

Sustainability in agriculture

How autonomous technologies
are enabling farmers to reach new
heights of sustainability



Autonomous capabilities on today's farms are driving efficiencies, reducing fuel use and carbon / nitrogen emissions, decreasing inputs like chemicals, and enabling farmers to do more with less – ultimately reducing or eliminating costs. Beyond the “green” benefits that serve the planet, fiscal sustainability offers farmers a full slate of efficiencies and productivity for additional fiscal sustainability benefits that enable them to cultivate new levels of profitability.

Where are the sustainability benefits within the agriculture industry?

Autonomous machines are able to move in a more controlled, coordinated and precise way than humans can — particularly when complemented by precise positioning technology. This is demonstrated in the ability to reduce overlap, which reduces the number of passes, gets work done faster and cuts down on time spent in the fields.

This also equates to less crop damage from tires, less fuel, less water and fewer chemicals and fertilizers used, demonstrating the causal benefits of these technologies — one benefit leading to another, and another. Benefits like these are sustainable not only for farmers, but for the planet, by reducing greenhouse gasses and the overall draw on natural resources.

Data puts farmers in more control, taking sustainability to new heights

Precision farming through autonomous technology offers additional sustainability benefits via real-time collection of digital data, with onboard computers that optimize the application of water, fertilizers and pesticides, under- or over-application and utilizing sensors that seek out and spray / irrigate only the crops that need it.

Easy access to reliable data also makes identifying areas for adjustments simple, integrating variables like weather forecasts for optimum yield projections, helping to minimize crop waste as a result of the shortage of labor and dwindling interest in farmwork.

Fertilizer Fact

The application of nitrogen (N) fertilizer in particular results in nitrous oxide (N₂O) emissions, a potent greenhouse gas with a global warming potential 265 to 298 times that of carbon dioxide (CO₂) over a 100-year period.¹





Sustainability drivers within the farming industry

The Environmental Protection Agency reported in late 2022² that sustainable agriculture plays a key role in making sure that we have — and will continue to have — the water, materials, and resources to protect human health and our environment for present and future generations.

But satisfying the increasing global demand for food is only getting more challenging with the reduction in skilled and unskilled labor facing the agricultural industry today — leaving farmers with the challenge of meeting demands while also meeting today's evolving sustainability guidelines.

Worldwide, the percentage of people who work in agriculture has dropped from 44% in 1991 to 26% in 2020³, due to a combination of advancing agricultural technology and declining interest in farm work. Continuing to provide for the growing needs for food amid an increasing shortage of farm labor across the globe, both skilled and unskilled, making autonomous advancements even more critical in order to keep up.

Unavailability of labor doesn't just make it difficult for farmers to find the labor required to maintain crops, it also has a ripple effect in food waste — with nearly 20% of U.S. produce never leaving the farm in 2012 due to lack of farm labor⁵, reports the Natural Resources Defense Council.

Adding to the complications created by lack of labor, the Food and Agriculture Organization's July 2022 State of Food Security and Nutrition in the World report cautions that a reduction in food exports caused by the conflict between Russia and Ukraine could lead to an additional 19 million people being undernourished⁶.

The latest agriculture statistics as they relate to use of chemicals and natural resources alone support a growing need for change in order to empower farmers to meet growing demand while meeting stringent environmental requirements:

2.7M

Pesticide consumption worldwide stood at nearly 2.7M metric tons in 2020⁷, an increase of more than 57% compared to 1990

70%

About 70% of all the **world's freshwater withdrawals** goes toward industrial agriculture⁸

190M

Global nitrogen fertilizer use went from 46.3 million metric tons in 1965 to 190 million in 2019⁹

30%

Industrial agriculture contributes around 30%¹⁰ of **total greenhouse gas emissions**, mainly due to use of chemical fertilizer, pesticides and animal waste

Labor Fact

The average age of principal operators on farms is 59.4. As they reach retirement age, there are fewer young farmers coming in to fill their shoes. Farmers under 35 account for only 9% of the total population.⁴

