Factbook World Nutrition

Facts, trends and potential solutions to feed the world's population

K+S

Handelsblatt
RESEARCH INSTITUTE

While
821 million
are suffering from **hunger**,
a third
of food goes to waste.

/see page 8/9

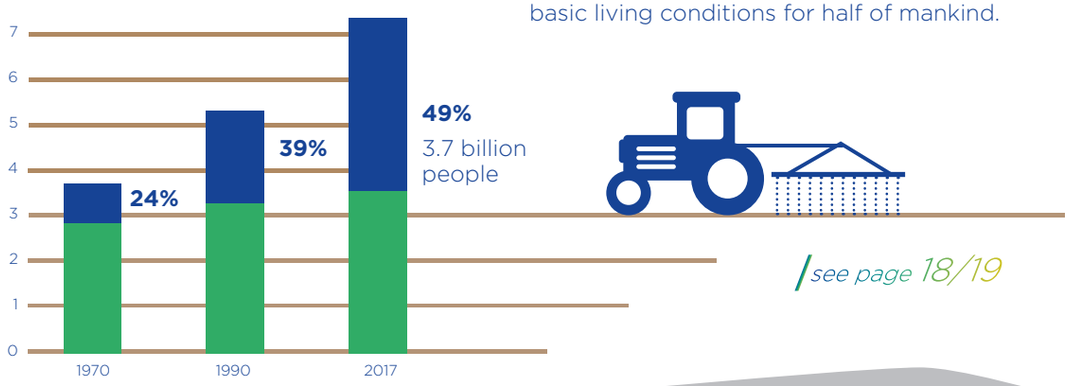
The effects of **climate change** on harvests in sub-Saharan Africa by the middle of the century will be immense.

-22 %	Maize
-18 %	Peanut
-17 %	Sorghum
-17 %	Millet
-8 %	Manioc

Climate-related changes in yield relative to 1961/2000, in percent

/see page 12/13

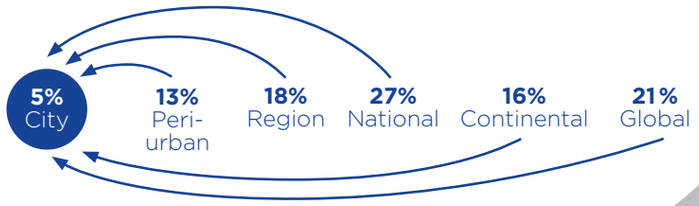
Mineral fertilizers already help to provide basic living conditions for half of mankind.



/see page 18/19

Today more than half of mankind lives in **urban areas**. But cities are dependent on **food production** from all regions, as only a fifth of the food required there is produced locally.

/see page 12/13



Smallholder farmers in Asia and Southern Africa produce up to
80 percent
of their region's food on land the size of a football pitch.

/see page 24/25

Digitalization is causing further change in agriculture. By 2050, farms will deliver up to 4.1 million data points – evaluation and application should increase crop yields and save resources.

/see page 20/21

2050
4.1 million

2014
190 000

Sources: FAO, IVA, Schlenker et al., 2010, BI Intelligence

Dear Readers,

The right to enough food is a human right. Much has changed for the better, but the objective has not been reached by a long way. 821 million people still suffer from hunger. Meanwhile, the global population continues to grow – and with it the need for food. And then there is climate change and the increasing competition for land to be used for agriculture - the problem of scarce resources exacerbating the situation.

In this factbook we have briefly compiled substantial facts, trends and potential solutions to feed the world's population. As a supplier of mineral plant nutrients we focus on the needs of our customers and help farmers to secure world nutrition. Because there is a real chance to provide every human being on the planet with enough food of sufficient quality. However, a huge amount of effort is required to achieve this goal.

For decades now, in rural areas of emerging and developing countries, in particular, there has been practically no investment to speak of. That is why there is too little know-how and technical prerequisites, infrastructure and rural services are inadequate. There is hardly any balanced provision of nutrients; soil and water, the most important production prerequisites, are not used competently. Possible consequences: soils erode and their yield potential is lost.

And yet – here is the opportunity – rural areas offer big development potential. This is shown by the progress made in recent years, particularly in Latin America, the Caribbean and Southeast Asia. But also in places where this is not yet the case there is still a great deal of potential. However, it has to be used more efficiently, if the problems of rural areas are to be solved.

Facts have been compiled here with a view to showing how to approach this and how it can work. In all our interests we should continue to work together to achieve the global objective of creating food security and to focus on the potential of agricultural production in the future.

Dr. Burkhard Lohr

Chairman of the Board
K+S Aktiengesellschaft

We face a big challenge.

Many young people in our country still know very little about agriculture. Not even this year's exceptionally dry summer in Germany will have made it clear just how vulnerable our nutritional basis is.

That is different in many developing countries, where people struggle almost on a daily basis to secure adequate supplies of grain and vegetables – meat and milk products are still frequently seen as a luxury in rural areas. And at first glance, future prospects are not exactly a source of hope. On a global scale, politicians are faced with a double challenge: the global population continues to grow – according to United Nations' estimates, to a total of about 10 billion people in the next 30 years. To exacerbate the situation still further, this population growth will be almost exclusively in Africa. At the same time, natural production conditions for food are deteriorating in many parts of the world. For example, for some time now karstification, salinization and urbanization are resulting in the loss of 10 million hectares of agricultural land every year. And Africa is disproportionately affected by these losses. In the last 50 years alone, fertile areas the size of France (650,000 square kilometres) have been transformed into barren steppes and deserts. In view of these menacing findings, the company K+S Aktiengesellschaft in cooperation with the Handelsblatt Research Institute, has compiled the most important facts and arguments about "World Nutrition" on a scientific basis. The central question is how adequate supplies of food can be secured in future for growing populations in emerging and developing countries, while areas of agricultural land continue to shrink.

A factbook is an appropriate presentation format for this purpose, because the explanation of complex content using graphics provides a broad readership with easy access to the subject matter. Of course, we realize that information graphics and plausible statistics alone cannot cover the whole issue of world nutrition exhaustively. But we are confident this provides a serious basis for a fruitful discussion about practical solutions.

Prof. Dr. Dr. h.c. Bert Rürup

President of the Handelsblatt Research Institute
and Chief Economist of Handelsblatt

A look into the future

Sustained population growth worldwide can be expected in the coming decades, especially in urban regions of Africa and Asia. However, not just increasing population numbers, also changing dietary habits are influencing the demand for agricultural products. Moreover, as a consequence of political or economic crises and weather extremes, certain regions cannot be provided with adequate food supplies. Secure food means that all inhabitants of a country have access to healthy nutrition in all places at all times.

million

people in the world suffering from hunger.

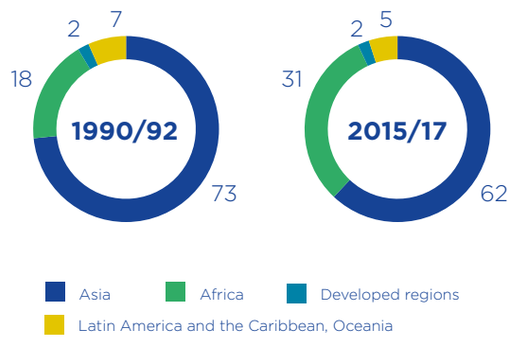
Eleven percent of the world's population suffers from chronic **undernourishment**. Focal points are mainly in sub-Saharan Africa and South Asia.

In addition, around 2 billion people lack **nutrients like iron, iodine, zinc or vitamin A**.

Reasons for these shortages and hunger include armed conflicts and wars, natural catastrophes, poverty, low agricultural productivity and lack of infrastructure.

Hunger in the world

Existence of hunger by regions, in percent



The number of people suffering from hunger declined by more than 200 million in the last 25 years – although numbers varied strongly by region. Whereas they declined sharply in **East and South-East Asia** in particular, numbers increased by more than 50 million in sub-Saharan Africa.

