

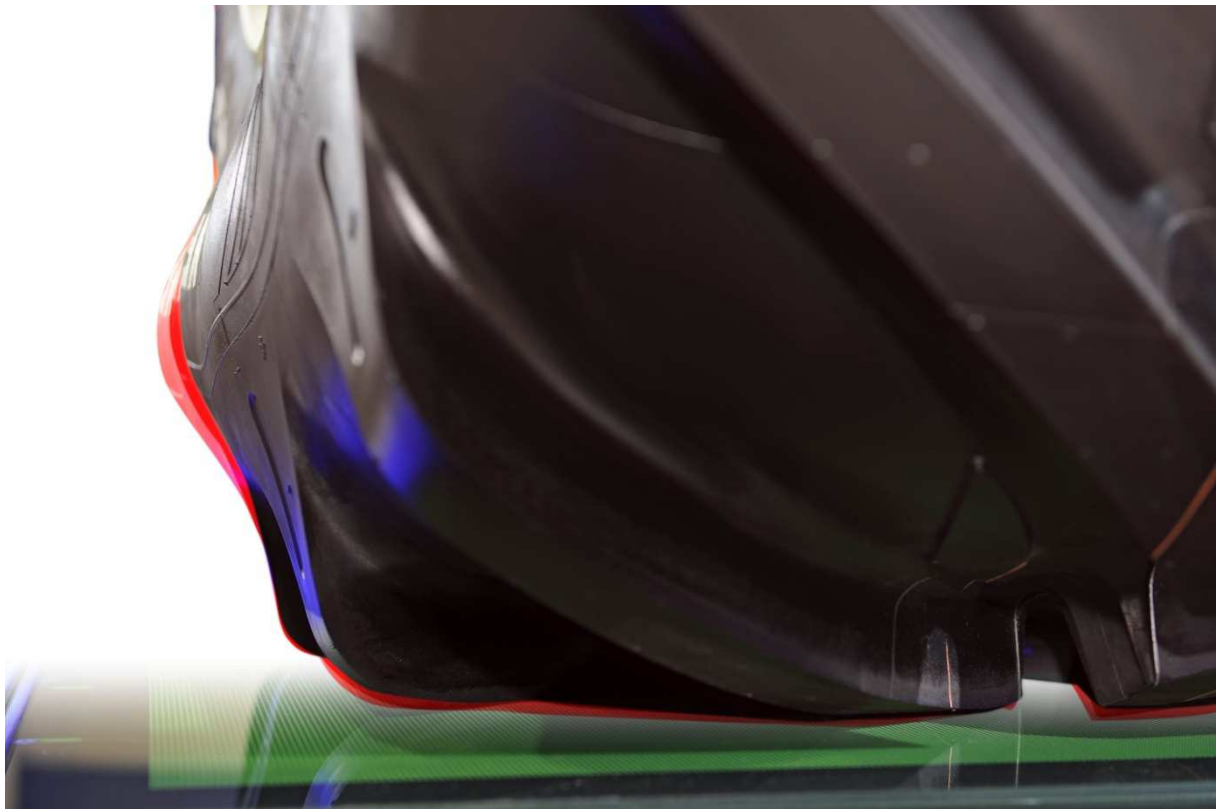
Press Release

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10 years of MICHELIN Ultraflex Technology

2004-2014: MICHELIN Ultraflex Technology celebrates its 10th anniversary

A decade of low-pressure tires offering productivity gains and
soil protection at every stage of the crop cycle



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2004-2014: a decade of low-pressure tires improving crop yields, productivity and soil protection

MICHELIN Ultraflex Technology celebrates its 10th year as a solution for every stage of the crop cycle

✓ Key information

At a time when university researchers are busy evaluating the yield and productivity gains achieved with farming practices that are gentle on the soil, Michelin is celebrating the 10th anniversary of MICHELIN Ultraflex Technology, a breakthrough innovation allowing agricultural tires to work at low pressure to improve soil protection and thereby boost crop yields.

MICHELIN Ultraflex Technology provides a response to the dual challenge of supporting developments in farm machinery to enhance productivity while also preserving the soil. Michelin provides a range of IF, VF and now standard class MICHELIN Ultraflex Technology tires covering every stage of the crop cycle.

