WEAR CHECK Est 1976 Condition Monitoring Specialists A Part of Torre Industries

TECHNICAL BULLETIN ISSUE 64

Condition Monitoring Specialists

MAINTENANCE SAVINGS SWEETEN THE SUGAR INDUSTRY

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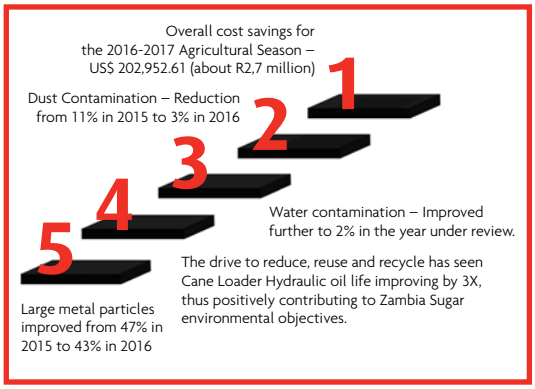
CASE STUDY: ZAMBIA SUGAR

WearCheck's oil analysis program is anchored in Zambia Sugar's overall business strategy and entrenched in its overall vision and mission. WearCheck serves as a key stakeholder especially in the area of "Being world-class and an efficient, low-cost producer, whilst achieving a balanced and integrated economic, social and environmental performance".

Throughout WearCheck's decade-long partnership with Zambia Sugar, there is a constant drive to instil best practice in the sugar producer's maintenance culture. This is complimented by Zambia Sugar's crusade for continuous improvement. This partnership has yielded very positive results in concrete areas such as these:



The general challenge facing the agricultural industry is the need to increase crop yield utilising existing fleet, at the lowest possible operating cost. Zambia Sugar is no exception. WearCheck partners Zambia Sugar with this shared goal in mind.

The oil analysis program has continuously yielded a positive return on investment for Zambia Sugar, clearly demonstrated by the savings of US$ 202,952.61 (about R2,7 million) in the latest financial year.

The ongoing aim of the partnership is to improve operating efficiency of the fleet and increase productivity by making full and efficient use of existing assets.

THE OIL ANALYSIS PROCESS

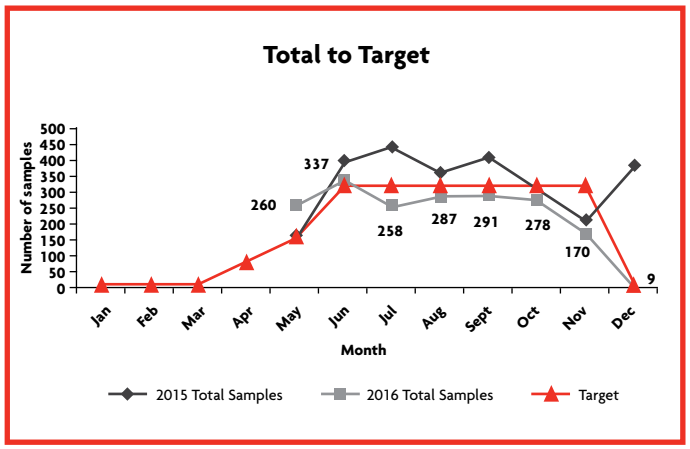
Samples from the fleet's oil-wetted components (engines, transmissions, hydraulic systems and axles) are analysed, imminent problems are identified, corrective action is prescribed by WearCheck's diagnosticians, and the workshop takes timely corrective action addressing the root source of discovered problems, thus enhancing fleet availability and reliability throughout the agricultural season.

WearCheck's technical support team meets the agricultural workshop team monthly to discuss critical issues and trends and assist with implementation of maintenance recommendations.

This Technical Bulletin examines sampling compliance, the findings for the season, actions and feedback, cost savings, as well as the recommendations for the next agricultural season.