Source: FAO, 2018

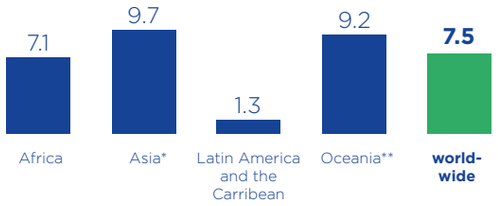
Malnutrition

51 million

children under five years are underweight due to malnutrition.

151 million

children under five years are too small for their age due to chronic undernourishment.



Percentage of children under five years underweight due to malnourishment

* excluding Japan, ** excluding Australia and New Zealand

Sources: UNICEF, WHO, World Bank, 2018

Lack of nutrients

Low hemoglobin concentration (anemia)

43 % of children 5 years of age

Lack of iodine

2 billion people

Vitamin A deficiency

1 in 3 pre-school aged children

Zinc deficiency

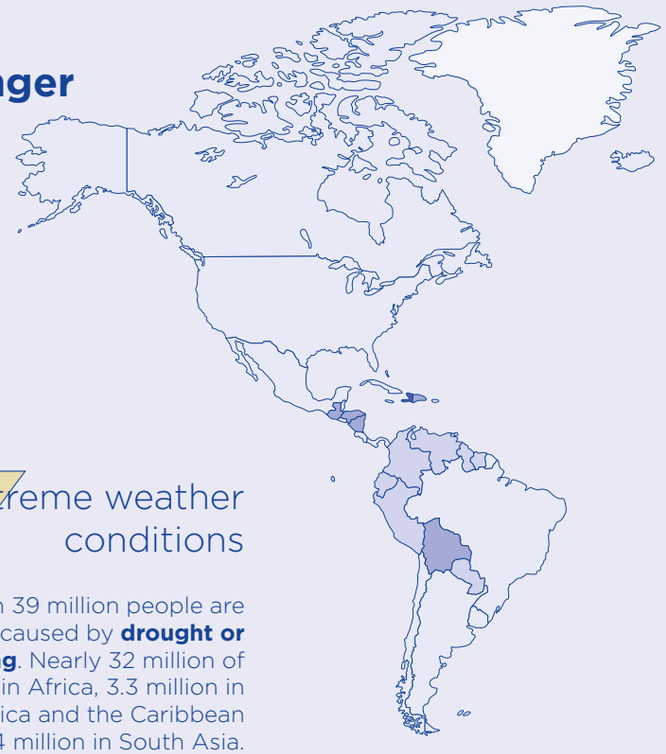
1 in 5 of the global population

Around 2 billion people worldwide and at least half of all children under five years suffer from one or more **micronutrient deficiencies**.

Source: US Centers for Disease Control and Prevention, 2018, worldwide data

Conflicts and weather extremes also cause hunger

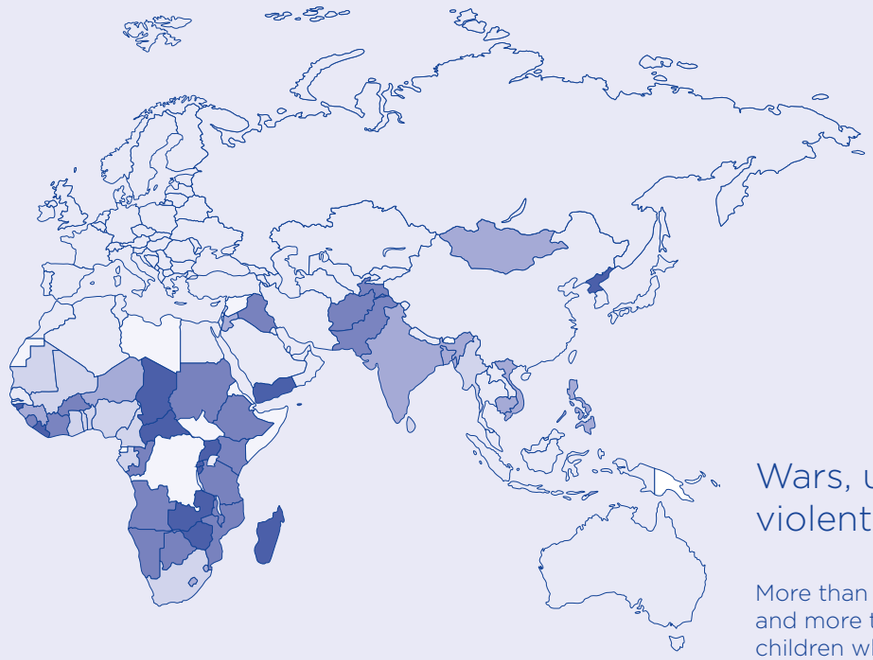
Percentage of the population affected by hunger, 2015/2017



Sources: World Bank, FAO

Extreme weather conditions

A total of more than 39 million people are affected by hunger caused by **drought or flooding**. Nearly 32 million of these people live in Africa, 3.3 million in Latin America and the Caribbean and 4.4 million in South Asia.



Wars, unrest and violent conflicts

More than half of all starving people and more than 80 percent of children who are underdeveloped due to malnutrition, live in countries affected by **wars, conflicts and violence** – most of them in Africa.

2 1

billion

more humans are expected to be living on the planet by 2050.

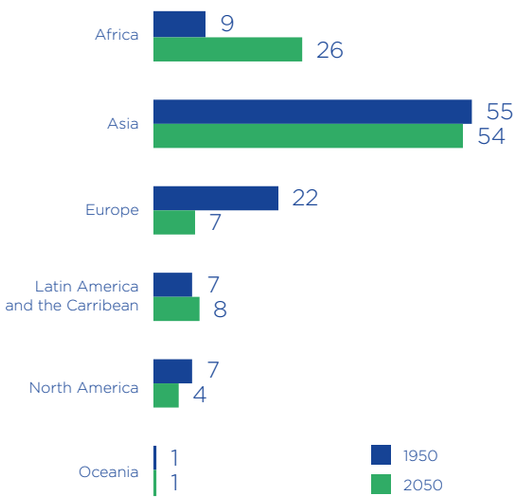
The world is filling up. **Global population growth is slowing down**.

In Africa and Asia above all, population figures are increasing, and **by 2050 India will be the most heavily populated country in the world**.

And the rapidly **growing middle classes in Asia**'s emerging countries are more demanding about their nutrition. This will further increase the demand for animal proteins worldwide.

Population growth in Africa

Share of world population by regions, in percent



The biggest population growth is in Africa – it will have doubled by 2050. However, even then every **second person will live in Asia**.

Source: UN Desa, 2017

The global population is growing ...

...every year by about the population of Germany - or to put it another way: by about 150 humans per minute.

