level, which are sent through to the responsible paddy group and investigated for aeration/receival related quality downfalls. This is expected to continually allow revision of the manual and further improve the aeration practices within SunRice.

**Implications and recommendations**
The new system allows us to further define the requirements for aeration which will continue through analysis of the data now available.

So far we have seen a major improvement in the quality of paddy whilst in storage through a standard procedure streamlining this process. Also, we have identified a target storage moisture which will lead to increased savings from lower energy use and less quality downgrades. This target is expected to be reviewed and increased at the beginning of each crop year.

Lastly, it was identified that temperature measurement would assist in determining areas known as ‘hot-spots’. Such areas occur when a pocket of higher moisture grain is in a bin and is not receiving enough drying air. These pockets, if left, will increase in temperature, encourage insect infestation and lead to mould and heat damage. If these are detected early, aeration can be increased to dry these high moisture areas. During the 2005 harvest, different pieces of temperature measuring equipment will be trialled for adaptability.

Although the first year of data analysis was difficult with the lack of availability, it will now be performed regularly to ensure aeration of paddy rice is a scientific phenomenon.

From harvest 2004 and the introduction for the Aeration Manual, monthly audits were introduced to ensure the manual was being followed and data recorded correctly. These continue as a way of life to also assist in continuous improvement.

**Project Intellectual Property**
No IP

**References**
N/A

**Acknowledgements**
Ms Bronwyn Sigmund  
Mr John Johnson  
Mr Sam Gaston  
Mr Tim Allen  
Mr John Flisher  
Ms Kellie Close
Sub-Project Name: Image Analysis as quality measurement at point of receival (2003-2005)

Background
Currently, SunRice employs harvest casuals to assist in the short-term increased responsibility at receival points. This means that operators are trained just prior to harvest for roles such as that in the testing platform. Many tests are required to determine the quality of a load as it is brought onto a receival site. Knowledge of the quality is important for segregating; varieties, varying moisture levels, defect loads (dockage) etc.

The process of such testing relies on operator interpretation of contaminants only. Other defects are not identified at this point as there can be great variation between operators and as result no uniform segregation of grain.

In 2003, FOSS loaned a 1625 Cervitec Grain Inspector to SunRice, however through a change of role in our department; passwords, training and instructions for the machine were not received until 2004.

Objective
To determine whether image analysis can replace operator determination of quality and allow a broader analysis of grain quality at point of receival.

Progress
FOSS and SunRice have made many attempts to outline a strategy for use of this machine. It is necessary to perform such a study in stages and was decided that initially a limited number of defects would be studied. The defects would be isolated from those removed during milling quality tests for finished product brown rice and forwarded through for processing through the Cervitec. Due to crop and sales forecasts, only a limited number of samples have become available to date and have not been sufficient to develop a calibration.

FOSS has removed this machine for a short period of time as it is required for other studies. Samples will remain to be collected and on the return of the Cervitec this trial will continue. This is most likely when crop size improves ensuring samples are available.
XVI Sub-Project Name: Analysis of the Infratec as a replacement for the Grainspec for moisture determination – Phase 2 (2003-2005)

Background
Previous trials had outlined that the Grainspec gave a much more accurate result when testing rice and recommendation were to purchase second hand units from other grain bodies who had replaced their Grainspecs with other units. As 2003 drew to a close, it was identified that the supply of second-hand units were declining. The purchase of parts for such a unit experience high costs and long delays which has been deemed as unsuitable for the industry.

FOSS approached SunRice in late 2003, showing us the Infratec unit once again. New calibrations for rice had been developed in Japan and the unit had been upgraded.

Objective
To revisit and determine whether the Infratec is a suitable replacement for the Grainspec for moisture determination.

Methodology
Samples of varying moisture (ranging 10-26%) are experienced during harvest receivials. The current process involves the checking and altering of calibrations of the Grainspec during harvest on a weekly basis.

Data will be gathered by scanning identical samples through the Grainspecs and Infratecs, to be then verified by laboratory moisture analysis.

All harvest samples were scanned through the Infratec. The results were then forwarded to FOSS for further calibration development.

Results

![Infratec Result Compared to Lab Result](image)

Figure 1: Infratec Result Compared to Lab Result for Mill Paddy
There is no real correlation between increasing moisture and increasing error. The Infratec is predicting results outside of the desirable 0.5%; however most are within this range. This may result from a smaller moisture range and lower moisture levels in the grain.
There is no real correlation between increasing moisture and increasing error. The Infratec is predicting results outside of the desirable ±0.5%, however mainly lie within a 0% to 1.0% range; suggesting incorrect scaling in the calibration.

