Factbook World Nutrition

Facts, trends and potential solutions to feed the world’s population
While 821 million are suffering from hunger, a third of food goes to waste.

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.

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

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.

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.

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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.
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.

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.
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.
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.

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.

The existence of hunger by regions, in percent, in 1990/92 and 2015/17:
- Africa: 18% in 1990/92, 7% in 2015/17
- Asia: 31% in 1990/92, 2% in 2015/17
- Developed regions: 62% in 1990/92, 5% in 2015/17
- Latin America and the Caribbean, Oceania: 73% in 1990/92, 2% in 2015/17

Source: FAO, 2018

Of the people suffering from hunger, more than 39 million are affected 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.

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.

Common micronutrient deficiencies:
- Low hemoglobin concentration (anemia): 1 in 5 of the global population
- 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

Sources: World Bank, FAO, UNICEF, WHO, World Bank, 2018
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

- Africa: 9% (2020), 26% (2050)
- Asia: 55% (2020), 54% (2050)
- Europe: 22% (2020), 22% (2050)
- Latin America and the Caribbean: 7% (2020), 8% (2050)
- North America: 4% (2020), 4% (2050)
- Oceania: 1% (2020), 1% (2050)

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 Data, 2017

Middle classes emerging in Asia, in particular
Global middle-class, in billions and as a share of regions in percent

- 2009: Total 1.9 billion
  - Europe: 0.6 billion
  - Central and South America: 0.3 billion
  - Middle East and North Africa: 0.2 billion
  - Asia Pacific: 0.7 billion
  - Sub-Saharan Africa: 0.1 billion
- 2015: Total 3.0 billion
  - Europe: 1.2 billion
  - Central and South America: 0.4 billion
  - Middle East and North Africa: 0.2 billion
  - Asia Pacific: 1.1 billion
  - Sub-Saharan Africa: 0.1 billion
- 2030: Total 5.4 billion
  - Europe: 1.4 billion
  - Central and South America: 0.6 billion
  - Middle East and North Africa: 0.2 billion
  - Asia Pacific: 2.6 billion
  - Sub-Saharan Africa: 0.4 billion

Growing affluence changes the menu
Meat consumption and gross national product by countries, 2016

- Europe: 100
- North America: 80
- Asia: 60
- Latin America and the Caribbean: 40
- Middle East and North Africa: 20
- Sub-Saharan Africa: 0

Source: Brookings, 2017

The taste for meat
Annual meat consumption, in kg per capita

<table>
<thead>
<tr>
<th>Region</th>
<th>2000</th>
<th>2015</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed</td>
<td>39.4</td>
<td>45.6</td>
<td>49.5</td>
</tr>
<tr>
<td>Developing</td>
<td>86.5</td>
<td>91.1</td>
<td>95.8</td>
</tr>
<tr>
<td>Total</td>
<td>60.5</td>
<td>37.7</td>
<td>41.9</td>
</tr>
</tbody>
</table>

Source: IFPRI, 2018

Grain – nutrition for humans and animals
Utilization of world cereal production, in percent

- Food: 43%
- Animal fodder: 35%
- Biofuels (15%) and other uses: 22%

Source: FAO, 2017

Growing affluence changes the menu
Meat consumption and gross national product by countries, 2016

- EU: 100
- US: 80
- China: 60
- India: 40
- Brazil: 20

Source: OECD, World Bank
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.

Little room for food
Distribution of the total surface area of the world

Deserts, mountains, glaciers and urban areas, 10%

Water 71%

Forest 8%

Arable areas 11% of that:

Pasture 8%

Farmland 3%

Food 0.3 billion hectares

Animal fodder 1.0 billion hectares

Biofuels, industry 0.2 billion hectares

Sources: FAO, Nova-Institut, 2017

68 percent of the global population will be city dwellers by 2050.

