

FINAL REPORT

Mentorship for Milling Index Project M102-10 at the
Agricultural Research Council in Potchefstroom
from April 2008 to June 2009

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Introduction

The Milling Index Project had a major setback after the resignation of the initial project team under the leadership of Apie Pretorius in 2005. It was felt that the new team did not have sufficient milling background, given that the focus on the next phase of the project was on the commercial milling of maize cultivars and the correlation of these with the laboratory Roff Mill. With this in mind the Mentorship Programme was conceived and approval from The Maize Trust was received on the 1 May 2008.

Objectives

In fulfilling this mentorship role it was imperative that the focus be maintained on the following objectives.

- Refinement of the Near Infrared Spectroscopy (NIRS) calibration.
- Comparison of the Milling Indices of the NIRS and Roff Mill, with the extraction values of an Industrial Mill, using a number of different maize cultivars.

Findings and Observations

It is not the intention of this report to go into the details of the results of this project as these are comprehensively covered in the ARC report already submitted to The Maize Trust. Suffice it to say that the objectives have been achieved.

Instead, I wish to give my experiences and observations over the duration of my involvement, with the intention of considering what may need to change and how best to structure these projects in the future. I will cover these under the following categories.

- Staff
- Equipment
- Operating Procedures

Staff:

Unfortunately, the Project Leader over the previous 3 years, Johnathan Wong, resigned in the first month of the new project and departed in May, before his replacement commenced. Obviously this was hardly favourable for a detailed hand over of the project to the new Project Leader, Anita Ybema. Consequently, Anita

spent a lot of time researching the project, looking for information and in general just finding her feet. Anita was also contracted on a 3 monthly basis, which I believe was probably not the most motivating aspect towards a fully committed attitude.

Fortunately, Johnathan Wong was cooperative and helpful, although this invariably needed to be by phone communication, which was not ideal. On a few occasions he kindly gave of his weekend time to assist with some of the background.

In addition, due to a restructuring by the ARC head office during the year, changes occurred at the Potch facility. This saw the project, including the laboratory, shift away from Thinus Prinsloo and become the responsibility of Dr Jeanetta Saayman-du Toit. This also meant Jeanetta had to familiarize herself with the project, past and present, as she had no previous involvement.

Anita Ybema's contract was not renewed at the end of March 2009 and an internal appointment was made to the position of Project Leader. This was Constance Chiremba who has been at the ARC for about 4 years. She is a Food Technologist and has a Masters degree. I did not work with Constance but understand she was very enthusiastic about this appointment and was considering doing her doctorate in a field taken from the Milling Index Project.

The remaining person, who is actively involved on this project, is Martin Molebatsi. He is responsible for carrying out all the required tests and passing on the raw data to the Project Leader. Martin has been involved since 2001 and does a fine job in running the tests. However, as his knowledge and responsibility are limited to this area his guidance and instruction should come from the Project Leader.

Equipment:

My main focus was on the Roff Mill, as this was to be the milling comparison with the Industrial Mill, and in particular during the set up and milling of the cultivar samples received from the Industrial Mill. I did not get involved with the testing of the 37 white maize cultivars from the National Cultivar Trials. These tests did form part of the project but mainly for the NIRS calibration and the Maize Information Guide booklet.

Roff Mill - Before commencing with milling the 6 cultivars, 25 samples of each, I inspected the Roff Mill, checking on the roll flutes, the speed differentials, the flute disposition and the sieve covers. I was concerned that the 1st Break rolls were a bit blunt and I also found some differences compared to the specification sheet on the mill. I then checked the Roff Mill at the SAGL to confirm how this compared.

Table 1 gives the specifications from the manual and compares these with what was actually found at the two mills.

