

GROWING PROFITABILITY IN AGRICULTURE



How lubricants can help farmers
increase productivity and reduce total
cost of ownership



FOREWORD

A message from Virginie Chan, Shell Lubricants Global Sector Marketing Manager for Agriculture



After a decade of expanding at around 2.5% per annum, the global agriculture industry is now facing a new set of challenges linked to declining global commodity prices and economic slowdown in key markets such as China¹. While a slowdown in global population growth will limit the overall increase in demand,

rising incomes are expected to boost the appetite for meat, fish and dairy products.

In an environment where meeting global demand by maximising productivity and minimising costs is key, making the most of the 'off season' to conduct proper equipment maintenance is essential to help avoid costly unplanned downtime during peak planting or harvest times.

However, **the potential impact of effective equipment lubrication on equipment durability and reliability is too often underestimated.**

According to an international industry study commissioned by Shell Lubricants², only 39% of agricultural companies believe lubrication can influence equipment availability and only 29% understand how wear protection delivered by a lubricant can lead to cost savings.

Perhaps unsurprisingly in light of this, the study also showed that many companies underestimate the potential extent of these savings. Over 60% of those surveyed believe that cost savings linked to lubricants would not exceed 5%³. However, Shell Lubricants has seen that far greater savings are possible and in recent years has delivered **close to \$2 million in savings** to agriculture customers⁴.

For decades, Shell Lubricants has worked closely with customers to help identify opportunities to **reduce maintenance costs and enhance equipment productivity by upgrading lubrication**. This can contribute to Total Cost of Ownership (TCO)⁵ savings and help extract the best possible value from machinery.

There are two equally important elements to seizing this opportunity. The first is **selecting the right lubricant or grease**; the second is **effective lubrication management**.

When under pressure to reduce maintenance spend, farmers often look to cut their lubricant costs. However, while buying cheaper lubricants can achieve immediate cost savings, the detrimental effect on equipment can prove more expensive over time. The best value is found in competitively-priced, high-quality lubricants that deliver longer oil drain intervals and protect equipment under all conditions to help limit unplanned downtime and lower maintenance costs.

This paper outlines the potential business benefits of effective lubrication, with case studies of those who have successfully worked with Shell Lubricants to extract cost savings and improve equipment reliability.

I hope you find it both informative and useful.

¹ OECD-FAO Agricultural Outlook 2016-2025 (www.agri-outlook.org).

² This survey, commissioned by Shell Lubricants and conducted by research firm Edelman Intelligence, is based on 120 interviews with Agriculture sector staff who purchase, influence the purchase or use lubricants / greases as part of their job across 8 countries (Brazil, Canada, China, Germany, India, Russia, UK, US) from November to December 2015.

³ 39% of businesses say purchasing lubricants based on TCO rather than price can reduce overall costs (maintenance, labour, fuel) by 5% or more.

⁴ Shell Lubricants documented customer savings. More information available upon request.

⁵ Total Cost of Ownership (TCO) is defined by Shell Lubricants as the total amount spent on industrial equipment, including cost of acquisition and operation over its entire working life, including costs of lost production during equipment downtime.



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1. TOTAL COST OF OWNERSHIP: UNDERSTANDING THE POTENTIAL

Shell Lubricants believes that there is potential for lubrication to deliver significant business value by contributing to improved productivity and reduced costs. However, the potential impact of lubricants is often significantly underestimated.

Understanding how lubricants contribute to Total Cost of Ownership (TCO) is the first step to realising potential savings.

UNPLANNED DOWNTIME CAN BE COSTLY



58% of farmers acknowledge that their lubrication errors have led to unplanned downtime.^[2]