A recent study has shown that annual productivity gain are up to 4 %. In this case scenario, the return on investment with MICHELIN Ultraflex Technology tires can exceed 24% because crop yields improve when soil is less compacted. Capable of operating at low pressure while supporting more load and more speed, they also offer better traction, which in turn improves productivity in the field.

How can we best feed the planet when the population is rising and arable land is becoming scarce?

It was with this question in mind that the Michelin Group, whose corporate signature is “a better way forward”, developed a breakthrough mobility innovation in 2004 that would make farm machinery more efficient: MICHELIN Ultraflex Technology.

Soil fertility needs to be optimized in order to boost farm productivity, which is why it is so important to avoid compacting the soil. At least 45% of the surface area of a field of grain is traversed by farm machinery in a given year (Kroulik *et al*, 2009), and that percentage can easily exceed 90%. The cost of soil compaction, as estimated in a Harper Adams University study, exceeds \$1.2 billion per year in

the United Kingdom. These figures clearly illustrate the magnitude of the challenges that farmers have to face.

This is why the Michelin Group has mobilized all of its technology in support of farmers, giving them access to a comprehensive range of low-pressure tires that cover all of their needs from the beginning to the end of the crop cycle:

- For tractors: MICHELIN XeoBib, AxioBib and YieldBib.
- For combine-harvesters: MICHELIN CerexBib.
- For sprayers and crop conditioning equipment: MICHELIN SprayBib.
- For trailers: MICHELIN CargoXBib.

MICHELIN Ultraflex tires are the key variable in the following equation:

**Lower pressure = reduced compaction = enhanced soil protection
= higher yields = improved productivity**

MICHELIN Ultraflex Technology, the best investment for increasing crop yields

In the United Kingdom, researchers at Harper Adams University have studied the productivity gains achieved on sample wheat field plots using farm machinery equipped with MICHELIN Ultraflex Technology versus conventional radial tire technology. Similar studies are to be conducted in other environments in the future.

The study revealed that Michelin's tires drove an annual productivity gain of 4%. Given a crop yield of 8 tonnes per hectare and a price of €200 per tonne of harvested wheat, this translates into an additional €64 per hectare per year. Taking into account that MICHELIN Ultraflex fittings represent an added investment of €1.20 per hectare per tractor (representing a further €1.00 per hectare for a combine-harvester and €0.50 per hectare for a trailer), **the return on investment in this scenario amounts to more than 24.**

MICHELIN Ultraflex tires are clearly the best investment that farmers can make to boost crop yields and protect the soil.

The low-pressure challenge

Pressure is created by applying force to a given area. A farm vehicle therefore exerts a certain amount of pressure on the soil through its tires. Studies show that soil compaction occurs above just one bar of pressure. As the soil is compacted, its structure and chemical composition change. Macropores, which allow air and water to move through the soil, are eliminated, thereby depleting roots of nutrients. Significant compaction can reduce soil productivity by 30% to 40%.

As the famous formula goes:

$$P_s = Z/S_a$$

where...

P_s is the pressure applied to the soil

Z is the load

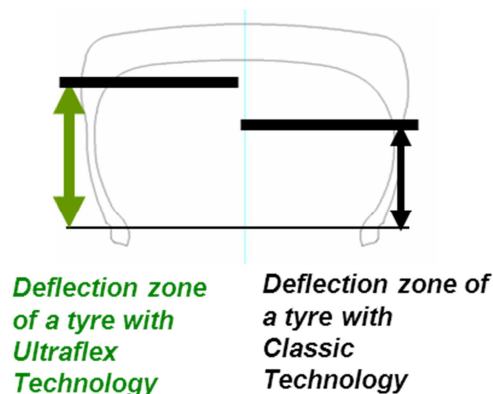
S_a is the surface area of the soil

...such that any increase in soil surface area results in a decrease in pressure.

How do we increase soil surface area?