Table 1: Description	Comparison of Roff Mill Specifications								
	1 st BREAK			2 nd BREAK			3 rd BREAK		
	Manual	ARC	SAGL	Manual	ARC	SAGL	Manual	ARC	SAGL
Roll Flutes-per inch		8.5	8.5		15	15	25	25	25
Roll Differential	1:1.5	1:1.5	1:1.5	1:2.5	1:2.5	1:2.5	1:2.5	1:2.5	1:2.5
Roll Disposition	N/A	S:S	S:S	N/A	S:S	S:S	N/A	S:S	S:S
Top Sieve-apertures per inch	N/A	8	8	N/A	14		N/A	26	
- micron equivalent	2 680	2 680	2 680	1 534	1534	1807	727	820	727
Bottom Sieve-apertures per inch	N/A	40	40	N/A	40	40	N/A	40	40
- micron equivalent	495	485	485	495	485	485	495	485	485

NB The same source was used for the micron equivalents.

From the table one can see two major differences, which are the Manuals specification for the flutes on the 1st and 2nd Break rolls. I am confident that this was just an error, or perhaps these were the initial specifications at the commencement of the Milling Index Project but then changed. The flutes, as specified, would be too fine for these rolls for milling maize. The roll flutes are consistent on the ARC and SAGL mills and therefore the specifications in the Manual should be changed accordingly.

The only other differences were on the top sieve covers of the 2nd and 3rd Breaks. The ARC mill had two cover sizes finer than the SAGL mill on the 2nd Break and two cover sizes bigger on the 3rd Break. These are quite small differences and probably unlikely to significantly influence the results between the two mills.

These specifications are measured by physical counts using a magnified counter. For this reason I would recommend that a second person verify my findings.

Following this investigation it was felt that the 1st Break rolls on the ARC mill should be changed. However, we wanted to establish what difference there would be between the new and old before we commenced with the samples from the Industrial Mill. We needed to establish if there would be consequential differences on the Milling Index values.

A spare set of rolls were purchased and the intention was to mill a number of replications, using the old and then the new rolls. Once we new the impact of the new rolls over the old and whether there was a consistent difference between the two a final decision was to be made as to which rolls we would use. Unfortunately, the Roff technician replaced the old rolls and took these back to their workshop for re-fluting before the tests had been run. This meant we had no comparison to make and had no choice but to proceed with the new rolls and treat the milling of the cultivar samples from the Industrial Mill as a separate exercise. All the mill settings were

checked as it was critical to ensure a high level of repeatability from the mill after the change. Adjustments needed to be made on all the roll passages as this had not been done for some time. The procedures manual requires the roll gaps to be set by a feeler gauge, which did not exist and confirmed that the rolls had probably never been checked. A new gauge was purchased.

Milling of control samples had also been dropped over time and so two large control samples were obtained, one hard and one soft. We milled 10 replications of each control sample and had these results assessed by Dr Manley, Stellenbosch University, and also the ARC statistician Marie Smit. Both felt there had been an improvement in the mill's performance from earlier tests that had been completed and that the repeatability was very good. I am, therefore, satisfied on the current reliability of the ARC mill. The milling of the samples then commenced, but only at the end of January 2009.

Moisture testers – The equipment stated by the ARC as being used to determine moisture content was the Precisa Moisture Balance HA 300. In fact, these had not been used for some time. Johnathan Wong had switched from these to using the oven method. I am led to understand that he felt the Precisa was not accurate and I suspect there was also a question of sample numbers, which may have influenced this decision. The two ovens could handle approximately 70-80 samples each cycle.

I found that the oven equipment was also unreliable and the moisture variation over duplicate samples was substantially greater than the tolerance of $\pm 0.1\%$.

Operating Procedures:

My experience, and admittedly in some instances my perceptions, were that the project was not run under the strict operational protocol that one would expect on a research project and within a research organization. The Roff Mill is a fairly basic milling facility and does not offer the accuracy that one may typically expect in a laboratory environment. Therefore, it is even more important to put stringent controls in place.

The conditioning of the maize prior to milling and the milling process was handled well. Only a few minor corrections were made here. However, the practise of milling known control samples had been dropped and is a major concern as without these there is little chance that changes or problems would be detected.