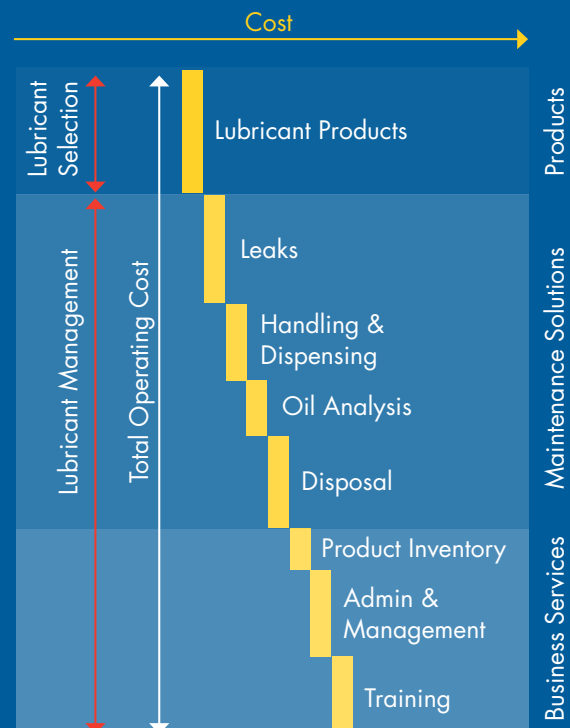
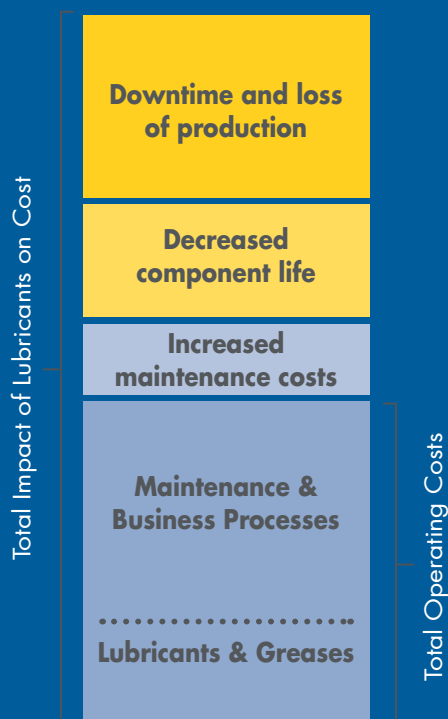
Total Cost of Ownership (TCO)

When evaluating the effect of lubricants on TCO, Shell Lubricants considers the end to end impact on maintenance budgets and processes, but also any costs related to lost production during equipment downtime. Optimising lubrication can have a significant impact on component life, maintenance costs, and unplanned downtime, so it can contribute to cost savings far higher than the price of the lubricant itself.

Seizing the Opportunity

Lubricant product selection or management can impact many elements of a company's maintenance budget. Seizing the cost-saving opportunity depends on addressing two equally important elements:

- 1.** Selecting the right lubricant or grease - the right product
- 2.** Effective lubrication management – including the right storage & handling, the right place, the right time, the right amount, the right monitoring and the right people



HELPING BOOST FARMING PRODUCTIVITY WITH EFFECTIVE LUBRICATION

COMPANIES UNDERESTIMATE POTENTIAL PRODUCTIVITY IMPROVEMENTS FROM EFFECTIVE EQUIPMENT LUBRICATION

54%

do not believe choosing higher quality lubricants will **help reduce unplanned downtime**



Only **32%**

believe lubrication can influence **equipment availability**



Only **29%**

understand how **wear protection** can lead to savings



1 in 3

do not expect higher quality lubricants to help **reduce maintenance costs**



LACK OF UNDERSTANDING IS AN OBSTACLE TO SAVINGS

47%

do not believe lubrication can help extend equipment life



77%

think they do not conduct staff training on lubricants as regularly as they should



44%

place importance on **product performance** when purchasing lubricants



THE IMPACT OF THIS CAN PROVE COSTLY

58%

admit their errors in equipment lubrication have led to unplanned downtime



SELECTING THE RIGHT LUBRICANT AND MANAGING IT CORRECTLY CAN HELP **REDUCE UNPLANNED DOWNTIME AND LOWER MAINTENANCE COSTS**, CONTRIBUTING TO **IMPROVED PRODUCTIVITY AND LOWER TOTAL COST OF OWNERSHIP (TCO)**¹

SHELL LUBRICANTS WORK WITH CUSTOMERS TO HELP DELIVER TCO SAVINGS

Over **\$1.9 million** savings delivered to agriculture customers²



260 Shell Lubricants technical specialists help customers reduce TCO through effective lubrication



OEM and customer collaborations enable Shell Lubricants to develop products that help improve equipment reliability and productivity



Shell Lubricants Services to help upgrade lubrication management:

Shell LubeAdvisor

Helping identify and seize savings

Shell LubeMatch

Tailored product advice

Shell LubeAnalyst

Lubricant monitoring

Shell LubeCoach

Staff training

This survey, commissioned by Shell Lubricants and conducted by research firm Edelman Intelligence, polled 120 decision makers in the agriculture industry in 8 countries (Brazil, Canada, China, Germany, India, Russia, UK, US) from November to December 2015.

1. Total Cost of Ownership (TCO) is defined by Shell Lubricants as the total amount spent on industrial equipment, including cost of acquisition and operation over its entire working life, including costs of lost production during equipment downtime.

2. Based on savings delivered to Shell Lubricants customers.

SHELL LUBRICANTS
TOGETHER ANYTHING IS POSSIBLE

2. LUBRICANT SELECTION

From tractors to harvesters, balers to grinders, every piece of farming machinery made by different original equipment manufacturers (OEMs) has its specific lubrication requirements. OEMs define the minimum requirements for lubricants or greases, but not all products that meet these standards deliver the same level of performance.