2.5 billion

1950

6.1 billion

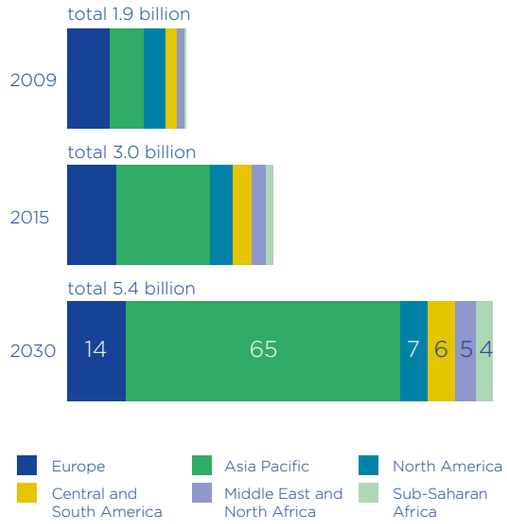
2000

9.8 billion

2050

Middle classes emerging in Asia, in particular

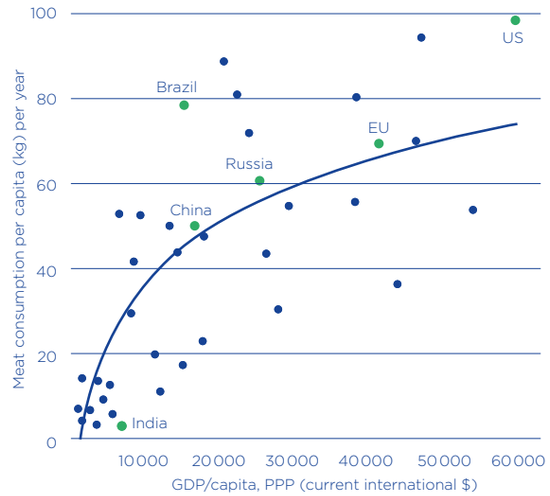
Global middle-class, in billions and as a share of regions in percent



Source: Brookings, 2017

Growing affluence changes the menu

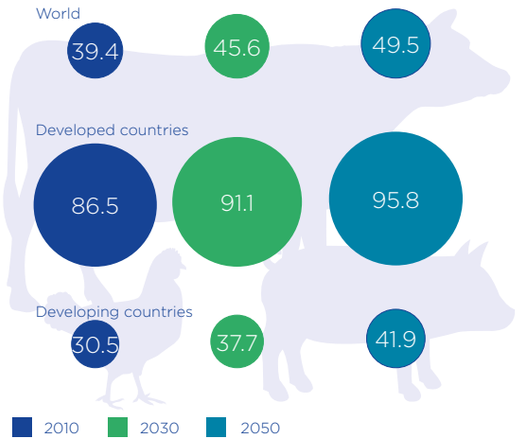
Meat consumption and gross national product by countries, 2016



Sources: OECD, World Bank

The taste for meat

Annual meat consumption, in kg per capita



Source: IFPRI, 2018

Grain – nutrition for humans and animals

Utilization of world cereal production, in percent

43 %
Food

35 %
Animal fodder

22 %
Biofuels (15 %) and other uses

Source: FAO, 2017

68 percent

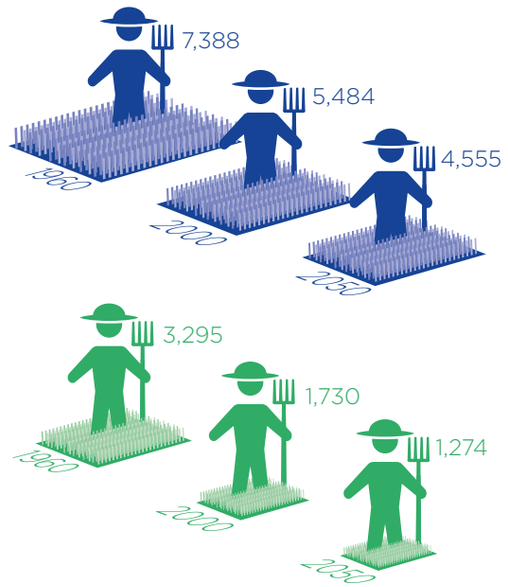
of the global population will be city dwellers by 2050.

In 1950 two-thirds of humans lived in the countryside - 100 years later, two-thirds will live in cities.

In order to grow, cities require **quality arable land**. In addition to an increase in **urbanization**, desertification and salinization of soils in the coming years will lead to a continuous reduction in the globally **available agricultural area** per capita.

Agricultural area per capita sinking

In square metres per person

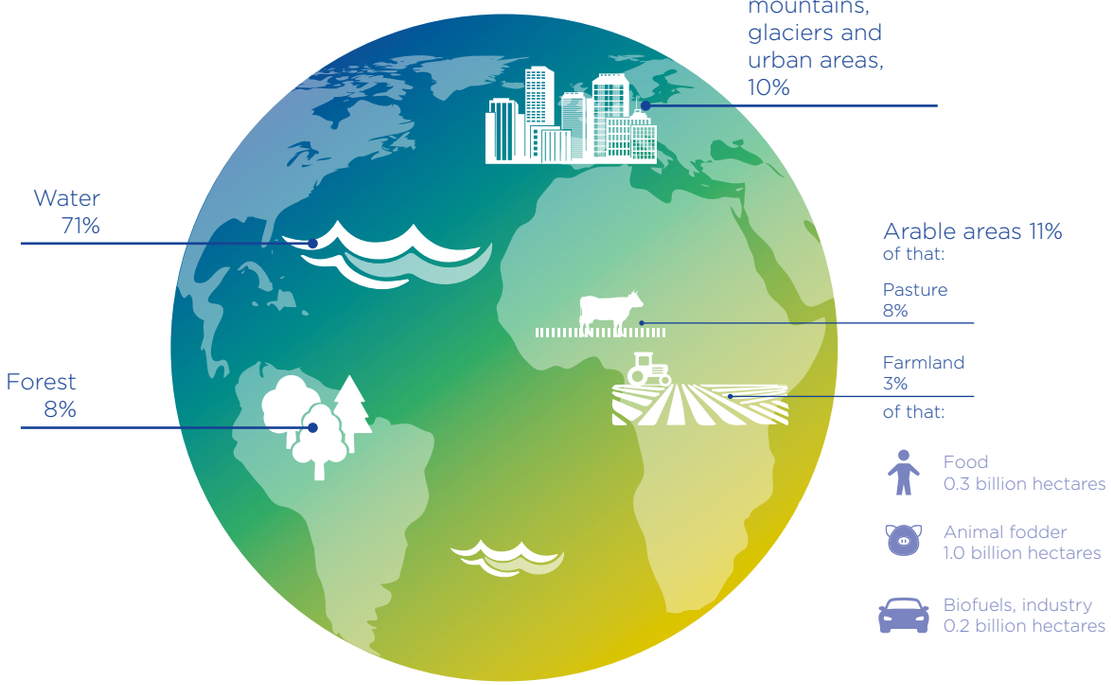


Developed countries Developing countries

Sources: UN, FAO, 2017

Little room for food

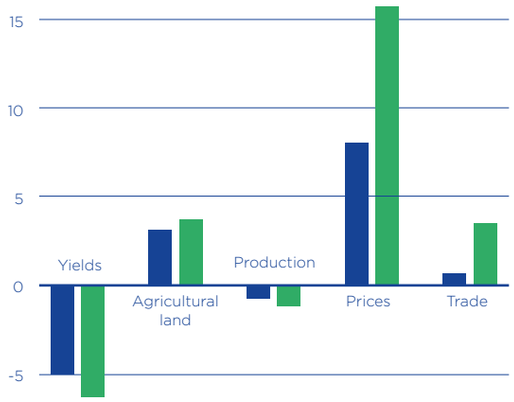
Distribution of the total surface area of the world



Sources: FAO, Nova-Institut, 2017

Agriculture and climate change

Average changes by 2050, in percent



Scenario SSP 1-RCP 4.5

Small increase in global agricultural production and average warming by 2100 of 2.6 degrees C compared with pre-industrial figure.