With regards the assessment of the condition of the plant and ensuring the correct settings were in place, this was not given adequate attention, possibly due to a lack of understanding of the milling process? This was supported by the fact that the Roff

technician was not properly supervised when changing rolls. He was not adequately directed and supported in understanding that this was part of a research facility and needed to be set to the required specifications. His adjustment of the rolls was with a piece of paper and when a cracked gear was found on the 1st break roll he was about to replace this with a different size gear, which would have changed the speed differential of the rolls and with it the milling result. These situations were corrected.

Product moistures were not always tested in duplicate and even if they were there seemed no reaction to re-test if the results were unacceptable. We had to redo moistures and still needed to take a view on allowing certain moistures to be used even though these fell outside of the acceptable tolerance. This was only done with the understanding that the impact of the moisture on the Milling Index value would not be very large given the moisture variation experienced.

I understand that Anita spent quite a lot of time looking for information and Jeanetta as well, although to a lesser extent. This does raise questions on the project administration and record keeping. I am sure that the information is in the system somewhere but it seems not to be particularly well documented and filed for easy retrieval. However, I did not focus much on this as I felt this to be an ARC internal responsibility and not part of my brief.

Recommendations

Now that we have a good correlation between the extraction values of the Industrial Mill with the Milling Index values of the Roff and NIRS systems, there is no doubt in my mind that this work should continue and even be expanded. I also believe that the ARC facility, under normal circumstances, is the right institute to handle this work. They are best placed to handle the planting and controls of all the cultivar trials and have most of the facilities, although certain upgrades are required. Unfortunately, based on past performances, the ARC has not created the confidence within the industry to justify their continued involvement. However, given the new structure at the ARC in Potch and with the new people involved things could be different. It would be up to the ARC to satisfy the relevant role players that they now have the capacity, the motivation, the structures and controls to again participate in the Milling Index project.

There are broadly three areas making up this project.

1. Planting and controlling the various cultivars for testing.
2. Completing the various tests that are required
3. Interpreting the data and generating the necessary reports.

Planting and controlling the various cultivars

I am not aware of problems in this area and therefore it would make sense for the ARC to continue with this work. Clear guidelines would need to be given by industry. For example, what cultivars should be grown, number of locations and replications, whether whiteness measurement is required, etc. Planting for the 2009/10 summer grain season is underway and this information would need to be finalized immediately if not already done so.

If another institute is to handle the testing then consideration also needs to be given to arranging the orderly and controlled movement from the ARC of 400 to 500 samples, which seems to be the normal quantity given the number of different cultivars, locations replications, etc. This must be arranged between the Testing Institute and the ARC

Milling and testing of the maize samples

If the ARC was assigned this responsibility then a number of improvements would first have to be implemented. On the equipment side a reliable moisture testing facility is essential. It is also essential to ensure that there are properly documented procedures for all the tests and that the staff is correctly trained and fully competent in these procedures and apply these rigidly. I would strongly recommend that the SAGL be used for this training. Some training and understanding of the Roff Mill and the milling process in general is also recommended. The Project Leader must play a crucial role in setting the correct standards and creating a mindset of excellence. This person needs to be well supported by the Departmental Head.

If this function is not covered by the ARC then I believe only the Southern African Grain Laboratory (SAGL) would be able to fill this role immediately with the minimum of effort. They have the Roff Mill and most, if not all of the other testing/analytical equipment. The one area of concern would be the suitability of their NIRS machine. They would need to have the correct software and the calibrations to handle the required analyses including the Milling Index value.

Whoever is charged with this work would need to commence with the samples from the 2008/09 season if a seasons data is not to be lost. They would also need to assess the workload, given that this additional work will also take place at the commencement of the new summer grains harvest when other work is traditionally undertaken.

Interpretation and Reporting

More meaningful results are likely to be obtained by someone who has worked on the project for a period of time. However, with the change in structure and personnel at

the ARC they are not particularly advantaged in this area relative to say someone at the SAGL. Statistical analysis is important in this assessment and outside assistance could be contracted if not available in house.

Having spent time with Jeanetta in compiling the current report I am confident that she could handle this in the future. I am not familiar with the SAGL capabilities in this particular field so can't comment.

Thanks

Certainly this past year had challenges but I found the project stimulating and exciting and would like to thank The Maize Trust for giving me the opportunity to participate.