2a. LUBRICATION CHALLENGES

When evaluating the effect of lubricants on TCO, Shell Lubricants considers the end to end impact on maintenance budgets and processes, but also any costs related to lost production during equipment downtime. Optimising lubrication can have a significant impact on component life, maintenance costs, and unplanned downtime, so it can contribute to cost savings far higher than the price of the lubricant itself.

Below are two of the farming industry's primary applications and some of their specific lubrication challenges. In all cases, **selecting the right lubricant is an important first step in helping to improve reliability, boost productivity, and lower costs.**

LUBRICANT PRODUCT PERFORMANCE IS OFTEN OVERLOOKED



Only **44%** believe product performance should be a very important consideration when purchasing lubricants.^[2]



ENGINES

Effective engine lubrication is critical to protect high-cost equipment, and minimize downtime due to frequent oil changes, maintenance or even component failures.

Protection against deposits

Dirt in the engine, whether piston deposits or crankcase sludge, can reduce operating efficiency and increase fuel costs. This risk is heightened at times such as peak harvest season, when equipment runs for longer periods of time. A higher-quality engine oil actively works to remove deposits, helping keep the engine **clean and protected**.

Wear control

Wear protection is particularly critical at high-pressure contact points, such as in the engine valve train and gearbox. A heavy-duty engine oil that includes adaptive molecules can help **protect against engine wear** by reacting under heat and pressure to form a protective film between key components.

Corrosion protection:

Gases and acids are generated as a natural by-product of the combustion process. The lubricant neutralises these acids to help avoid corrosion that can increase the risk of engine failure.

Long Oil Life:

Oxidation, soot accumulation and oil thickening, and the build-up of acids in the lubricant all contribute to oil aging. High quality synthetic engine oils with the right base oil and additive technology -including anti-oxidant additives -can maintain performance characteristics for longer in the presence of contaminants and by-products^[6].

“The right engine oil helps protect equipment in all conditions, even when operating at maximum load. By guarding against wear, deposits and corrosion, it can help keep machinery operating efficiently and reduce the risk of costly unplanned downtime.”

– Nils Richardt, Shell Lubricants Product Application Specialist

AXELS AND TRANSMISSIONS

With modern farming machinery working under higher loads, the demands on transmission lubricants are increasing. The universal transmission oil (UTTO) is, for most farmers, the most vital lubricant. It must successfully lubricate the transmission, wet brakes and hydraulic systems of machines including tractors, diggers and combine harvesters, to help keep equipment running smoothly for longer.

1. Wear protection

A lubricant that offers higher levels of wear protection can help guard against wear and tear of equipment components that can lead to unplanned downtime, significant repair costs, and revenue loss.

2. Smooth brakes

If brake pads are not properly lubricated, it can result in extreme noise levels, making the vehicle extremely uncomfortable to use. The right friction modifiers in the lubricant help ensure smooth brakes.

3. Long Oil Life

Oxidation stability and corrosion protection are also important to maintain oil performance. High quality transmission oils with good oxidation resistance can resist degradation and break-down over time^[7], thereby reducing downtime required for frequent oil changes.

Shell Spirax S4 TXM is a universal transmission oil, formulated, tested & recommended specifically for agriculture equipment. Tested and approved by the leading agriculture and transmission OEMs, it can be used to protect the transmissions of equipment from a range of manufacturers, helping simplify maintenance and deliver cost savings. Shell Spirax S4 TXM is designed to protect equipment against wear, with high shear stability and anti-oxidants to deliver long-lasting performance.

“The reliability and efficiency of any piece of farming equipment is dependent on the lubricant performing well in the transmission. A reliable, high-performing universal transmission oil helps simplify maintenance procedures, while still giving the peace of mind that equipment will be protected for longer. All of this can help customers to improve productivity and reduce total cost of ownership.”

– Nils Richardt, Shell Lubricants Product Application Specialist

2b. DELIVERING SAVINGS WITH HIGH QUALITY LUBRICANTS

Selecting a less effective lubricant rarely results in immediate equipment failure, but can lead to increased maintenance expenses over time. For example, lower levels of wear or corrosion protection can lead to more rapid degradation of equipment components, resulting in increased maintenance costs from more frequent replacement. These mounting costs can be far greater than the savings from selecting a lower price lubricant.

In contrast, a high quality oil or grease that keeps equipment clean of deposits and effectively protects against wear and corrosion can help extend equipment life, reduce frequency of breakdowns and increase the machine's availability. Selecting a lubricant with numerous OEM approvals for multiple applications can also enable businesses to take advantage of economies of scale, which creates an overall reduction in operating costs.