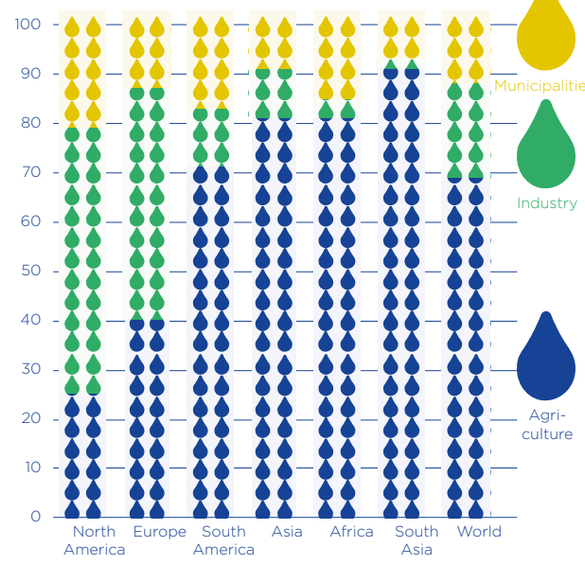
Scenario SSP 3-RCP 8.5

Higher increase of global agricultural production and average warming by the year 2100 of about 4.8 degrees C compared with the pre-industrial figure.

Source: FAO, 2016

Thirsty agriculture

Water consumption, share in percent

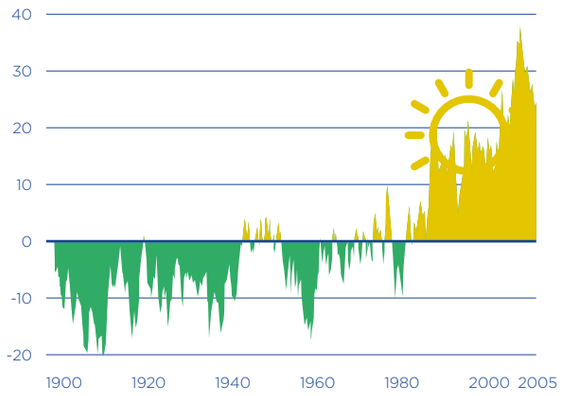


Source: FAO, 2016

Periods of drought increasing worldwide

Development of the Palmer Drought Severity Index

The dryness indicator measures the frequency of droughts and extreme levels of rainfall using 0 as the normal situation.

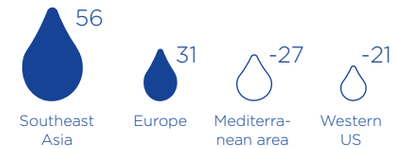


Source: Palmer Drought Severity Index, 2018

Heavy rain and other **extreme weather** are becoming more frequent. This can lead to floods and decreasing water quality, but also decreasing availability of **water resources** in some regions.

Extreme rainfall

Increase and decrease of record-breaking rainfall, by regions, in percent



Sources: European Commission , PIK Potsdam, 2015

Intelligent solutions

New concepts for growing food needed. Particularly in emerging and developing countries there are discrepancies between actual harvests and possible yields. And it is there, in particular, that agricultural infrastructure and training have to be improved to avoid food crises. Intelligent solutions for nutrient and water management and the sustainable, state-of-the-art use of agricultural technology, seeds, fertilizers and pesticides are needed for a future-oriented approach to nutrition.

50

percent

more agricultural production than in 2013 will have to be generated by the middle of the century, according to an estimate by the FAO.

Farmers today produce much **more stable and higher yields** than in the past. However, the average global yield of wheat per hectare, for example, is only about half as high as in Western Europe. If agricultural areas were used **more efficiently** in emerging and developing countries, yields could be increased significantly.

Efficient farmers

Number of people fed annually by one farmer

Germany

1950 10

2016 148

US

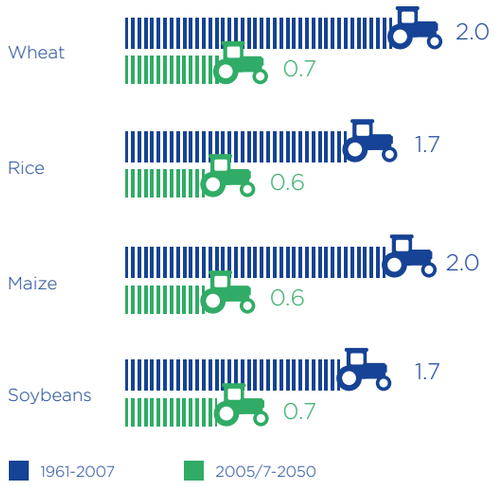
1950 46

2016 168

Sources: American Farmers Bureau, Bauernverband, BZL

Yields increasing more slowly

Average annual growth of yields, in percent

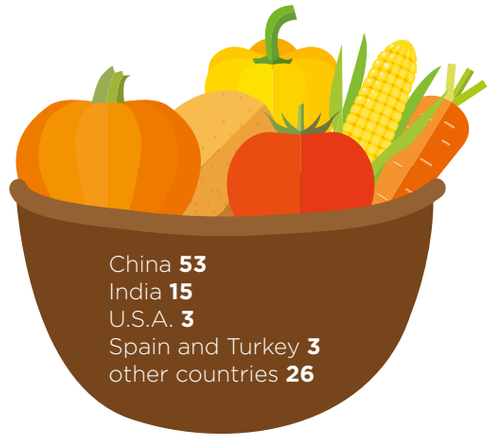


In order to cover **demand up to 2050**, yields will have to **increase by a good one percent every year.**

Source: FAO, 2012

China grows the most vegetables

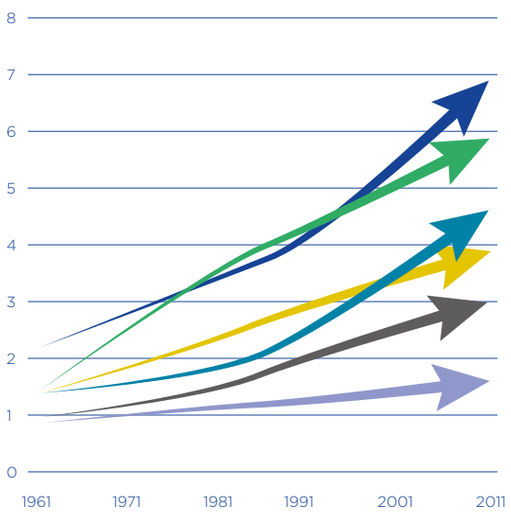
Share of vegetable production 2017 in percent



Source: FAO

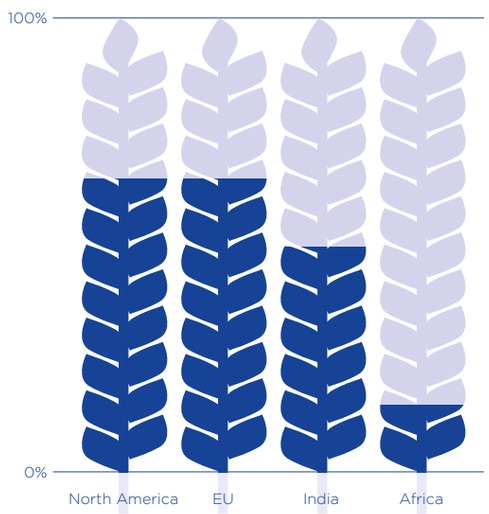
African yields are below average

Average cereal yields, in metric tons per hectare



North America **East Asia** **South America**
South Asia **Africa** **global average**

Share of potential yield achieved by actual yields 2015

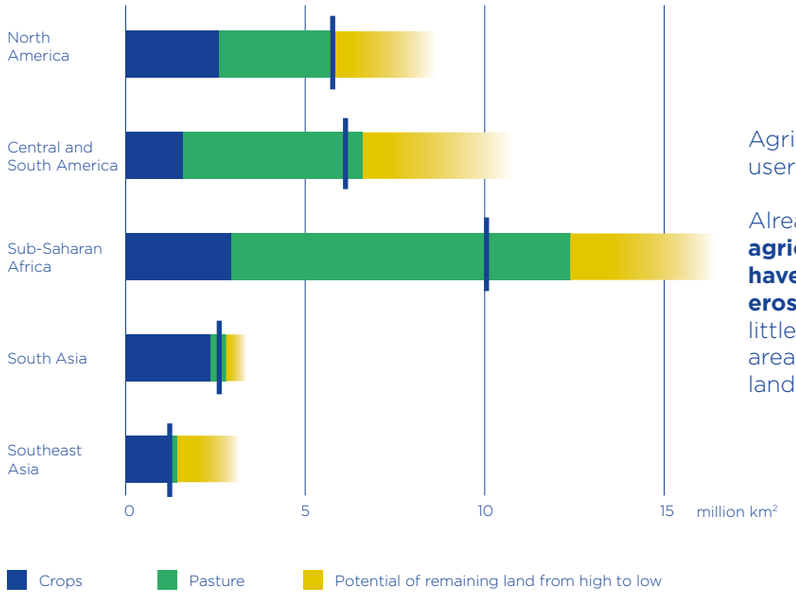


Source: FAO, 2017

Source: FAOSTAT

Sustainable land management needed

Land used in 2010 (line), 2050 and the potential of remaining suitable land for agriculture



Agriculture is the biggest user of land on the planet.