1. Sampling Compliance

At the start of the season, monthly targets are set determining how many samples are to be submitted. The monthly target is set considering only the running fleet in the season under review and the sampling levels achieved are as illustrated in the graph and table below:



Month	2015 Total Samples	2016 Total Samples	Target	Sampling Compliance
May	164	260	161	161%
June	397	337	322	105%
July	441	258	322	80%
August	360	287	322	89%
September	407	291	322	90%
October	307	278	322	86%
November	211	170	322	53%
December	383	9	14	64%
Total	**2670**	**1890**	**Average**	**91%**

The average sampling compliance level achieved in the 2016 – 2017 agricultural season is 91%. The main objective of monitoring sampling compliance is to ensure that all equipment on the oil analysis program is sampled. A target of 100% sampling compliance has been set for the 2017 – 2018 season.

2. Findings

This section explores these questions:

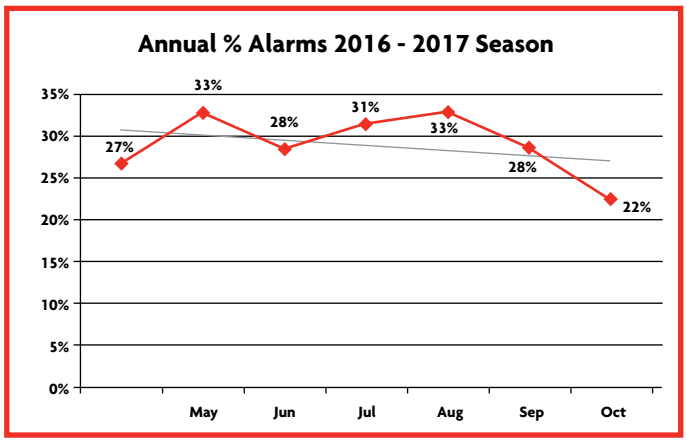
a. What is the ratio of alarms to samples submitted by month in 2016?
b. What is the trend in annual percentage alarms over the past five years?
c. What is the picture per section (cane haulage, cane loaders, heavy plant and farm tractors)?
d. What are the major problem types and contaminants affecting the fleet?

2.1 Percentage alarms – May to November 2016

Alarms are a computation of all samples where the laboratory picks up problems, recommends corrective action and requests feedback from the customer. This is important for ongoing monitoring and as an indicator of the following:

- General improvement or deterioration in equipment health.
- Indicator of a positive response by the maintenance team to identified equipment problems leading to improvement (when looked at in conjunction with positive feedback compliance).

The graph below shows annual percentage alarms for the 2016 – 2017 agricultural season:



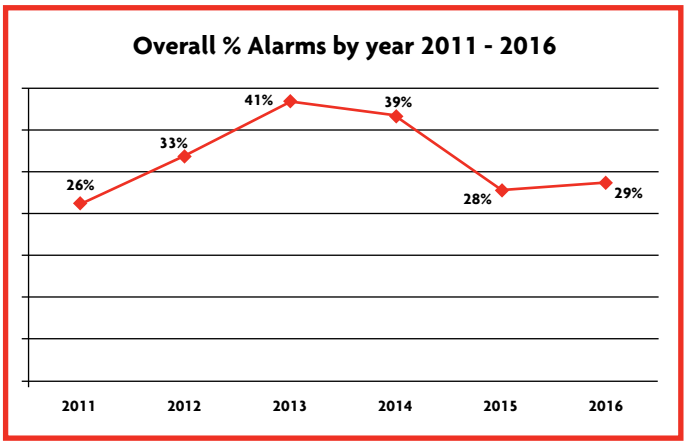
In the graph, a general downward trend in percentage alarms is notable as the agricultural season progresses from May to October 2016. This can be due to:

- Environmental impact and operational problems associated with wet weather harvesting, which mainly affected the tractor drive trains especially at the beginning of the season. This impact is reduced as the agricultural season progresses due to improvement in the field operating conditions.
- Bedding-in wear following the off-crop period component overhauls.
- The progressive improvement in percentage alarms as the season progresses is in line with the customer's continuous improvement system.