“With only 2-3 months to complete an entire harvest, even a single day of unplanned downtime can be extremely costly. A high quality lubricant or grease that keeps machinery clean of deposits and effectively protects against wear and corrosion can help extend equipment life, reduce the frequency of breakdowns and increase equipment availability. This can all contribute to improved equipment reliability and decreased maintenance spend.”

– Virginie Chan, Shell Lubricants Global Sector Marketing Manager for Agriculture

MISCONCEPTIONS ABOUT LUBRICANTS ARE COMMON



1 in 3 do not
expect higher quality
lubricants to help reduce
maintenance costs.^[2]



POWERING PROFITABILITY IN PAKISTAN – CUTTING DOWNTIME BY 75%⁸

In the rice-exporting region of Gujranwala, Pakistan, the 200+ harvester owners have only a single measure of lubricant quality for their \$20,000–\$40,000 equipment: the oil's ability to maintain compression pressure in the engine.

Failure of compression pressure due to engine oil quality means prolonged downtime for equipment, which leads to vital loss of revenue.

After introducing Shell Rimula heavy-duty engine oil, the company found that the engines were able to better maintain compression pressure.

As a result, the owners reported a **75% reduction in downtime** in their reconditioned and used machinery. **Maintenance costs also shrank by 60%.**

⁸ The savings indicated are specific to the calculation date and mentioned site. These calculations may vary from site to site and from time to time, depending on, for example, the application, the operating conditions, the current products being used, the condition of the equipment and the maintenance practices. More details available on request.



3. LUBRICANT MANAGEMENT

Even the best product cannot perform effectively if it is not applied and managed correctly.

Effective lubrication management is vital to unlock potential TCO savings. It can help deliver value from improved productivity and reductions in lubricant consumption, maintenance and operating costs.

**MANY BUSINESSES
DO NOT REALISE THE
POTENTIAL BENEFITS OF
EFFECTIVE LUBRICATION
MANAGEMENT.**

Only **2 in 5** believe
that it can help reduce
unplanned down time.^[2]



SHELL LUBRICANTS' SIX STEPS TO GOOD LUBRICATION MANAGEMENT

- 1 Right storage & handling** – the lubricant must be stored in the right conditions and handled correctly to avoid contamination and preserve its key characteristics
- 2 Right place** – for the oil or grease to reach the right surface it must be properly applied to the equipment
- 3 Right time** – the correct frequency of oil change or re-greasing ensures the lubricant reaches the surface at the right time. Delays can result in accelerated wear
- 4 Right amount** – the correct volume of lubricant or grease applied and topped up to protect moving parts effectively
- 5 Right monitoring** – regular sampling and analysis to ensure the lubricant remains fit for purpose and check for early indications of equipment wear. Inspections also ensure the consistent application of the first four steps. For a complete analysis service, Shell offers LubeAnalyst
- 6 Right people** – the competence of those who lubricate equipment can greatly affect its positive impact, particularly when it comes to ensuring all of the above happens

3a. CHALLENGES & SOLUTIONS

The following examples highlight some of the different lubrication management challenges commonly faced in the agriculture sector, the importance of taking action to address these, as well as the available Shell Lubricants Technical services to support.

The Challenge: Right product portfolio

The need to use different lubricants for different OEM equipment can present a major challenge. It requires a lot of working capital, is hard to manage, and increases the risk of using the wrong lubricant in the wrong equipment, which can cause breakdowns and unplanned downtime.

The Solution: Streamlining portfolio

A universal transmission oil such as Shell Spirax S4 TXM that works equally effectively across multiple OEM equipment can help simplify maintenance, reduce the risk of errors, and improve cash flow by limiting the number of transmission oils farmers need to stock.

77% of farming businesses do not conduct staff training on lubricants/greases as regularly as they think they should.^[2]



And they lack external support: Only 30% of companies have regular visits from their lubricant supplier's technical staff.^[2]



The Challenge: Storage and handling

Contamination control is critical to maximising the performance of the lubricant in equipment. How the oil or grease is stored, handled and transported around the farm greatly impacts the likelihood of contamination.

Storing drums in a sheltered place and wiping the top clean before it is opened will help limit the risk of contamination by water and particles. Applying filtration can also help ensure product cleanliness before oil enters equipment.

The Solution: Expert advice and staff training

Underpinning good lubrication management practices is industry knowledge and expertise. One of the core lubrication management services offered by Shell Lubricants is building technical competency across a customer's organisation. This is delivered through Lubricant Technical Advisors, supported by a team of Global Product Application Specialists and Lubricants Services Experts. They regularly visit customer farms to share expertise about lubrication management and help farmers realise the full value of a high performing lubricant portfolio.