The simplest solution is to increase tire volume. Agricultural tires, which generally needed 1.6 bar of pressure to operate a decade ago, could operate at 0.8 bar carrying the same load if their volume was doubled. This posed a number of problems relating to sizing, regulatory requirements, mounting, cost, equipment modifications, etc.

Michelin opted for the more innovative solution of increasing the dynamic flexibility of its tires, adding to this difficult task the challenge of maintaining the best possible handling on the road, where farm vehicles generally spend 20% to 40% of their time, travelling at speeds of up to 65 km/h where the law allows.



The birth of MICHELIN Ultraflex Technology

After inventing the radial agricultural tire at the start of the 1980s, Michelin went back to the drawing board and came up with the MICHELIN XM 108, a large volume agricultural tire that was 25% wider than its predecessor but fitted to the same rim. This tire pushed back the 1.6-bar limit, operating at pressures as low as 1.2 bar. More recently, a second development phase was initiated to build tires capable of operating at less than 1 bar of pressure, in the field as well as on the road. Dubbed “HSLP” for “High Speed Low Pressure”, this project involved revising the entire structure of the standard-casing tire, including the tread, crown and sidewalls.

The goal was to develop a prototype tire that could travel at speeds of up to 65 km/h, meet every safety requirement and operate in the field at just 0.8 bar. Throughout its development, the prototype consistently demonstrated a 20% larger contact patch and good road handling, at the same time delivering an excellent degree of comfort, better resistance to wear and a 25% longer potential useful life. Its ability to provide traction, also considerably linked to the size of the contact patch, was improved. In this way, the HSLP tire set in motion a virtuous circle, with better grip leading to less slippage, which in turn reduces rut depth, which subsequently enhances soil protection, improves fuel efficiency, boosts productivity, decreases wear and increases crop yields. With this innovation, Michelin is able to combine more performance in the same tire.

And then Michelin created the MICHELIN XeoBib

Once the prototype had fulfilled its objectives, it was time to move on to the production stage. The MICHELIN XeoBib tire was unveiled to the general public, the press and to professionals at all the major farm shows of winter 2003/2004.

The first two sizes of the MICHELIN XeoBib were designed to equip tractors developing around 130 horsepower, with its VF 520/60 R28 size for the front and VF 650/60 R38 size for the rear respectively replacing the standard 480/65 R28 and 600/65 R38 sizes that were generally used for these types of tractors at the time.

Compared with a conventional Series 65 tire, the MICHELIN XeoBib delivered much better performances in the field:

- For a load of 3,650 kg, the XeoBib operated at 0.9 bar of pressure whereas the standard Series 65 tire operated at 1.4 bar.
- The XeoBib’s contact patch was 24% larger than that of the standard tire.
- The ruts left in the soil by the XeoBib were 21mm deep compared with 46mm for the standard tire, representing a 55% reduction in rut depth.
- The XeoBib’s rolling resistance on loose soil was 20% lower than that of the standard tire.
- At the same rate of slippage, it delivered 7% more torque.

When it comes to tire pressure, MICHELIN Ultraflex Technology delivers clear advantages in the field and on the road, as shown in the table below analyzing tire pressure at different speeds given a load of 3,300 kg:

	30 km/h	40 km/h	50 km/h	65 km/h
Standard Series 65 tire	1.1-1.2	1.2-1.3	1.3-1.6	1.4
MICHELIN XeoBib	0.8	0.8	0.8	0.8

A golden innovation, a wealth of rewards

The true value of the MICHELIN XeoBib was unanimously recognized by the agricultural industry in 2003 when the tire was awarded the Gold Medal for Innovation on its unveiling at Europe's largest farm machinery trade fair, AgriTechnica in Hanover, Germany. The jury concluded that "the MICHELIN XeoBib meets a long-established need that farming experts thought impossible to satisfy until now." To Michelin's further credit, this was the first time in the history of the trade fair that the top prize was handed to a tire.

For the MICHELIN XeoBib, this medal was to be the first in a long series:

- First Prize for Technical Innovation at the EIMA trade fair in Bologna, Italy in November 2003.
- PHB Award for its "revolutionary" value at the farm machinery show in Zuidlaren, Netherlands in December 2003.
- "Epi d'Or" Gold Medal at the AgriBex show in Belgium in February 2004.