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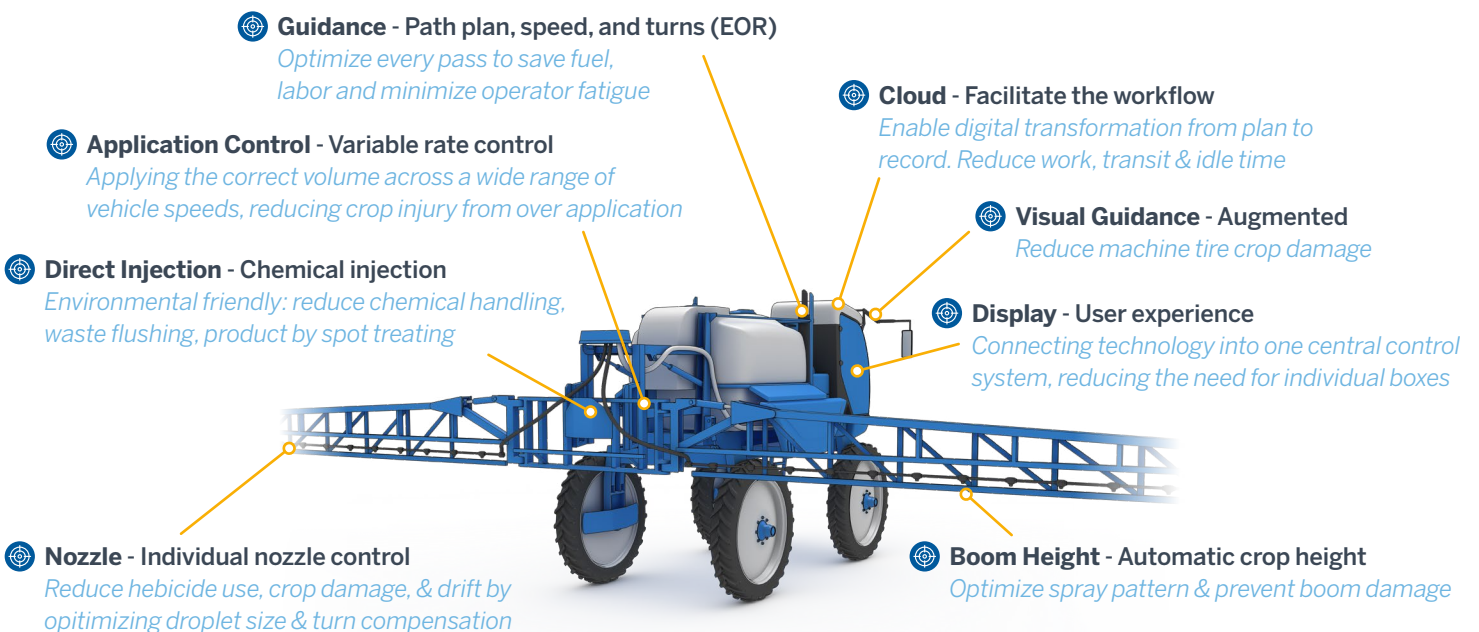
One industry-leading study on the sustainability of autonomous technologies by the Association of Equipment Manufacturers in 2022¹¹ has turned heads for analyzing the benefits of automatic steering, machine control, variable rate technology, machine and fleet analytics and precision irrigation. Their study, *The Environmental Benefits of Precision Agriculture*, found that farmers consistently using autonomous technologies were able to reduce various inputs equating to:

- 30 million fewer pounds of herbicide
- 100 million fewer gallons of fossil fuel
- Enough water saved to fill 750,000 Olympic-size swimming pools

Furthermore, sustainability through ensuring the health and safety of today's farmers must enter into the equation as well, as numerous studies have shown farmers are at higher risk of developing forms of cancer due to exposure to pesticides¹². This links us back to the importance of leveraging technologies like AI to reduce the use of pesticides and herbicides.