Already **24 percent of agriculturally used areas have been damaged by erosion**. But as there is very little scope to develop new areas, sustainable use of land and soil is essential.

Source: UNCCD, 2017

1843

Justus von Liebig made a discovery: “It must be accepted as a principle of agriculture that the soil be given back everything which is extracted from it.”

No nutrients, no crop growth. And yet only a small minority of soils worldwide are well supplied by nature with **nutrients easily available to crops**.

The way **arable crops** are grown today, many of these nutrients are removed from the soil and have to be returned in the form of organic or mineral fertilizers in the interests of good, long-term harvest yields.

It’s all about location

Influence of zinc fertilizer (1,140 g/ha zinc) on corn maize yield

Without fertilizer
4.7
corn yield (t/ha)

With zinc fertilizer
7.7
corn yield (t/ha)

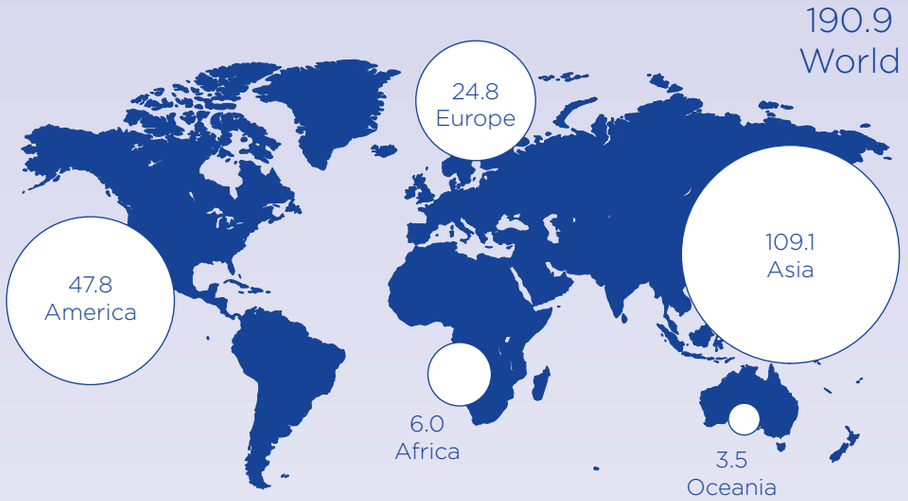
The example of zinc shows clearly how – depending on the location of the crop – zinc is **the limiting factor**.

An increase in yield of 3t/ha is possible using zinc fertilizer providing there are **optimal levels of all other nutrients**.

Source: McArthur, et al., 2017

High potential for fertilizer in Africa

Collective demand for nitrogen, phosphate and potash fertilizer, 2017 in millions of tons

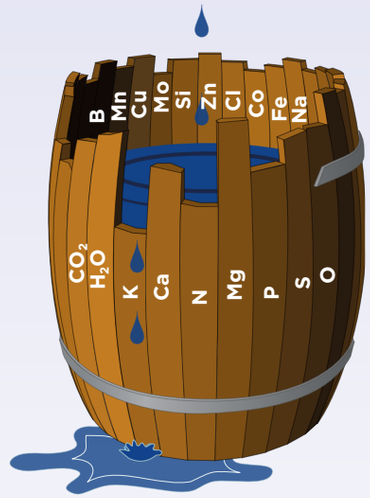


The average **usage of fertilizer** in Africa is 12 kg per hectare and south of the Sahara 8 kg, while in Asia it is anything up to 150 kg per hectare.

Source: FAOSTAT

Liebig’s barrel

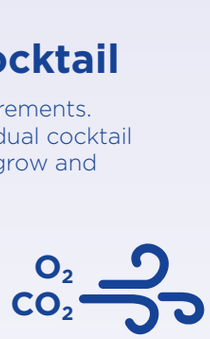
The German chemist and agronomist **Justus von Liebig** concluded at the end of the 19th century that **crop growth was restricted by the nutrient or growth factor which was least available**. The lack of a particular micronutrient cannot be compensated for by using additional supplies of other crop nutrients.



Explanation of Liebig’s Law of Minimum: Water level = size of harvest

Nutrient cocktail

Crops have differing requirements. Each crop needs its individual cocktail of nutrients to be able to grow and thrive optimally.



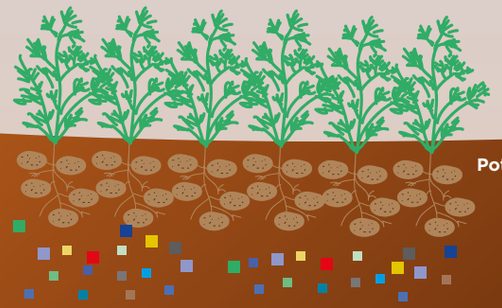
The right amount of all nutrients has to be available at all times:

Macronutrients

- N – Nitrogen
- S – Sulphur
- P – Phosphorous
- Mg – Magnesium
- K – Potassium
- Ca – Calcium

Micronutrients

- Fe – Iron
- B – Boron
- Mn – Manganese
- Zn – Zinc
- Mo – Molybdenum
- Si – Silicon
- Cu – Copper
- Co – Cobalt
- Cl – Chlorine



420

tons

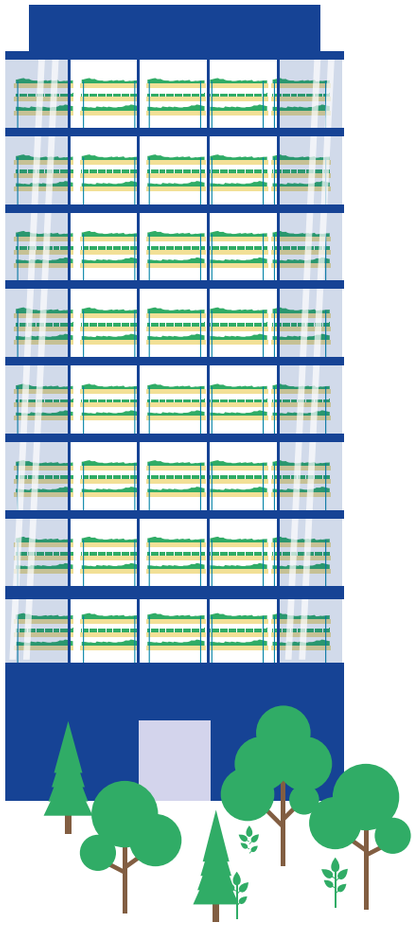
of leaf vegetables grow every year in Europe's biggest vertical farm. That is equivalent to the weight of 70 elephants.

Modern agriculture needs innovation.

Urban agriculture emerges where agricultural land is scarce.

Digital technologies are permeating agriculture. They help to save resources and increase yields.