This was the beginning of a success story that developed into many more chapters:

2006: the MICHELIN AxioBib IF (Improved Flexion) 710/85 R38 became the first 2.15m diameter agricultural tire.

2010: The MICHELIN SprayBib VF (Very High Flexion) 380/90 R46 tire became the first Ultraflex tire designed specifically for sprayers and crop conditioning equipment.

2011: the MICHELIN CerexBib IF 800/70 R32 CFO became the first Ultraflex tire designed specifically for harvesters.

2012: the MICHELIN YieldBib VF 480/80 R50 became the first VF class row-crop farming tire to be launched on the North American market.

2013: Michelin launched the MICHELIN AxioBib IF 900/65 R46, the biggest tractor tire in the world.

2014: the MICHELIN CargoXBib High Flotation became the first Ultraflex trailer tire, enabling Michelin to present a comprehensive range of solutions for all stages of the crop cycle.

Delivering performance where it counts

Safety, soil protection, crop yields, productivity and traction... For each of these challenges, the MICHELIN Ultraflex range has a leading-edge technology solution.

To coincide with the 10th anniversary of MICHELIN Ultraflex Technology, Michelin is organizing four workshops at its technology center in Ladoux, France to demonstrate the performance attributes of its tires.

Safety: testing the limits of dynamic performance with the MICHELIN SprayBib

Background: Sprayers and crop-conditioning machines are becoming increasingly larger and heavier. These high center of gravity vehicles transport heavy loads. When compared to a tire built with standard technology, the MICHELIN SprayBib and its Ultraflex technology offer 40% more load capacity with 43% less pressure.

To show that this level of performance is synonymous with safety, Michelin has fitted its new MICHELIN SprayBib VF 420/95 R50 tires to the latest generation John Deere sprayer.

In the field, Michelin's test drivers have no difficulty maneuvering between cones at a speed of around 40 km/h, which is very fast for these high-riding vehicles. Pushed to their limit, they demonstrate an ability to handle any risky situation that farmers could potentially encounter in their day-to-day operations.

Protecting the soil: a compaction ditch puts the MICHELIN XeoBib to the test

A practical way of demonstrating the ability of MICHELIN Ultraflex Technology tires to protect the soil is to roll them over a ditch filled with layers of soil of alternate colors.

The layers make it easy to visualize the impact of tire pressure on the soil. Using this method, the impact of a conventional MICHELIN MachXBib 650/65 R38 tire inflated to 1.4 bar of pressure can be compared to that of a MICHELIN XeoBib VF 710/60 R38 tire inflated to 0.9 bar, with both carrying a load of 4,500 kg.

A reduction in compaction can be observed in the different soil layers up to a depth of 1 meter.

The thin zebra-like stripes of soil layered in the ditch highlight differences in rut depth and depth of impact. The advantage of using MICHELIN Ultraflex Technology tires is therefore clearly apparent when visually comparing cross-sections of the ditch. They compact the soil less.