The 260-strong team of Shell Lubricants technical specialists, supported by distributor partners, provides lubrication management services across various industries. For agriculture, this includes a dedicated Global Product Application Specialist, who works closely with OEMs to understand their latest equipment technology and develop lubrication solutions to match; and a technical specialist for each country, focused on supporting and advising farming customers locally.



The Challenge: Right monitoring

Regular monitoring and analysis helps ensure the lubricant or grease is functioning well and remains fit for purpose. Lubricant analysis is vital to business continuity. Owners and operators of mission-critical assets need advance warning of mechanical problems that are likely to damage equipment, reduce productivity and increase maintenance costs.

The Solution: Oil Condition Monitoring Services

Oil condition monitoring services, such as Shell LubeAnalyst, can provide early warning of equipment wear or lubricant degradation, enabling the lubricant to be changed before issues escalate and thereby helping reduce the frequency, time and cost of maintenance. This also helps improve productivity due to greater equipment availability.

“A common mistake is reducing the oil drain intervals, even though the lubricant in use remains satisfactory. Implementing an effective oil monitoring programme can allow plant managers to increase ODIs and, ultimately, achieve even bigger savings.”

– Praveen Nagpal, Shell Global Product Application Specialist

DELIVERING BUSINESS VALUE THROUGH LUBRICATION SERVICES

Shell LubeAnalyst

Lubricant Analysis

A global oil and equipment monitoring service that helps customers assess lubricant condition, identify potential problems, and benchmark equipment performance against comparable oil samples from around the world. Available in 95 countries and 28 languages, it has more than 60,000 users worldwide, and analyses over 750,000 samples a year. The service allows customers to monitor equipment without interrupting operations, and provides guidance on interpretation of results.

Shell LubeAnalyst Lite

Rapid On-site Analysis

Shell LubeAnalyst Lite¹⁰ on-site analysers deliver fast, comprehensive test results for machine lubricants including engine and gearbox oils, hydraulic fluids and power steering and transmission fluids. Maintenance staff can test lubricants on-site at any remote location and get results within 15 minutes. The service can help limit downtime and lower maintenance costs by capturing early signs of abnormal wear, and helping extend oil-drain intervals.

Shell LubeCoach

Upskilling Employees

A customised training programme, led by Shell technical experts with substantial in-field experience, which offers practical coaching to customers' staff on lubricant management techniques.

Shell LubeAdvisor

Identifying and Seizing Value Opportunities

Specialised Shell Lubricant Technical Advisors (LTAs) conduct farm surveys to help customers identify areas for improvement in lubrication. All stages of the lubrication process are addressed, including: product selection; delivery; storage; distribution across the farm; product application; and disposal of used lubricants. Changes are implemented through 'Value Improvement Projects'.

Shell LubeMatch

Monitoring Performance

Dedicated teams of highly-trained technicians - Lubricants Service Experts (LSEs) - spend most of their time at customer sites, inspecting critical machinery like excavators, draglines, shovels, mills and kilns, and identifying potential lubrication issues. This alerts customers to the need for preventive maintenance, which can lead to savings of millions of dollars by helping to avoid major breakdowns.

9 Shell LubeAnalyst Lite complements the off-site, laboratory-based service offered by Shell LubeAnalyst. Shell LubeAnalyst remains the recommended analysis service when extreme precision is more important than fast results. Shell LubeAnalyst Lite is not currently available in all regions.

3b. UNLOCKING VALUE

The following case studies show how Shell Lubricants technical experts have worked together with farming customers to help upgrade lubrication management processes and generate substantial cost savings¹⁰.

Over the last five years, Shell has delivered **\$1.9 million** to customers in the agriculture industry¹¹. These savings represent only a portion of the real-world total, which could be as much as 10 times higher. This indicates great potential for TCO reduction and productivity increases across the industry through lubrication excellence.

OIL CHANGE SAVES PLANTATION OWNER \$31,000 A YEAR¹²

The Challenge

With a limited number of farm tractors to cover a large plantation area, the reliability of the tractors is crucial to the success and cost of operation of the plantation at Kokorotus Estate in Sabah, Malaysia. The vehicles are required to operate for long hours with medium to heavy loads in both wet and dusty conditions. The owners were seeking an alternative tractor transmission oil that could help extend the oil drain interval and, most importantly, reduce equipment downtime.

The Solution

Shell Lubricants technical experts worked with Distributor Front Line Technical Support and the maintenance team at Kokorotus Estate to introduce Shell Spirax S4 TXM across its farm tractor fleet, a premium UTTO designed for use in transmission, hydraulic system and wet brakes. Results were tracked using Shell LubeAnalyst, the oil condition monitoring programme.



