

Let's talk about

Climate-friendly agriculture

What exactly is it and
how can it work?

Agriculture is not only affected by climate change, but also contributes to it. That's why we need innovative solutions to pave the way toward a climate-friendly agriculture of the future. Many aspects and expectations play a role here – which are partly conflicting, but are interconnected –, such as ensuring security of food supply and economic viability without further expansion of arable land. Is there a way to protect the climate while safeguarding food stability for a growing population?

 **BASF**

We create chemistry

Let's talk about Climate and agriculture

What climate-friendly agriculture means and why we urgently need it

Agriculture is impacted by the climate

– but also vice versa. Ruminants produce methane, nitrogenous fertilizers release nitrous oxide, plowing brings up soil-bound carbon which in the air turns into climate-damaging carbon dioxide (CO₂). Agriculture today causes around 100 million tons of CO₂ equivalents every year to be released into the atmosphere. Carbon dioxide, methane and nitrous oxide each account for roughly one third. At the same time, experts calculate that 70 % more crop yield will be needed to feed the world's population by 2050.

But if we are to have more food at lower costs for the environment, agriculture needs to change.

And it is changing. Three dimensions play a role in the search for the right balance: Future agriculture must be socially responsible, ecologically balanced and economically viable. There are several approaches to reducing greenhouse gas emissions. These include innovative additives which prevent nitrous oxide from fertilizers from escaping into the air, technologies that ensure pinpoint, sparing application of fertilizers and pesticides, as well as breeding for new

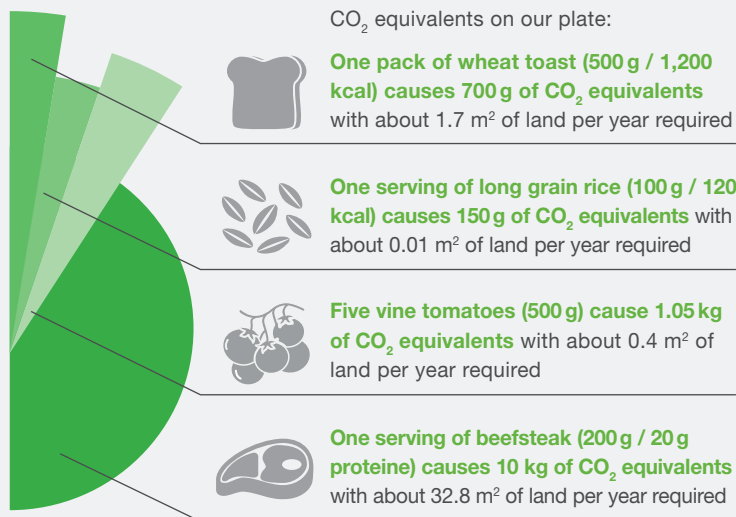
plants that are considerably more stress tolerant to adverse environmental conditions such as drought, or more resilient to plant diseases.

Seeds adapted to local environmental/climatic conditions, and pesticides – only applied when necessary – lead to an increased yield without automatically producing more CO₂.

Feeding the world's population while preserving natural resources is a challenging conflict of objectives that can only be solved by pursuing various approaches. Agriculture has to fit in with local conditions and challenges and be supported by the population.

How much our food costs the environment

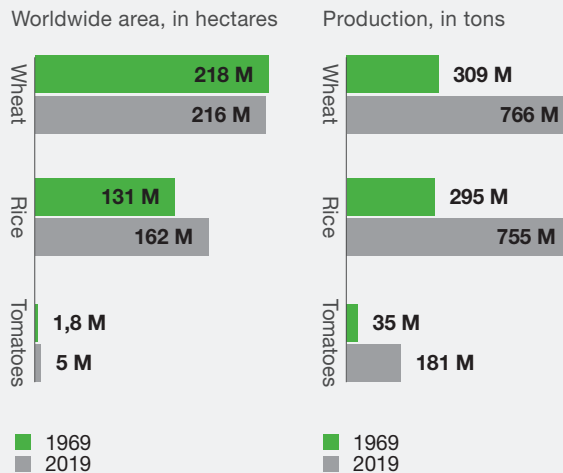
An estimated 23% of human-induced greenhouse gas emissions are caused by agriculture, forestry and other forms of land use.