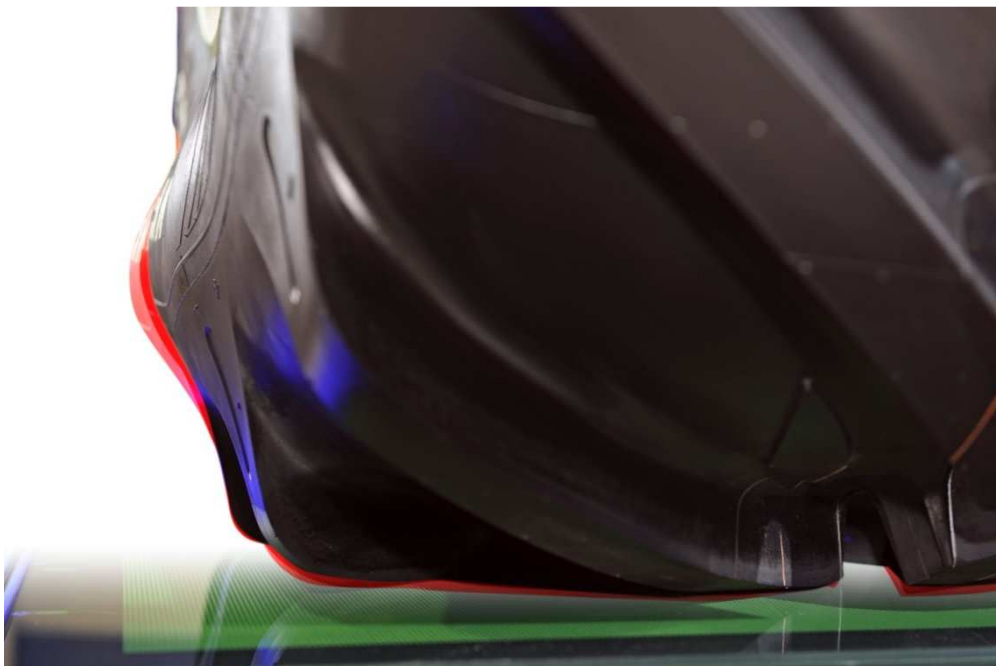
In reducing soil compaction, they protect the integrity of the soil more effectively – by decreasing nitrate leaching and water erosion and maintaining porosity and soil biodiversity – thereby sustainably improving the quality of the crops produced.

Traction, soil protection and productivity: the MICHELIN AxioBib IF 900/65 R46 transfers all its power to the soil

The MICHELIN AxioBib IF 900/65 R46 Ultraflex Technology tire has been specially designed for high-power tractors. For demonstration purposes, it has been fitted to one of the most powerful, latest generation tractors, the +500 hp New Holland T9, hooked up to an 8m-wide Grégoire Besson chisel plow. Compared with a MICHELIN AxioBib IF 900/60 R42, the MICHELIN AxioBib IF 900/65 R46 has a 10% larger footprint (measuring 6,642 sq.cm vs. 6,014 sq.cm) when inflated to a lower pressure (1.1 bar instead of 1.4 bar), carrying an identical load of 7,000 kg per tyre. This means that larger machines can be used to increase productivity and reduce vehicle traffic in the fields to preserve the soil, operating at higher speeds to achieve productivity gains or working in extreme conditions, i.e. on slippery soil or at greater depth.

Technology: the MICHELIN CargoXBib High Flotation tire takes on the technologies of tomorrow

All of the advantages of MICHELIN Ultraflex Technology are now available for trailers and can be enhanced with tire pressure control systems. The MICHELIN CargoXBib High Flotation has the unique ability to adapt to all types of loads and soil surfaces thanks to a specially designed casing allowing it to work within a wide pressure range of 0.8 to 4 bar.



MICHELIN Ultraflex Technology in action: contact patch enlargement and sidewall deflation.



A few key facts and figures on Michelin Ultraflex Technology

2.32: the height in meters of the world's largest tire, the MICHELIN AxioBib IF 900/60 R46.

4: the number of innovation awards won by MICHELIN Ultraflex Technology at international trade shows.

6: the number of tire families in the MICHELIN Ultraflex Technology range, offering comprehensive coverage of crop cycle needs.

9: the number of billions of people that will inhabit the Earth in 2050.

15: the average number of times that a farm vehicle traverses a given field each year.

20: the percent increase in footprint size enabled by the first Ultraflex Technology tire, the MICHELIN XeoBib, versus a standard tire.

20 (to 40): the percentage of total operating time that a tractor spends on the road.

24: the potential return on investment that can be obtained thanks to the yield gains driven by MICHELIN Ultraflex Technology (Harper Adams University study, 2012).

25: the percent increase in useful life offered by an Ultraflex Technology tire versus a standard tire.

45: the minimum surface area, expressed as a percentage of total field surface area, that is traversed by farm machinery in a given year.

2004 (May 26): the date the international patent was filed for MICHELIN Ultraflex Technology.

1,200,000,000: the estimated cost in dollars of the decrease in crop yields caused by excessive soil compaction in the United Kingdom (Harper Adams University study, 2012).