The Results

Increased oil drain interval of the transmission and hydraulic systems of their Kubota M108S from 500 running hours to 1,300 running hours, **a rise of 160%.**

- A **significant reduction in operating downtime** resulting from oil changes and maintenance.
- Total annual savings of **US \$31,000**

¹⁰ Case study savings/benefits were reported by one customer. Actual savings/benefits will vary. More details available on request.

¹¹ Documented customer savings from 2011 to October 2015. More information available upon request.

RUSSIAN FARM EXTENDS OIL DRAIN INTERVALS AND CUTS ANNUAL OPERATING COSTS BY OVER \$10,000¹²

The Challenge

Medium-sized Farm Sapphire in the Kursk region of Russia operates a fleet of 21 John Deere Wheel Tractor 6930s. Using their existing heavy-duty diesel (HDD) oils and transmission oils, the farm was achieving oil drain intervals of 250 operating hours (HDD oil) and 1,000 operating hours (transmission oil). To help minimise costs and reduce stock, they wanted to extend this.

The Solution

Shell Lubricants technical experts suggested the farm trial Shell Rimula R5 E 10W-40 as its HDD oil and Shell Spirax S4 TXM as its transmission oil. Oil condition during these field trials was monitored by the Shell LubeAnalyst programme.



The Results:

- Extended HDD oil drain interval from 250 to 450 operating hours.
- Transmission oil drain interval extended by 50%, to 1,500 operating hours.
- Total cost savings of US\$10,690 (481,166 RUR) per year.

¹² The savings indicated are specific to the calculation date and mentioned site. These calculations may vary from site to site and from time to time, depending on, for example, the application, the operating conditions, the current products being used, the condition of the equipment and the maintenance practices. More details available on request



MALAYSIA'S HAPPY VALLEY INCREASES OIL DRAIN INTERVALS BY 160%¹²

The Challenge

Happy Valley Sdn Bhd farm was looking to achieve longer oil drain intervals for their Ford New Holland 6610 tractors. The vehicles are required to operate for long hours with medium to heavy loads in both wet and dusty conditions. Unhappy with their current oil drain interval of only 500 hours, which required an oil change every two months, the farm approached Shell to help them extend ODIs.

The Solution

The Shell Lubricants technical experts and distributor Distributor Front Line Technical Support suggested Happy Valley perform a trial using Shell Spirax S4 TXM. They also introduced the Shell LubeAnalyst oil condition monitoring programme to assess the oil's performance in the tractors' transmission and hydraulic systems.

The Results:

- Increased oil drain intervals for the transmission and hydraulic systems from 500 running hours to 1,300 running hours, an **increase of 160%**.
- **Significant reduction in oil change frequency and maintenance downtime**, giving the farm more operational flexibility in its tractor fleet.
- Total annual savings of US **\$22,000**.

4. REALISING VALUE THROUGH LUBRICATION

BUILDING A STRONG FOUNDATION

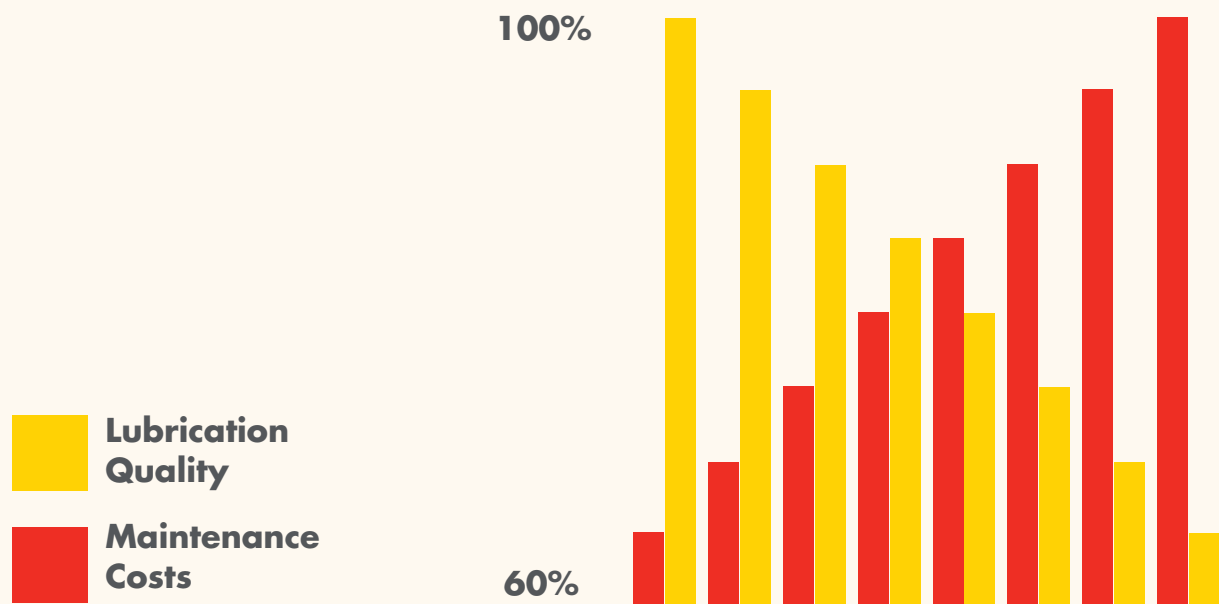
A look at companies who have successfully implemented structured, TCO-driven lubrication projects together with Shell Lubricants reveals a number of initial actions that help drive success.