An average annual percentage alarms figure of 29% was achieved in the season under review. The section below illustrates the trend over a five year period:

2.2 Percentage alarms trend 2011 to 2016

The graph below illustrates the outlook in percentage alarms between 2011 and 2016.



There was a marginal increase in percentage alarms by 1% between 2015 and 2016. The target of 25% set at the beginning of the season was missed by 4%.

A submittal to alarms ratio of 1:3 was achieved. In other words, 1 in 3 samples submitted in 2016 required corrective action. The repeat axle wear problems contributed to the upward movement in % alarms by one percentage point. This ratio can be improved if the repeat problems on the tractor axles are nipped in the bud.

2.3 Percentage alarms by section

Percentage alarms were examined per section and expressed as a ratio as follows:

Ratio of alarms to submittals:

- Cane Haulage – 1:3
- Cane Loaders – 1:4
- Farm Tractors – 1:3
- Heavy Plant – 1:4

The ratio is more favourable in the Cane Loaders section. In the Heavy Plant section, though the ratio seems favourable, the figure may have been affected by low sample volumes.

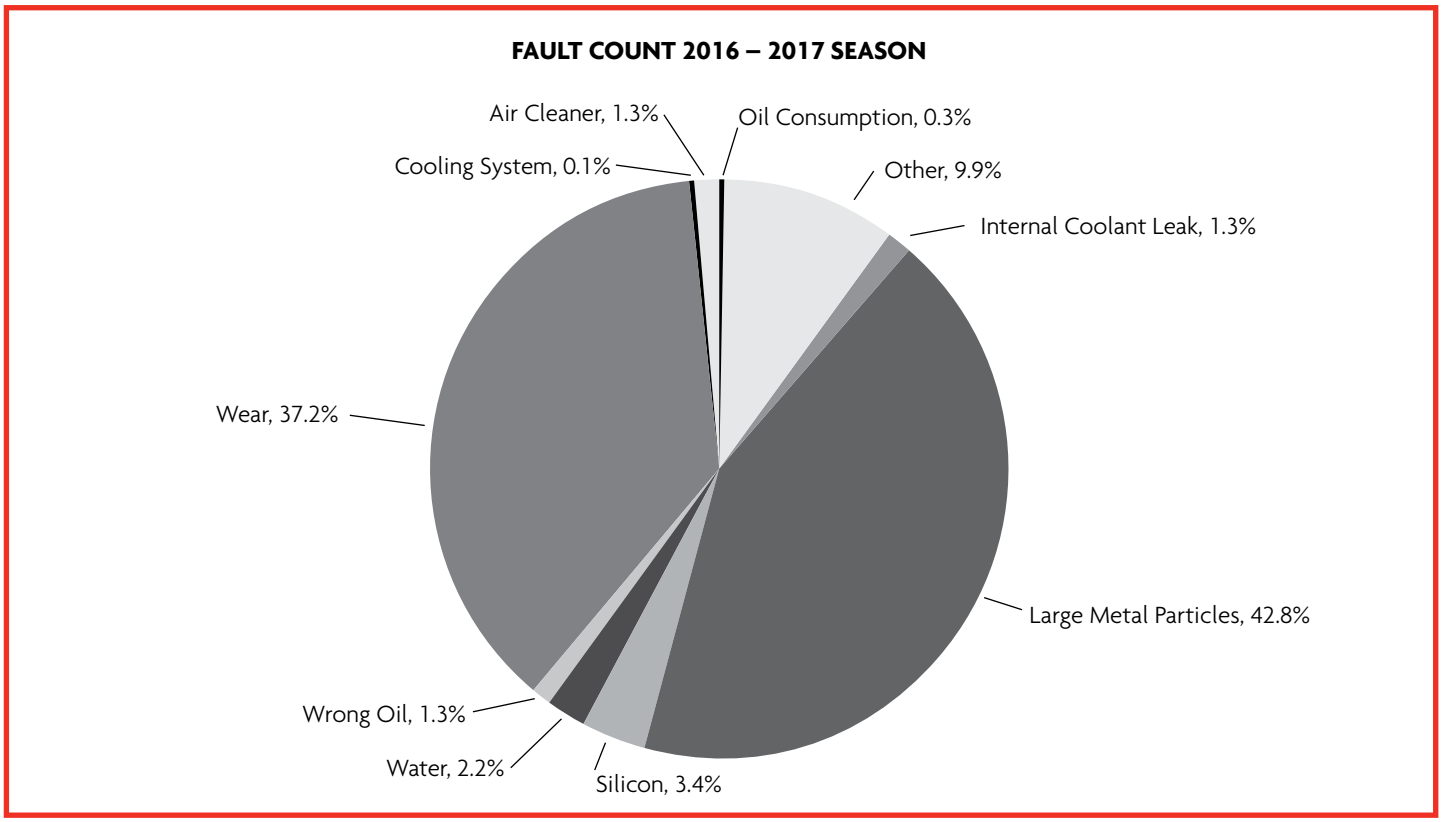
There is room for improvement in the main production fleet, Cane Haulage Section, especially if the operational problems affecting axles are averted. This issue is discussed in more detail under the findings section.