Michelin Milestones

For more than a century, MICHELIN has leveraged its expertise and innovation to enhance the mobility of motorists around the world.

- 1889:** Founding of **Michelin et Cie**.
- 1891:** Michelin files its first patents for removable and repairable tires.
- 1895:** Michelin introduces Éclair, the first car to be fitted with pneumatic tires.
- 1898:** Birth of **Bibendum**, the Michelin Man.
- 1900:** First **Michelin guide** published.
- 1905:** Introduction of the “**semelle Michelin**” tread with hobnails to improve tire grip and durability.
- 1910:** First 1/200,000 scale Michelin **road map** published.
- 1913:** Michelin invents the **removable steel wheel**.
- 1923:** First **low-pressure car tire** (2.5 bar).
- 1926:** Michelin creates its first **Green Guide for tourists**.
- 1930:** Michelin files a patent for the **integrated tube tire**.
- 1938:** Michelin launches **Metalic, the first truck tire with a steel casing**.
- 1946:** Michelin invents the **radial tire**.
- 1952:** Michelin invents the **radial truck tire**.
- 1959:** Michelin introduces the first radial tire for earthmovers.
- 1979:** The Michelin radial tire wins the Formula 1 championship.
- 1981:** The MICHELIN Air X is the first radial aircraft tire.
- 1989:** Michelin launches the first online travel itinerary service, on France’s Minitel teletext network.
- 1992:** Launch of the fuel-efficient MICHELIN ENERGY™ tire.
- 1993:** Michelin invents the new C3M tire manufacturing process.
- 1995:** The US space shuttle lands on MICHELIN tires.
- 1996:** Michelin invents the vertically anchored PAX System tire.
- 1998:** The first Michelin Challenge Bibendum, the leading international clean vehicle event.
- 1998:** The Michelin Man’s 100th birthday.
- 2000:** The Michelin Man elected best logo of all time by an international jury.
- 2001:** Michelin brings to market the world’s largest earthmover tire.
- 2003:** Launch of a range of MICHELIN brand automotive accessories.
- 2004:** New corporate signature introduced: “**Michelin, a better way forward**”.
- 2004:** Launch of the MICHELIN XeoBib, the first agricultural tire that operates at constant low pressure.
- 2005:** Michelin provides tires for the new Airbus A-380 aircraft – Launch of the MICHELIN Power Race, the first dual-compound racing tire approved for road use.
- 2006:** Michelin revolutionizes truck tires with MICHELIN Durable Technologies.
- 2007:** Launch of the new MICHELIN ENERGY™ Saver tire, which reduces fuel consumption by nearly 0.2 liters per 100 kilometers, thereby avoiding the release of nearly 4g/km of CO₂.
- 2009:** 100th edition of the MICHELIN guide France.
- 2010:** Market launch of the MICHELIN Pilot Sport 3 and MICHELIN Pilot Super Sport tires.
- 2012:** Publication of a position paper on fuel savings from truck tires.
- 2013:** Market launch of the new MICHELIN X[®] LINE ENERGY™ long-haul truck tire, which saves nearly 0.74 liters of fuel per 100 km.
- 2014:** Launch of the MICHELIN X[®] Multi T tire.

Michelin facts & figures

Founded:	1889
Production base:	67 production sites in 17 countries
Number of employees:	111,200 worldwide
Research and development:	More than 6,600 people working in R&D in Europe, North America, South America and Asia
2013 R&D budget:	Over €640 million
Annual output:	171 million tires produced, over 13 million maps and guides sold in more than 170 countries, and 1.2 billion itineraries calculated by ViaMichelin
2013 net sales:	€20.2 billion

An extensive portfolio of brands covering all market segments: Michelin, BFGoodrich, Kleber, Uniroyal, Warrior, Kormoran, Riken, Taurus, Tigar, Pneu Laurent, Recamic, Michelin Remix.

More than 3,500 proprietary and franchised outlets in 29 countries: Euromaster in Europe and TCi in the United States; TyrePlus in Asia, the Middle East, Russia, Australia and Mexico; Michelin Commercial Service Network in the United States; and Michelin Truck Service Center in Asia, the Middle East and Algeria.