- Senior management support of the TCO-driven approach to lubrication, to help overcome challenges such as resourcing alongside the demands of daily operations.
- Appointing a project lead and allocating the appropriate time and resources to a team tasked with implementing necessary changes.
- A good relationship with the lubricant supplier, whose technical teams play a key role in identifying and delivering value.
- A comprehensive analysis to identify, quantify and prioritise TCO-related projects. An important element of this is aligning on how value is measured, so savings can be recorded accurately. For example:
 - What is the hourly cost of maintenance and time required for repairs?
 - What is the cost of replacement parts?
 - What is the benchmark failure frequency?
 - What is the monetary value of downtime for each piece of equipment, in terms of lost production?
- Setting measurable targets to ensure that progress can be tracked.

Driving down maintenance costs

There are many factors impacting maintenance expenditure, but a direct correlation can be seen, where all other factors remaining equal, higher quality lubrication leads to lower maintenance costs.

Achieving excellence in lubrication (product selection and management) can result in far more significant reductions to total maintenance costs than purchasing lubricants based primarily on product price.



5. WHAT'S NEXT?

By 2050, it is projected that the world's population will have reached 9 billion. Meeting increased demand for safe, healthy and nutritious food, while adhering to strict CO2 emissions requirements, minimising environmental footprint and staying competitive by ensuring cost efficiency will require farmers to maximise equipment productivity and reliability.

That's why, as well as supporting customers in the present day, Shell Lubricants is always looking ahead to identify opportunities for the next generation of products and services that will help companies overcome the challenges of the future.

Looking at current industry trends, some issues Shell Lubricants is already addressing include:



Equipment advances

With the advance of precision farming techniques, larger horsepower vehicles, hybrid engines and 24/7 operations, it is vital that lubricants manufacturers work closely with OEMs to evolve suitable products.



Consolidated farms with less manpower

One path to higher production at lower cost is the creation of larger, multipurpose farms that rely on fewer workers. For this, the reliability of equipment, much of which may be unmanned, is vital. With fewer workers to take care of maintenance, that requires highly dependable lubricants.



Alternative energy

Driven by tightening emissions regulation, non-conventional fuels like bio and sewage gas, hydrogen and electricity are increasingly commonplace. This is presenting a raft of new compatibility and performance challenges for lubricants.



Growth of developing markets

Growth of developing markets – Farmers in markets such as Africa, China and India need products that work effectively in the different – and often more severe – local operating conditions. In Sub-Saharan Africa, where agriculture provides a livelihood for millions of people, growth is driven largely by productivity improvements, making improvements in equipment reliability and reductions in maintenance costs particularly valuable.



Real-time monitoring

Real-time monitoring – Applying sensor technology to enable real-time analysis of lubrication and equipment performance will play an increasingly important role in lubricant management, helping reduce downtime through preventative maintenance.



Technical innovation

Gas-to-liquid (GTL) technology could lead to significant performance improvements in lubricants. We expect GTL-based lubricants to be central to the farming industry of the future.



6. APPENDIX

Lubricant Technology - KEY FACTS



REDUCE FRICTION

Lubricants form a fluid barrier between moving surfaces to reduce friction between them, helping maintain smooth running and limit wear.



CLEAN

Lubricants flush away contaminants, removing dirt and wear particles from vital areas for removal via filtration. Many also contain active detergents for more powerful cleaning.



PROTECT

Lubricants and greases form a protective barrier between moving surfaces, preventing metal-to-metal contact and wear. They also contain additives that neutralize harmful acids such as combustion by-products that can impact equipment life. Enhanced protection helps limit wear and extend the life of components, helping to reduce spend on spare parts.



COOL

Lubricants absorb excess heat from high friction zones and transfer it away for cooling. This allows the equipment to function efficiently. (Not a critical function of greases).