Agricultural area per capita sinking
In square metres per person

<table>
<thead>
<tr>
<th>Year</th>
<th>Developed countries</th>
<th>Developing countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>7,388</td>
<td>5,484</td>
</tr>
<tr>
<td>1960</td>
<td>5,295</td>
<td>1,730</td>
</tr>
<tr>
<td>2000</td>
<td>1,274</td>
<td></td>
</tr>
</tbody>
</table>

Sources: UN, FAO, 2017

Agriculture and climate change
Average changes by 2050, in percent

-5 0 5 10 15 15
Yields Agricultural land Production Fruits Seeds

Scenario SSP 1-RCP 4.5: Small increase in global agricultural production and average warming by 2050 of 2.6 degrees C compared with pre-industrial figure.

Scenario SSP 3-RCP 8.5: Higher increase in global agricultural production and average warming by the year 2050 of about 4.8 degrees C compared with the pre-industrial figure.

Sources: FAO, 2016

Thirsty agriculture
Water consumption, share in percent

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.

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

Source: FAO, 2016

Source: European Commission, PIK Potsdam, 2015

Sources: Palmer Drought Severity Index, 2018

Southeast Asia Europe Mediterranean area Western US

56 31 27 21

Southeast Asia Europe Mediterranean area Western US

Source: Palmer Drought Severity Index, 2018

Source: European Commission, PIK Potsdam, 2015

Water 71%

Deserts, mountains, glaciers and urban areas, 10%

Forest 8%

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Food 0.3 billion hectares

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Sources: FAO, Nova-Institut, 2017
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.
Efficient farmers
Number of people fed annually by one farmer

<table>
<thead>
<tr>
<th>Year</th>
<th>Germany</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>10</td>
<td>148</td>
</tr>
<tr>
<td>2016</td>
<td>148</td>
<td>168</td>
</tr>
</tbody>
</table>

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.

Sources: American Farmers Bureau, Bauernverband, BZL

African yields are below average
Average cereal yields, in metric tons per hectare

Sources: FAO, 2017

Yields increasing more slowly
Average annual growth of yields, in percent

<table>
<thead>
<tr>
<th>Crop</th>
<th>1961-2007</th>
<th>2005/7-2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>0.7</td>
<td>2.0</td>
</tr>
<tr>
<td>Rice</td>
<td>0.6</td>
<td>1.7</td>
</tr>
<tr>
<td>Maize</td>
<td>0.6</td>
<td>2.0</td>
</tr>
<tr>
<td>Soybeans</td>
<td>0.7</td>
<td>1.7</td>
</tr>
</tbody>
</table>

China grows the most vegetables
Share of vegetable production 2017 in percent

China 53
India 15
U.S.A. 3
Spain and Turkey 3
other countries 26

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

Sources: FAO, 2012

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
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.
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.

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 fertiliser, 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 heath of crops.

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

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

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

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

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

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

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

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

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.

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*:

-0.2 Sprinkler irrigation

-0.3 Drip irrigation

-7.5 Precision agriculture

*relative to the baseline scenario
Source: IFPRI, 2014

Salad bar in a skyscraper

420 tons

of leaf vegetables grow every year in Europe’s biggest vertical farm. That is equivalent to the weight of 70 elephants.
Education helps in the struggle against hunger and poverty

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.

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

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

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.

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.

Research and development is important

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

<table>
<thead>
<tr>
<th>Year</th>
<th>Public sector</th>
<th>Private sector</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>17.8</td>
<td>9.6</td>
<td>27.4</td>
</tr>
<tr>
<td>2011</td>
<td>38.1</td>
<td>31.1</td>
<td>69.2</td>
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* in purchasing power parities 2009

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

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.

Unнат Краши 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.
Microfinancing empowers smallholder farmers

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.

Small farmers dominant

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

Loss and waste

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

Losses on the way from field to dining table

Share of kilocalories lost or wasted worldwide, in percent

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.

Source: FAO, 2011

Food waste

Food loss

Developing countries

Industrialized countries

40% food loss

40% food waste

Value chain

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.

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.
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.
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.

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