Source: J. Poore & T. Nemecek (2018)

How to limit the impact on the climate:

More efficient agriculture requires less acreage



Source: FAO

Stabilized fertilizers, less greenhouse gases:

Vibelsol® and Vizura® are nitrification inhibitors from BASF. If the fertilizer applied is enriched with them, they bring significant climate benefits: They bind ammonium gas in the soil for longer.

47% **50%** **30%**

of nitrate leaching can thus be prevented.

of nitrous oxide emissions are avoided.

of greenhouse gas emissions per ton of crop are cut.

Source: BASF

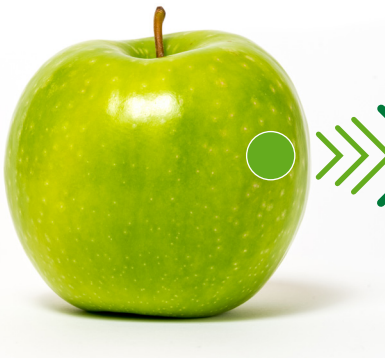
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Precise and digital for the climate

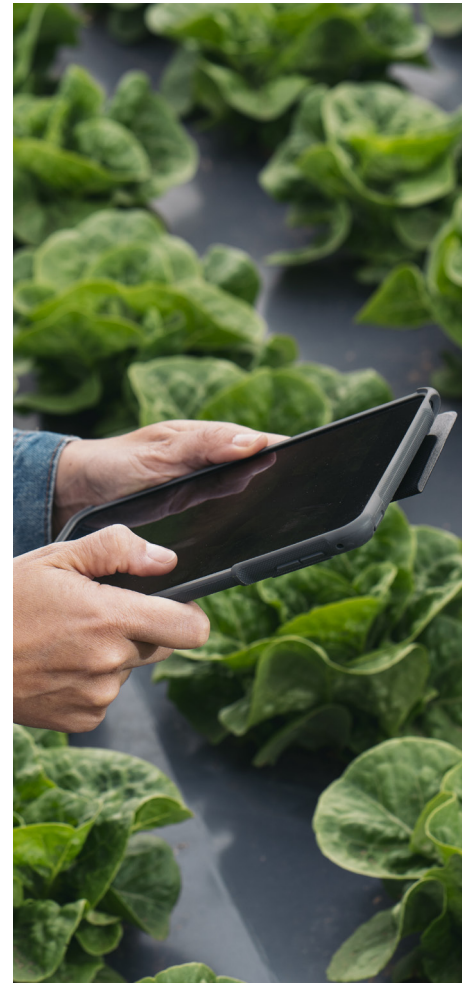
The application of modern information technology has become part and parcel of agricultural life. With data analyses, real-time monitoring and damage prediction, for example, digital applications help farmers refine and optimize the use of plant protection products. Farm machinery equipped with intelligent technology can distinguish between crop plants and weeds, identify plant diseases and apply pesticides with

pinpoint precision. More precision also means having to go out in the field less often and bringing in better yields on smaller acreage. With this data-supported, precise mode of production, the different operating resources can work together significantly better. This allows for more climate-friendly farming which reduces costs, preserves the environment and takes even better care of every single crop plant.

If this were the earth ...
(51 billion ha surface area)



... then this would be the area available for farming worldwide.
(1.5 billion hectares / approx. 3%)



How soils also shape the climate

Soils and climate change are inseparably linked. Did you know that soils store more carbon than all forests combined? This has a huge influence on global warming. The storage capacity of soils around the globe is around five times higher than that of the above-ground biomass. They are the second-largest reservoir of greenhouse gases on earth, the oceans being number one. Approximately 3,000 billion tons of carbon are stored in soils worldwide. Since there is already so much carbon in the ground, it is important that we work on keeping it there. If we do not take care of our soils in a sustainable way, we contribute directly to combining this stored carbon with oxygen and releasing CO₂. But how does the carbon actually get into the ground in the first place? During photo-

synthesis, plants absorb carbon dioxide from the air – both above ground and underground with their roots. The plants' roots are composed of carbon and if we can keep roots in the soil we help to reduce carbon dioxide in the atmosphere. And the deeper and more robust the roots, the more carbon can be stored by the plants in the long term. Over time the plants' roots decompose and turn into a food source for a multitude of microorganisms living underground. If these organisms proliferate, they too contribute to storing carbon in the soil. This is why scientists are beginning to examine the potential of optimizing root systems – not only to achieve higher crop yields, but also for increased carbon storage. But it is very difficult to assess how much

carbon is stored in the ground and how much of it is released as carbon dioxide. Researchers found out through long-term surveys that areas covered by forests and grassland usually are carbon sinks, which means they store more carbon than other soils – the ground is always covered and undisturbed. As a result, less oxygen enters the soil and combines with the carbon bound there. By contrast, agricultural areas such as arable soils, for example, generally are neutral or even are sources for the release of CO₂ and other climate-damaging greenhouse gases – particularly if the soil is plowed or left to lie fallow over longer periods of time. Soil-conserving cultivation of agricultural areas therefore is an important measure and an opportunity in the fight against global warming.