LUBRICANT FORMULATION

A lubricant's precise blend of base oil and additive package helps ensure that it is able to deliver optimum performance for the longest possible time in a cost effective manner.

The process of creating a new lubricant or grease – from selecting components, to rigorously testing the formulation and conducting field trials – is highly complex and can take several years. In some cases lubricants evolve over decades, with developments in chemistry and technology innovations.

DID YOU KNOW?

For decades, Shell has led the way in advancing lubricants technology for the benefit of customers.

1933

Shell develops the four-ball load and wear test. Now a standard lubricants industry test, this assesses wear prevention in highly loaded contacts, like rolling element bearings and open gears.

1936

The first oil company to invent lithium-based greases. An important shift for the industry, lithium greases now represent >80% of all greases used worldwide.

1990s

First to market with a 'low SAPS' heavy duty engine oil. Lower levels of sulphated ash, phosphorous and sulphur help reduce diesel exhaust emissions by protecting after-treatment devices.

2014

First to introduce lubricants formulated from natural gas, with Shell patented gas-to-liquid technology.

2016

Shell introduces Shell LubeAnalyst Sensors, designed for real-time oil condition monitoring

BASE OILS AND ADDITIVE PACKAGES

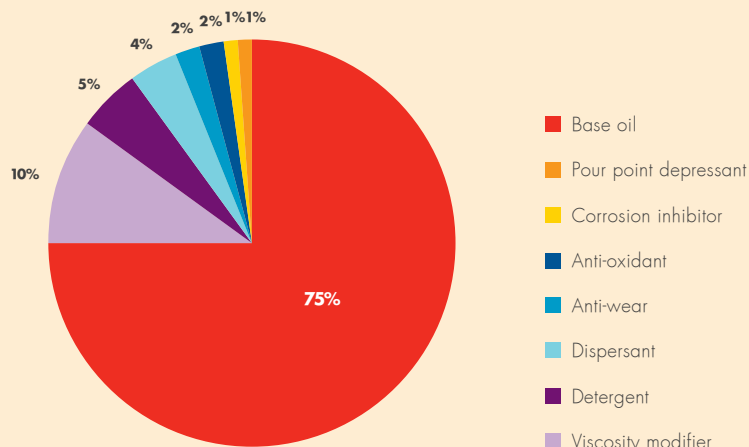
Base oils typically make up 75% to 95% of the finished lubricant and influence many of its key characteristics. They are key to determining factors like viscosity and lubricity.

The additive package comprises up to 25% of a lubricant's composition and works to enhance key performance aspects of the base oil, to achieve optimum performance of the finished product.

Examples of how this is achieved include:

- **Protection against wear** to help extend component life and contribute to reduced maintenance costs. This is delivered through:
 - Anti-wear additives that prevent metal-to-metal contact and control valve sticking
 - Extreme pressure agents that separate metal surfaces at high pressure
 - Solid fill additives that protect against shock loads at low speeds.
- **Operating performance**, delivered through **detergents and dispersants** that help manage the accumulation of soot and other impurities. This helps avoid abrasive wear that can impair equipment performance.
- **Reduced cost of lubrication** as a result of longer oil or grease life. This is achieved through **anti-oxidants** that help the oils deal with higher temperatures and loads, prevent corrosion, and guard against lubricant breakdown.

Typical composition of base oil and additive package for a heavy duty diesel engine oil



GREASE THICKENERS

Greases are designed to release lubricating fluid under pressure and then reabsorb it. The life of the grease is determined by its ability to do this without changing consistency – its mechanical stability.

Grease thickener is a key component of grease and impacts its quality. In addition, grease thickener is a key component of a grease and impacts its quality.

In most countries, lithium or lithium complex thickeners are used for the majority (~80%) of all applications. These deliver good water resistance, excellent mechanical stability and corrosion resistance, and remain thixotropic (fully viscous) at high temperatures. For highly specialised applications such as open gears, thickeners like bentonite or aluminium complexes may be used for their inherent temperature resistance and load carrying abilities.

DELIVERING VALUE IN AGRICULTURE

Committed to delivering value to customers, Shell Lubricants invests significant resources in developing new products for the agriculture sector.

A network of expert collaborations strengthens the innovation capabilities of Shell Research & Development teams located in Technology Centres in Shanghai, Hamburg and Houston:

- Working closely with top global agriculture OEMs, including key transmission and engine manufacturers such as ZF and Deutz, ensures Shell Lubricants products evolve in line with technological and industry advances, such as the introduction of PC-11 in the USA
- Field trials with customers also help validate functionality in real-life scenarios and steer the development of products that improve performance, productivity and profitability
- Shell Lubricants products are either approved or meet the specifications of many of the leading farming equipment OEMs, including: Massey Ferguson, John Deere, ZF, and more