Workshop team

2.4 Problem types and contamination

The problem types and contaminants section examines the major problems affecting the fleet and the compartments which are most affected.

The pie chart below illustrates the overall findings for the 2016 – 2017 agricultural season:

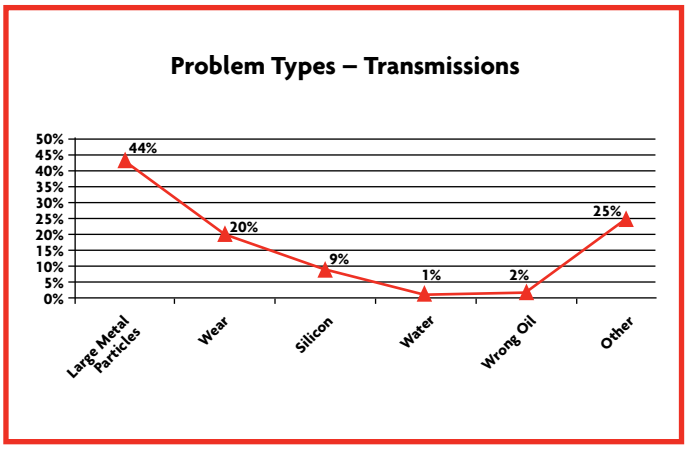


Below is a ranking of the major problems, with one representing the major problem affecting the fleet, in order of priority, up to number four as follows:

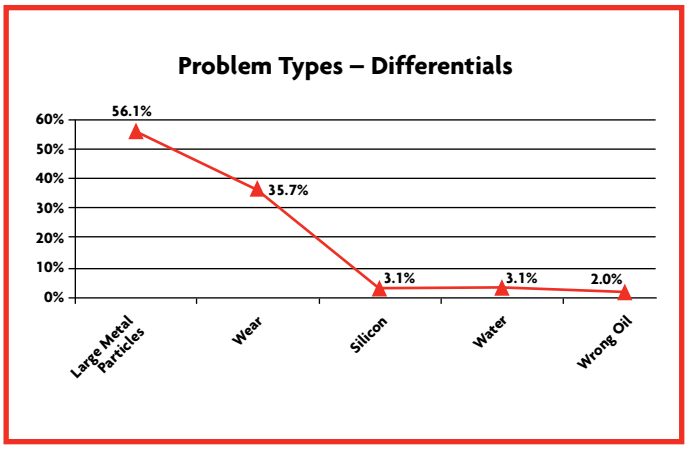
Large metal particles	42.8%
Wear	37.2%
Silicon	3.4%
Water	2.2%

The list in the previous diagram therefore outlines the highest risk areas for Zambia Sugar transport. This forms the priority list for issues to focus on during the 2017 – 2018 Agricultural season.