How Trimble is growing sustainability for agriculture

With sustainability being one of the primary motivators for creating solutions, Trimble introduced an autonomous sprayer developed with HORSCH in 2021. This solution offers the potential for avoiding a total CO₂ equivalent emissions of 27.4 million MT, the equivalent of 6 million passenger vehicles being taken off the road permanently, as shown in the graphic below:



7%



7% increase in fertilizer placement efficiency
(with 14% more possible through broader adoption)

9%



9% reduction in herbicide and pesticide use (with another 15% gain through full adoption)

4%



4% reduction in water use (with 21% more saved with full adoption of technologies like variable rate precision irrigation and soil moisture sensors)

6%



6% reduction in fossil fuel use (with another 16% drop through broader adoption of auto guidance and machine telematics)

Continued...

While autonomous technologies like path planning, speed control and auto steering offer multiple levels of fiscal and environmental sustainability, precision weeding technologies like Trimble's WeedSeeker® 2 are going a step further, enabling the pinpoint application of chemicals onto weeds only, reducing the amount of chemical applied by up to 90%.¹³

By reducing input costs, herbicide cost and use, run time and maintenance, this system enables a more sustainable — and profitable — operation. Spot spraying also means fewer chemicals leach into the soil, surrounding water systems, and into our food supply — in addition to reduced chemical exposure to humans.

Trimble's internal lab studies demonstrate an average savings of fertilizer using sectional control of 9.15%, compiling results from Africa, Australia/New Zealand, Asia, Eastern Europe, Europe, North America and South America.

Trimble's commitment to ongoing sustainability in farming is being embraced company wide as part of its ambitious climate goals of the Paris Agreement and a net-zero future. Read about that [here](#).

The future of sustainability is now

With fertilizer usage skyrocketing in recent years, all eyes are on the industry to embrace application techniques that reduce CO₂ emissions. Application based on subfield spatial variability and biological demand can reduce application by 36% for a 23% emissions reduction, reports PNAS¹⁴.

In the future, look to larger machines to call others out into a field or onto a worksite as needed as autonomous integration advances, taking productivity to even greater heights. And when the cab eventually goes away on many machines, they will be smaller, with a reduced carbon footprint — made even more green by not requiring air-conditioned cabs.¹⁵

“It's not just the environmental or “green” benefits, but also the fiscal sustainability they provide to industry players that make autonomy profitable.”

— Dietmar Grimm,
Trimble VP of corporate strategy
and sustainability solutions



Footnotes

1. Government of Canada, 2021.

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2. Environmental Protection Agency.

<https://www.epa.gov/agriculture/agriculture-and-sustainability>

3. BBC, 2021.

<https://www.bbc.com/future/feature/bespoke/follow-the-food/the-reason-we-are-running-out-of-farmers/#:~:text=Worldwide%2C%20the%20percentage%20of%20people,to%20work%20on%20farms%20anymore>

4. AgAmerica, 2022.

<https://agamerica.com/blog/the-impact-of-the-farm-labor-shortage>

5. Natural Resources Defense Council, 2012.

<https://www.nrdc.org/sites/default/files/wasted-food-IP.pdf>

6. FAO, 2022.

<https://www.fao.org/documents/card/fr/c/cc0639en>

7. Statista, 2023.

<https://www.statista.com/statistics/1263077/global-pesticide-agricultural-use>

8. Food and Agriculture Organization of the United Nations, 2017.

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<https://www.statista.com/statistics/438967/fertilizer-consumption-globally-by-nutrient/#:~:text=In%201965%2C%20the%20consumption%20of,to%20over%20190%20million%20tons>

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<https://www.iaea.org/topics/greenhouse-gas-reduction#:~:text=Agriculture%20is%20both%20a%20victim,fertilizers%2C%20pesticides%20and%20animal%20wastes>

11. The Association for Equipment Manufacturers, 2022.

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13. Global Agricultural Productivity Report, 2020.

<https://globalagriculturalproductivity.org/artificial-intelligence-is-in-a-path-to-reduce-herbicide-use-by-90>

14. PNAS, 2021.

<https://www.pnas.org/doi/10.1073/pnas.2022666118>

15. Trimble (sustainability blog), 2022.

<https://autonomy.trimble.com/en/resources/blog/how-autonomy-amplifies-the-boundless-benefits-of-sustainability-a-q-a-with-dietmar-grimm-2>