Viewpoint BASF

Limited farmland, but food for all?

The world's population is rapidly growing – and so is the demand for food. In the coming 50 years farmers will have to produce more food than in the past 10,000 years combined. And that despite shrinking areas per capita. This makes it all the more important to increase crop yields without harming nature and the climate.



The aim? More food from the same acreage with high environmental protection

Again and again, there is a conflict of interests between the population's food demand, farmers' economic interests and preservation and protection of our environment. One approach to resolve this is an overall more climate-friendly agriculture that protects and preserves natural resources like soils and water while also significantly reducing climate-damaging greenhouse gas emissions.

Our approach as BASF

Expansion of agricultural areas is avoidable if we manage to increase the crop yield on the existing acreage. To this end, we offer a number of technologies:

1. **Modern seed varieties**, that are more resilient and stress-resistant to negative environmental and weather influences.

2. **Innovative plant protection** with environmentally friendly active profiles.

3. **Data-supported technologies** able to apply crop protection agents with high precision in order to protect health and environment.

In addition, our products and services contribute to the reduction of greenhouse gas emissions by enabling "no-till farming" (direct sowing without any soil treatment). As a result, carbon stays bound in the soil instead of turning into CO₂ in the atmosphere.

In order to increase crop yields without further heating up the climate, the different operating resources have to be optimally harmonized and employed in a precise and responsible way.

What everyone can contribute to climate protection

- Make sure that your meat consumption doesn't exceed healthy amounts: Meat production goes hand in hand with high use of resources like acreage, water and nutrients. The manure produced results in the climate-damaging release of methane, among others.
- When shopping, don't just look out for the lowest price.
- Choose foods that have been grown in a climate-friendly way.
- Whenever possible, buy seasonal food from your region.
- Value your food and do not waste it.

Viewpoint BASF

What BASF specifically does in different phases

SOIL PREPARATION

The seed is directly placed on the fields without plowing which is harmful for the soil – in combination with herbicides because weeds, which would otherwise rob the seedlings of nutrients, haven't been plowed in.



FERTILIZING

Nitrogen is indispensable as a fertilizer. But if it decomposes in the soil, climate-damaging nitrogen compounds such as nitrous oxide are released. Our nitrification inhibitors, like Vizura® and Vibelsol® for example, reduce such greenhouse gas emissions per ton of harvest yield by up to 30%.



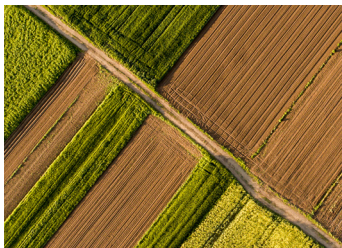
SEEDS

By the middle of this decade, BASF aims to bring to market a new wheat variety – hybrid wheat – with significantly higher crop yield on the same acreage.



RESOURCES

Digital technologies enable resource-friendly use of water, fertilizers, plant protectants and farming machinery. This also benefits the climate. For example, Bosch and BASF have developed a spraying system (Smart Spraying) which can clearly distinguish crop plants from weeds and thus can specifically treat the weeds with herbicides.



FUNGICIDES

The new active ingredient Revysol® can noticeably reduce disease-related yield loss on the field by effectively controlling many of the common fungal diseases in important crops like wheat.



BASF's targets to boost climate friendliness:

By 2030:

- Reduce CO₂ emissions per ton of crop by 30 %.
- Bring digital technologies to more than 400 million hectares of farmland.
- Annually increase sales share of solutions with substantial sustainability contribution by 7 %.
- Ensure safe use of BASF's products with right stewardship.

At a glance

Climate-friendly agriculture preserves natural resources like soils and water and significantly reduces climate-harming greenhouse gas emissions. This is crucial for greater sustainability. Also it is important that agriculturists farming this way have a financial livelihood.

Further Information

www.agriculture.basf.com/global/en/sustainable-agriculture.html

www.fao.com

ipcc.ch

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