There is no real correlation between increasing moisture and increasing error. The Infratec is predicting results outside of the desirable ±0.5%, most of which are approximately -1.00% less. This may be due to incorrect scaling in the calibration of the Infratec and the outlier at >19% could be due to an insufficient calibration range.
Figure 4: Infratec Result Compared to Lab Result for Mill Brown (Dry)
There is no real correlation between increasing moisture and increasing error. The Infratec is predicting results outside of the desirable $\pm 0.5\%$, most of which are range from -0.5 to -0.9 differences. This is may be due to incorrect scaling settings. The lower variation is probably due to a smaller moisture range and lower moisture levels in the grain.

Figure 5: Infratec Result Compared to Lab Result for Harvest Brown (Wet)
There is no real correlation between increasing moisture and increasing error. The Infratec is predicting results outside of the desirable $\pm 0.5\%$. Most lie within $-0.5\%$ to $-1.5\%$ range; which once again may be due to incorrect scaling in the calibration.
Figure 6: Infratec Result Compared to Lab Result for Mill White (Dry)
There is no real correlation between increasing moisture and increasing error. The Infratec is predicting most results inside of the desirable ±0.5%. This is probably due to a smaller moisture range and lower moisture levels in the grain.

Implications and recommendations
Overall there is no real correlation that can be drawn from these results. In most cases a smaller moisture range allows the Infratec to predict more accurately, and with larger moisture ranges it predicts much less accurately.

There also seems to be a common scaling issue where results are somewhat consistent but out of range. Overall it would be fair to conclude that the calibration is not yet strong enough.

The number of samples processed was largely minimised by a lower crop size resulting in less available samples.

Results were sent to FOSS for analysis to which they have developed the calibration further. Further trials will be conducted in the same manner using 2005 harvest rice.

Project Intellectual Property
No IP

References
N/A

Acknowledgements
Ms Bronwyn Sigmund
Ms Jacinda Boots
Ms Kellie Close
The FOSS team
XVII Sub-Project Name: Consolidation of all hygiene activities into a standard operating procedure (2004-2005)

Background
Hygiene at receival sites are varied across the industry. The lack of a uniform procedure doesn’t allow us to analyse the effectiveness of our activities or link these to our handle on grain quality.

It was identified as an area paramount to improvement of grain quality.

Objective
To consolidate all procedures and develop a standard operating procedure combining all findings of previous hygiene related trials.

Methodology
- Review recommendations from prior hygiene related trials and develop work procedures
- Compare current work procedures from each area and review for relevance
- Review trials of Alfacron® as a structural treatment
- Trial and identify any residues left in rice at 1 week, 1 month, 2 months and 3 months in bins treated with Alfacron® for structural treatment

Progress
The ‘Paddy Operations Hygiene Manual’ has been developed incorporating past learnings and recommendations from related trials.

The 1st samples were analysed for Alfacron (azamethiphos) residues returning results indicating no residue was detected. News of Novartis discontinuing this chemical production was realised during the 1 month sampling regime and as a result this trial was discontinued.

The impact of this chemical being discontinued by the manufacturer has left the industry with no structural treatment replacement and as a result must trial new and available chemical for reliability and residue risk. Unfortunately this information was not known until late 2004.

This has placed the Hygiene manual on hold, as references to Alfacron need to be reviewed and rewritten when a suitable replacement is found.
XVIII Sub-Project Name: Temperature and data analysis during storage of paddy rice (2005)

Background
Stackburn is a quality defect of rice normally eventuating from high temperatures within the bulk. This can be caused by high moisture pockets and insect infestation. Areas that have a high moisture will attract infestation and be of higher temperature that the rest of the bulk. This allows heating of the grain and subsequent loss of quality.

Aeration of grain lowers moisture and maintains the grain at a temperature not favourable for insect growth. Paddy storage facilities contain bins of approximately 1200-4000mT capacity, making it difficult to lower moisture in all points of the bin, at the same time. Measurement of temperature will allow the storage of paddy to be monitored more closely and appropriate action to be taken if high temperatures are found.

Objective
To compare various types of temperature measuring devices and their application to paddy storage

Methodology
SunRice will purchase a number of different temperature detectors for use in grain bulk. The units will be compared against one another for their depth adaptability, sensitivity and equilibration time.

We will also look at units that may be connected through the aeration management system to assist with fan requirement predictions in older sheds not capable of adapting to ADC.

Lastly, we will investigate the use of hand-held data collection tools to allow quick and easy determination of data.

Progress
As the rice harvest occurs during March to June of each year, this project has only just begun. This year we are experiencing a late and scattered start to the harvest causing a delay with the commencement of some of these trials. Equipment is being purchased and trials are due to commence soon.

It is unfortunate that the results will not be available for this report; however we see this area of study to be a promising and beneficial step in improving and maintaining quality at the paddy storage section of the supply chain.