2.5 Problem types by compartment



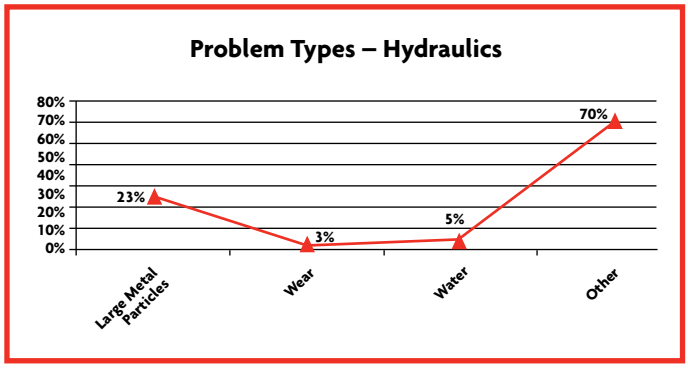
Transmissions



Differential

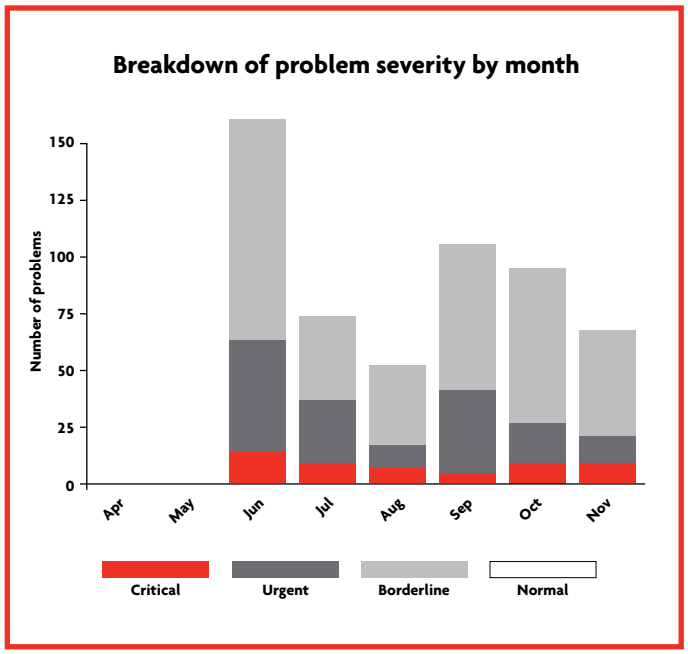
The differential wear problems are largely driven by axle wear problems as a result of operational problems being experienced on tractor axles. The tractor fleet is the main production fleet, an early start to the season (wet weather harvesting) results in accelerated axle wear as the tractors get stuck in the muddy sugarcane fields and operators try to force the tractors out of the fields, resulting in axle damage. This clearly demonstrates the impact of the operating environment on equipment health.

Hydraulics



2.6 Breakdown of problem severity by month

Below is a graph illustrating the severity status for all samples submitted by month:

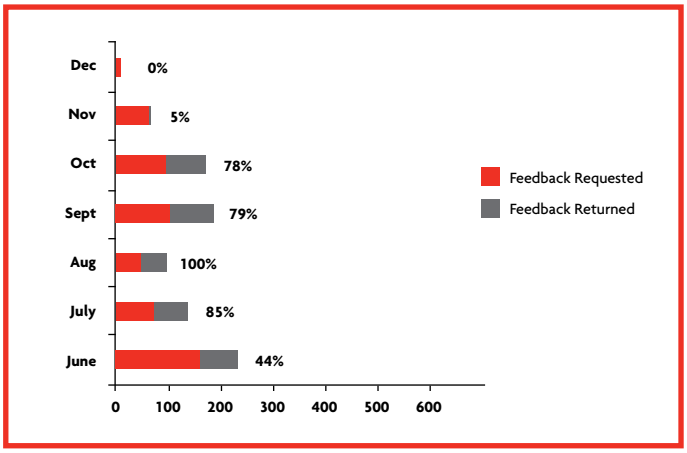


59% of the urgent and critical samples are attributed to axle (differentials and final drives) problems, mainly for tractors. 21% are attributed to engines, 13% to transmissions, while 5% is attributed to hydraulics.