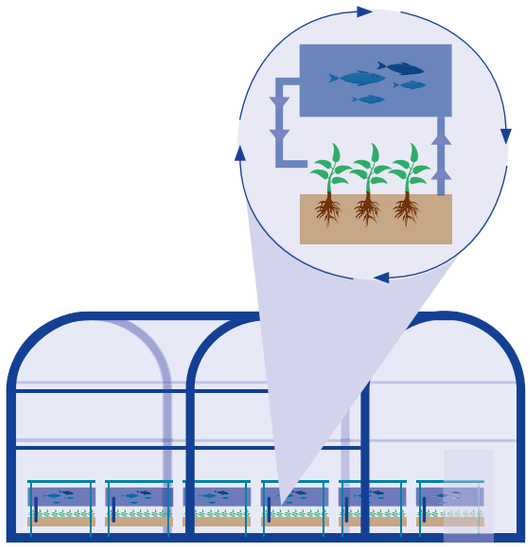
Salad bar in a skyscraper



Aquaponics combines the breeding of fish and the cultivation of plants in a closed system.

After being decomposed by bacteria, fish excretions act as fertilizers (nitrates) for the plants..

By absorbing nitrates, plants purify the water in which the fish swim.



Fruit, vegetables, edible mushrooms and algae are cultivated throughout the year in specially constructed towers. The crop plants are grown under **artificially created, ideal conditions** optimizing and synchronizing **processing cycles**.

There are already vertical farms in operation, especially in Japanese and North American cities. Japan's biggest vertical farm produces ten million lettuces a day.

The **main advantages** of vertical cultivation are, apart from needing less water and fertilizer, two to three times faster crop growth and the creation of new cultivation areas in urban environments close to customers.

Smart Farming – digitalization of agriculture

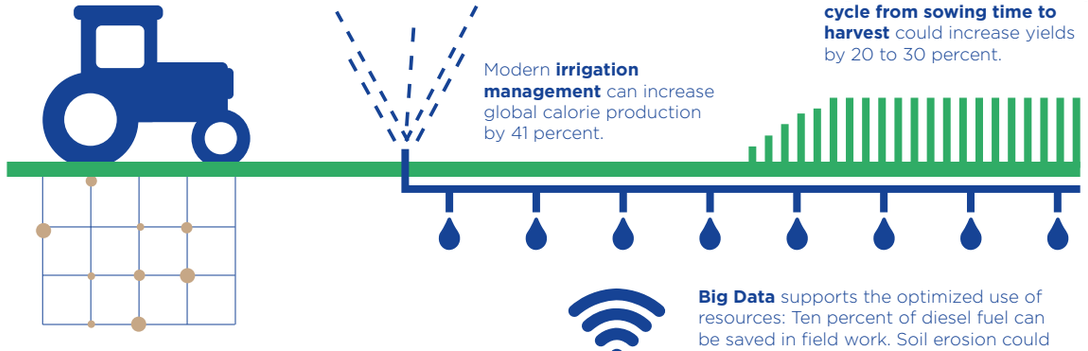
Digital technologies are increasingly the determining factors of agriculture. The farm of the future is fully networked. Highly specialized and automated farm robots take care of crop cultivation and harvest. State-of-the-art digital applications (using 4.0 technology) are already in operation on every second German farm.

Drones map out fields and provide infrared pictures enabling judgments about the health of crops.

Weather apps help farmers protect themselves from weather-related crop damage. Failures can be reduced by up to 25 percent.

Digitalization of the entire **crop cycle from sowing time to harvest** could increase yields by 20 to 30 percent.

Modern **irrigation management** can increase global calorie production by 41 percent.



Soil sensors measure the water and nutrient content of the soil.

Big Data supports the optimized use of resources: Ten percent of diesel fuel can be saved in field work. Soil erosion could shrink from currently 17 tons per hectare to 1 ton; herbicides could be reduced by 80 percent and nitrate residues in the soil by 50 percent.

Sources: EU-Parliament, IBM Research, Jägermayr et al, 2016, Bitkom, AT Kearney

The use of modern technologies substantially increases food security

Percentage change in number of people at risk of hunger in 2050 after adoption of improved agricultural technologies*

Sprinkler irrigation | Drip irrigation | Precision agriculture

*relative to the baseline scenario
Source: IFPRI, 2014

14 of the 15

countries in the world with the highest share of agriculture as a percentage of total economic performance are in Africa.

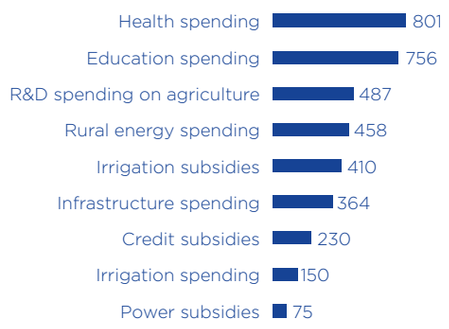
Investment in education is also an investment in global food security. Farmers need formal training to recognize new opportunities and expand their horizons.

This is the only way to assure a quick, comprehensive **knowledge and technology transfer** to everyday agricultural practice.

Education helps in the strug gle against hunger and poverty

Public spending on health and education has a great effect on the economic performance of the agricultural sector and the reduction of poverty.

Viability* of state spending and subsidies based on the example of India



* Returns in rural poverty reduction, decrease in number of poor per million rupees. spent)

Source: Bathla et al., 2015

Trained farmers are in a position to adapt fertilizing measures, to plant crops and harvest them. Small farmers who have participated in Farmer Field Schools achieve an average of 13 percent higher yields than comparative groups.

K+S and the non-government organization Sasakawa Africa Association (SAA) started the **"Growth for Uganda"** project in April 2013 to improve the **smallholders' situation**. It increases farmers' productivity and improves their food self-sufficiency and income situation. One focus is on **preserving and enhancing soil fertility**.

In the past five years, over **100,000 farmers** were given support, and their **yields** have increased by an average of **30 percent**. This has improved the quality of life for **650,000 people**.

Unnat Krishi means **'improved agriculture'** in the official Indian language Hindi. In the project K+S and the S M Sehgal Foundation have achieved considerable success as cooperation partners since 2013. **Women farmers in ten villages** are receiving help to help themselves – with seed and fertilizer.

The **crop yields** of farming families rose on average by **24 to 33 percent**.

Sources: www.k-plus-s.com, Campbell Collaboration

Many studies show that education has a positive effect on agricultural productivity, particularly in emerging and developing countries.

But this only applies if farmers can also be provided with the new opportunities created by technical progress. On average, each additional school year enjoyed by the population increases productivity by 3 percent.

Source: Reimers et al., 2011

Research and development is important

Global gross domestic public and private expenditures on R&D allocated to food and agriculture in $US billions*

1980		2011
17.8	Public sector	38.1
9.6	Private sector	31.1
27.4	Total	69.2

According to estimates R&D spending **requirements in the agricultural sector** worldwide will increase to **US$100 billion annually by 2050**.

* in purchasing power parities 2009
Source: InSTePP (Pardey et al, 2016, Cai et al., 2016)

17 UN Sustainable Development Goals
Target 9.5: Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation, substantially increasing the number of research and development workers per 1 million people, public and private research and development spending.

84

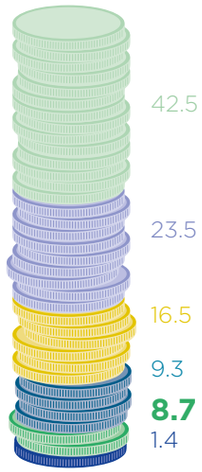
percent

of farms worldwide are less than two hectares in size.

Smallholder farmers are the backbone of nutrition worldwide. They have to be given the possibility to produce efficiently, sustainably and in accordance with demand using the **best possible technologies** and production systems. To gain better access to markets, they would also need an infrastructure which is fit for purpose.