3. Actions and feedback

This section looks at feedback requested by the laboratory versus actual feedback sent back to the laboratory. Feedback reveals the actual (findings) following the diagnosis and also shows evidence of the result (resultant problem) and hence assists in understanding the problem and planning of future preventative measures.

Feedback compliance is illustrated in the graph below:



	June	Jul	Aug	Sept	Oct	Nov	Dec	Total
Feedback Requested	160	74	49	103	96	64	8	554
Feedback Returned	71	63	49	81	75	3	0	342
%	44%	85%	100%	79%	78%	5%	0%	62%

Average feedback compliance level for the agricultural season is 62%.

Cane Loader at Zambia Sugar Estates

4. Cost savings

Cost savings are a measure of the effectiveness of the WearCheck oil analysis program in attaining the vision. They are mainly driven by actions and feedback.

The cost avoidance approach was used to calculate cost savings. Over the past decade it has been discovered that a sudden component failure has resulted in failure to timely move sugarcane from the fields, resulting in lost productivity. It was also evident that oil analysis has been a useful tool in identifying imminent fleet problems and timely corrective action has resulted in a reduction in the risk of catastrophic failures. Therefore, where the laboratory has discovered a threatening problem and workshop responds by taking timely corrective action, the risk of catastrophic failure and or resultant loss of production has been greatly reduced.

The table below illustrates the number of improved compartments following corrective action to problems identified by the laboratory.

2016-2017 Annual Savings							
	Cane haulage	Cane loaders	Farm tractors	Heavy plant	Total units	Typical repair cost (USD)	Total savings (USD)
Engine	11	2	2		15	8 600.00	129 000.00
Transmission	7	1	2		10	5 265.00	52 650.00
Differential	8				8	1 000.00	8 000.00
Final drive / hub / tandem	11	8	1		20	10 160.00	203 200.00
Hydraulics	1		3		4	445.00	1 780.00
							Total estimate savings: $ 394 630.00

Repeat problems result in component failure if they go unattended. In calculating the cost savings figure above, an assumption was made that is: where corrective action is taken and the health of the compartment improves, a potential failure is saved.

Savings for the 2016 – 2017 agricultural season – US $ 394 630.00

This figure could have been higher had it not been for the wet weather operations which affected tractor axles. It is also important to note that although the figure above gives us an indication of the level of savings, the actual figure is in reality way higher as downtime costs far more than the cost of replacing a component such as a failed differential.

Zambia Sugar has, over the years, implemented a Continuous Improvement (CI) programme. WearCheck plays a very significant role in the CI program, on a continued basis, where threatening problems are identified and best practice methods are implemented with the aim of addressing the root source and preventing the problem from happening again. The WearCheck diagnostic reports and feedback system are a way of documenting current improvements as well as potential opportunities for improvement. The WearCheck oil analysis programme has therefore provided a means of ensuring effective cost control which is extremely critical in improving operating margins.

Significant improvements have been noted over the last decade as a result of the dedication and commitment of the management team in partnership with WearCheck to continuous improvement and a drive to maximise cost savings. This has had a net effect of improved maintenance culture and general awareness of factors affecting the fleet health such as:

- The team is now better informed on the impact of the operating environment on equipment.
- The team is more aware of operational problems affecting equipment and nipping the axle wear problems in the bud, thus avoiding catastrophic failures.
- It is also evident that the simple issues such as oil filler cap o-rings are causing major problems of dust contamination – this is a good example of the Pareto 80/20 principle.