Microfinancing empowers smallholder farmers

Microcredits issued by regions, 2016, in $US billions



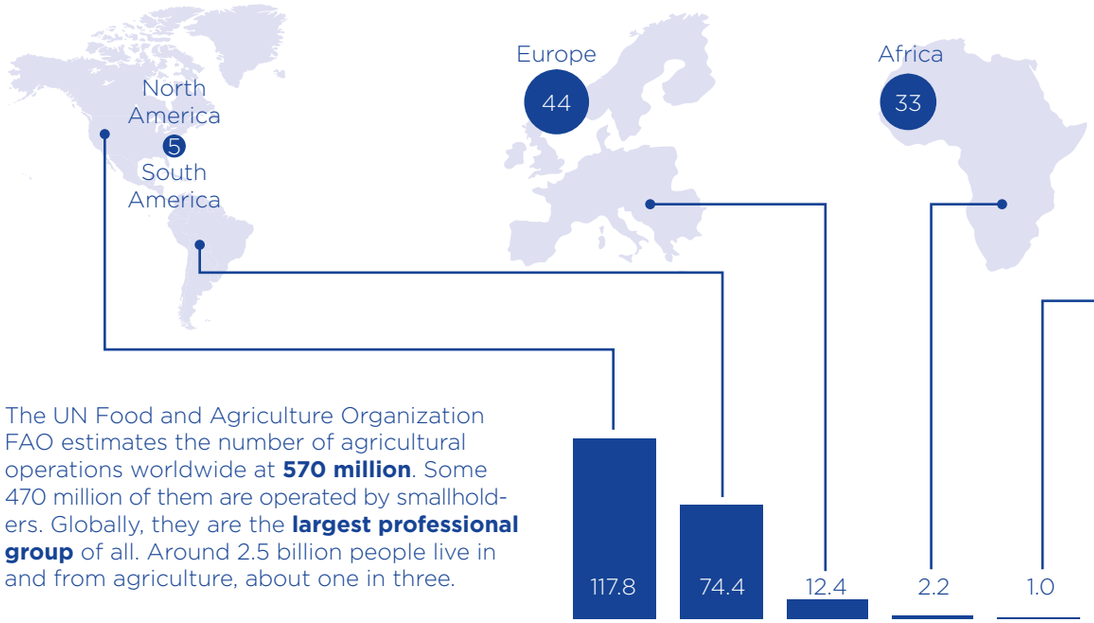
Latin America
South Asia
East Asia and Pacific
Eastern Europe and Central Asia
Africa
Middle East and North Africa

55 %
Share of the African population working in agriculture.

Source: Convergence „Microfinance Barometer 2017"

Small farmers dominant

Number in millions



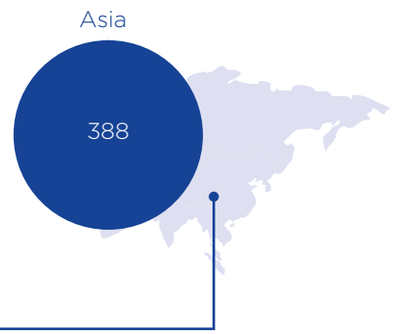
The UN Food and Agriculture Organization FAO estimates the number of agricultural operations worldwide at **570 million**. Some 470 million of them are operated by smallholders. Globally, they are the **largest professional group** of all. Around 2.5 billion people live in and from agriculture, about one in three.

Source: FAO 2014

Despite its enormous agricultural potential, the African continent is dependent on food imports. African economies together spend a total of $30-$50 billion a year on **food imports**. In developing countries a large proportion of food is still lost due to lack of infrastructure.

In fact, only every second inhabitant of rural Africa lives near paved roads.

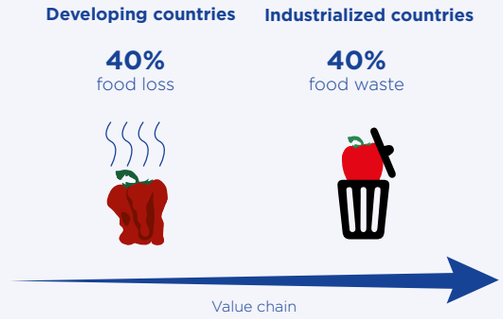
Source: AfDB, 2017



Smallholder farmers are responsible for half of food supplies, in developing countries as much as approx. 80 percent. But their productivity is often a great deal lower than that of agricultural operations in industrialized countries.

Loss and waste

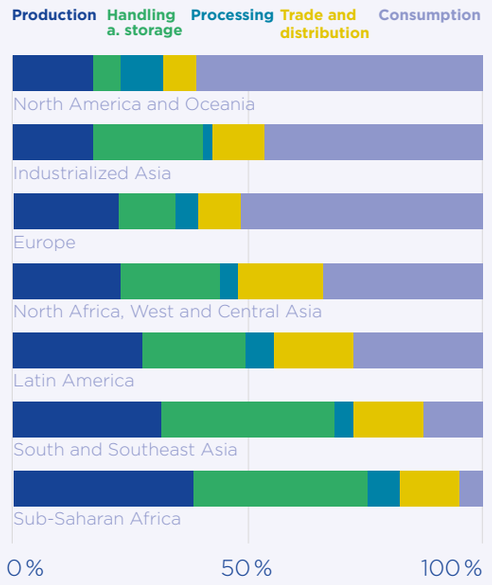
In percent



Whereas in industrialized nations, waste occurs predominantly at the consumer or trade level, in developing countries losses are incurred above all at the post-harvest or initial transport and processing stage.