6.1 Case Studies

Other notable case studies are summarised in the section below:

CASE STUDY #1	
Fleet Number **ZT16** **Differential** Cane Haulage Tractor 16/09/21 Problem Category MPE, Wear	**Problem** Abnormal wear of differential components.
	Diagnosis Debris analysis revealed a moderate concentration of very small wear particles. Gear wear rates higher than normal. Recommended checking of drain plug for wear particles, carrier bearing preload, pinion backlash and end float on bearings. repeat problem X3.
	Feedback and Comment Fine particles found on drain plug. Operational problem (wet weather harvesting) had resulted in abnormal wear of axle components. Though oil has been drained several times, carry-over of wear particles resulted in continued abnormal wear. This problem had affected several tractor axles, with broken gears and shafts being noticed upon investigation. In this case oil was drained, unit flushed and preloads checked and re-adjusted resulting in the improvement of severity from borderline to normal.
	Estimated Savings (cost avoidance per Differential) US $ 1 042.00

CASE STUDY #2	
Fleet Number **ZT52** **Transmission** Cane Haulage Tractor 16/06/27 Problem Category MPE	**Problem** Worn clutch plate poses threat to life of a manual gearbox.
	Diagnosis Debris analysis revealed a moderate concentration of very small wear particles.
	Feedback and Comment Manual gearbox, replaced worn clutch plate failure which was causing noisy gear change and grinding of gears.
	Estimated Savings (cost avoidance) US $ 5 265.00

CASE STUDY #3	
Fleet Number **ZT56** **Engine** Cane Haulage Tractor 16/08/05 Problem Category Water contamination	**Problem** Water contamination threatens the life of a tractor engine.
	Diagnosis High water contamination.
	Feedback and Comment Replaced worn rocker cover oil seals resulting in severity improving from borderline to normal. Oil analysis results in huge savings especially if problems are picked up and addressed at their onset. The cost of replacing a seal is by far more cost effective compared to an engine replacement cost or resultant cost of downtime in case of a catastrophic failure.
	Estimated Savings (cost avoidance) US $ 8 614.00

CASE STUDY #4	
Fleet Number **G28** **Right Rear Final Drive** Cane Loader 16/07/19 Problem Category Wear	**Problem** Abnormal wear of final drive components
	Diagnosis Gear wear rates were higher than normal. The diagnostics department recommended checking for abnormal noise and vibration.
	Feedback and Comment Replaced broken hub nut lock-washer. Hub nut had become loose, nut re-tightened and hub pre-loaded. This is a common problem affecting cane loader hubs. A thorough investigation into the problem revealed the lock washer was made of weaker material and hence prematurely breaking during operation resulting in excessive endplay and abnormal wear.
	Estimated Savings (cost avoidance per Final Drive) US $ 1 050.00

The Zambia Sugar agricultural workshop manager had this to say about the benefits his company is getting from the WearCheck oil analysis programme:

The benefits that we are realising are many and are as follows:

- Easier root cause failure analysis
- Preventing catastrophic failures before they occur
- Cost saving on very expensive vehicle/machine components, e.g. engines, transmissions, etc.
- Higher fleet performance
- Low downtime
- Higher fleet availability, average above 95%.
- Higher fleet reliability

The list is endless.

WAY FORWARD AND RECOMMENDATIONS FOR THE 2017 – 2018 AGRICULTURAL SEASON

2017 – 2018 Season Targets
Target sampling compliance: 100%.
Reduce percentage alarms to levels below 20%.
Eliminate fault repeats. Identified problems should not recur more than twice.
Improve logistics from workshop to courier.
Feedback returned: Improve corrective action and feedback returned to levels above 85% and maximise cost savings.
Schedule Operator training to improve awareness and curb operational problems affecting tractor axles.
Invest in colour coded oil dispensing equipment to prevent the possibility of top up with wrong oil.

CONCLUSION

As the leading oil analysis and condition monitoring company in Africa, WearCheck is proud to partner Zambia Sugar at a time when the company is expanding its operations by investing in the construction of the sugar refinery and the ethanol plant. WearCheck remains committed to offering the best service and saving our customers money by offering a world class service through our oil analysis and condition monitoring programmes.

Copies of previous Technical Bulletins can be accessed on WearCheck's web site: www.wearcheck.co.za

JOINING TOGETHER TO SUPPORT THE PLANET ♻

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