Losses on the way from field to dining table

Share of kilocalories lost or wasted worldwide, in percent



Source: FAO, 2011

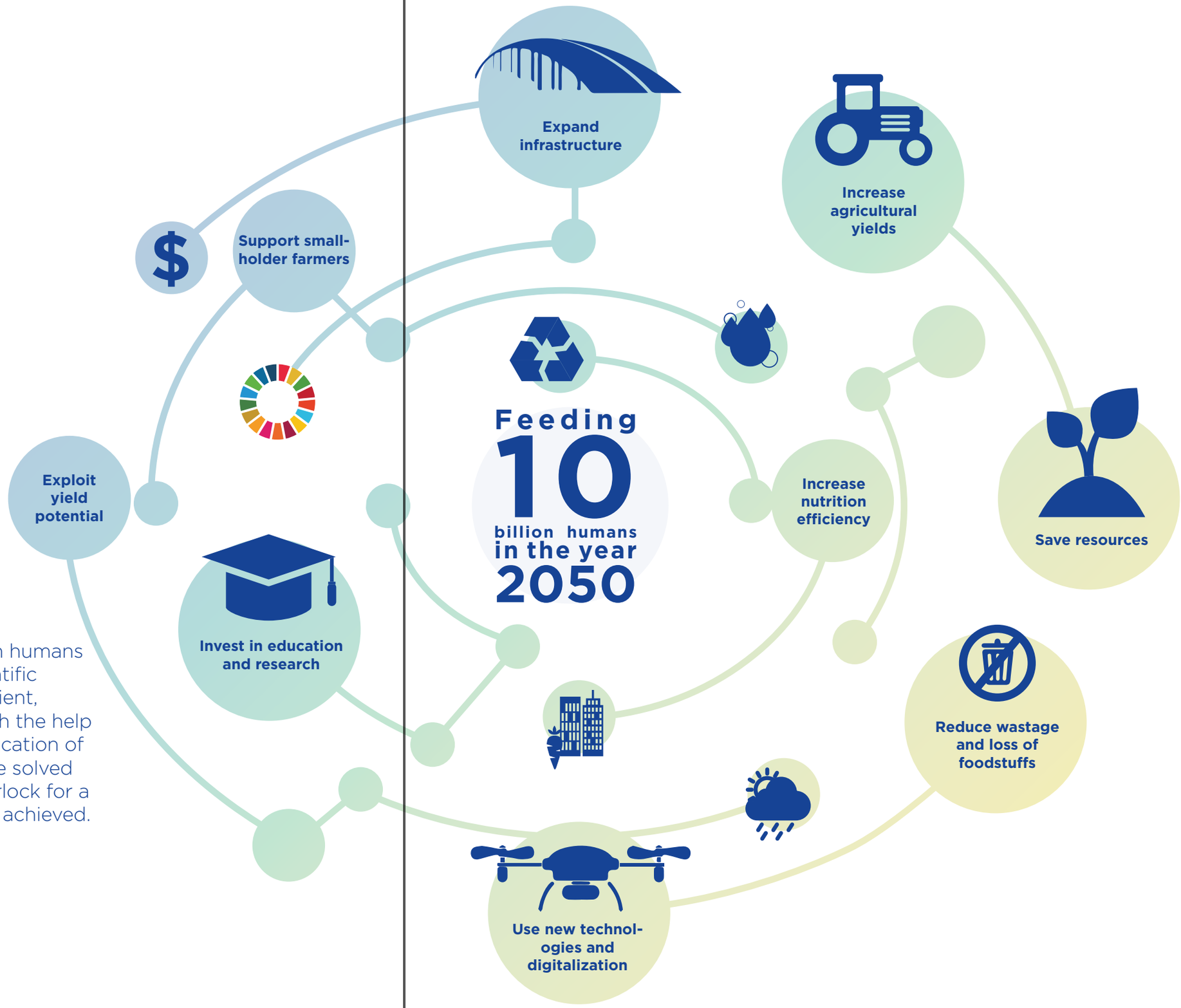
1.2 percent

Around the globe some 60 million hectares are being organically farmed – four times the figure in the year 2000. However, that is only 1.2 percent of agricultural land worldwide.

Even if agriculture is a contributory factor to global problems like water scarcity and climate change, it is still an important and significant part of the solution toward a sustainable society.

Agriculture plays a substantial role in achieving the UN's 17 Sustainable Development Goals.

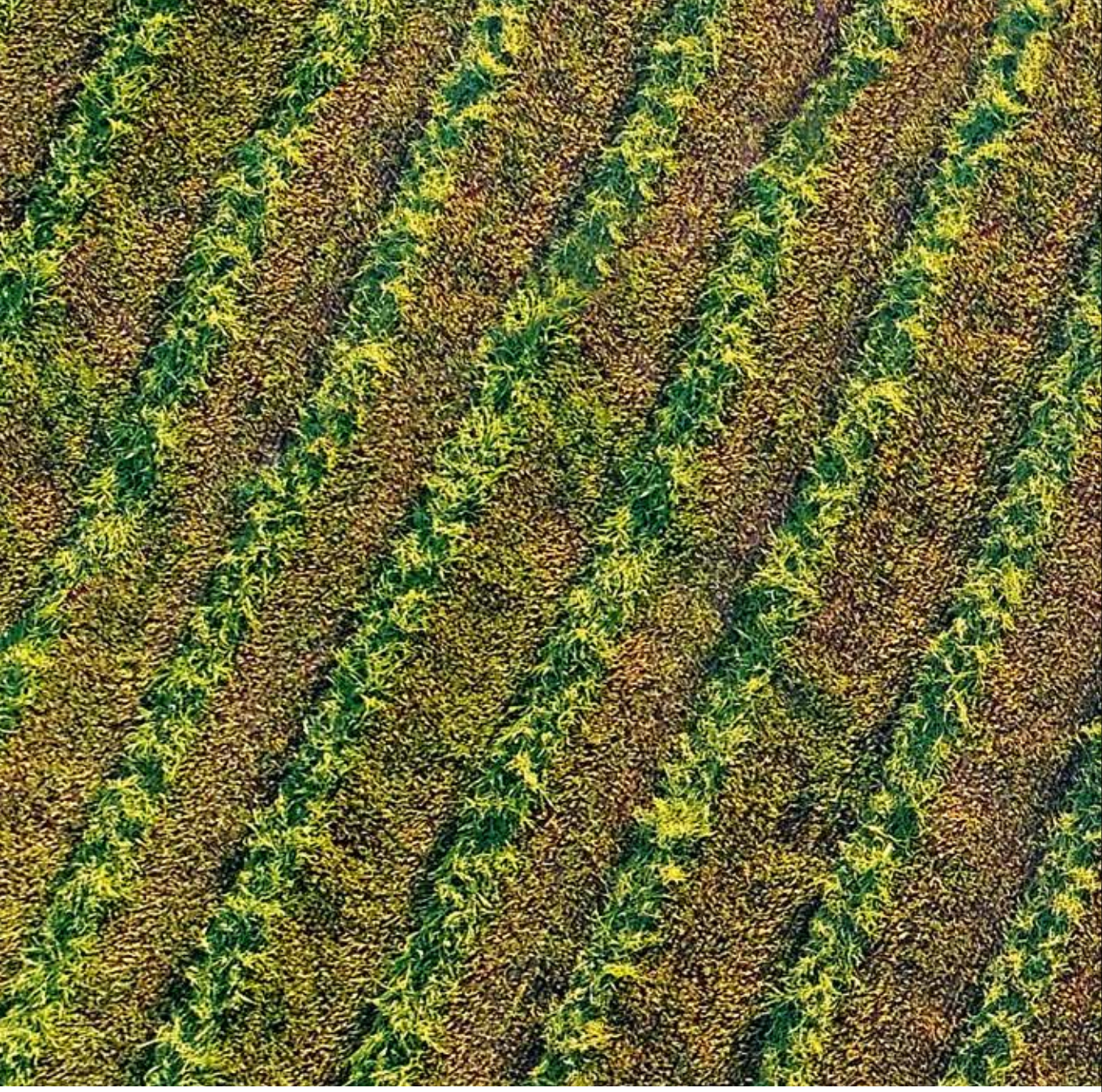
By the middle of the century, 10 billion humans will have to be fed. According to scientific estimates, by then yields will be sufficient, providing soils are used efficiently with the help of modern technology and better education of farmers. Global challenges can only be solved collectively. Many factors have to interlock for a sustainable, efficient agriculture to be achieved.



SUSTAINABLE DEVELOPMENT GOALS

1 NO POVERTY · 2 ZERO HUNGER · 3 GOOD HEALTH AND WELL-BEING · 4 QUALITY EDUCATION · 5 GENDER EQUALITY · 6 CLEAN WATER AND SANITATION · 7 AFFORDABLE AND CLEAN ENERGY · 8 DECENT WORK AND ECONOMIC GROWTH · 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE · 10 REDUCED INEQUALITIES · 11 SUSTAINABLE CITIES AND COMMUNITIES · 12 RESPONSIBLE CONSUMPTION AND PRODUCTION · 13 CLIMATE ACTION · 14 LIFE BELOW WATER · 15 LIFE ON LAND · 16 PEACE, JUSTICE AND STRONG INSTITUTIONS · 17 PARTNERSHIPS FOR THE GOALS

Further information:



Imprint

Publisher
K+S Aktiengesellschaft
Bertha-von-Suttner-Straße 7
34131 Kassel
www.k-plus-s.com

K+S considers itself as a customer-focused, independent minerals company for the Agriculture, Industry, Consumer and Communities segments. Its approximately 15,000 employees enable farmers to provide nutrition for the world, provide solutions that keep industries going, improve daily life for consumers and provide safety in winter.

Concept, research and design
Handelsblatt Research Institute
Toulouser Allee 27
40211 Düsseldorf
www.handelsblatt-research.com

HRI is an independent research institute and part of the Handelsblatt Media Group. It brings together the expertise of a team of economists, scientists and historians with the journalistic ability to present findings in a highly readable form.

Editorial closing: 14. September 2018