

Food, Jobs and Sustainability

What African Agriculture Needs to Achieve



...ge challenges +++ African farming not very productive +++ learn from Europe's experience and mistakes +++ sustainable intensification +++ mobile services and
...preneurism +++ build value-added chains +++ jobs for growing rural populations +++ sub-Saharan Africa must develop +++ time is running out +++ agriculture as a

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AFRICA MUST GET IN THE FAST LANE

The many problems that most sub-Saharan African countries have been struggling to deal with for many years are being aggravated by another factor: high population growth. Wherever infrastructure is not being expanded fast enough to keep pace with the number of people and to satisfy their basic needs this growth is unsustainable. Schools and healthcare, electricity grids, food and transport are all in short supply. Above all, there is not enough work for the rapidly growing younger generations.

These countries thus find themselves in a development trap. Without economic opportunities, better education and improved possibilities for earning a living, the fertility rate is likely to remain high for a long time to come. This means, in turn, that solving the problems will not get any easier and strong population growth will persist. Frustration among young people, social conflicts, dissatisfaction with political leaders, civil unrest and ultimately terrorism, flight and expulsion are the consequences. These problems accumulate precisely in those places where population growth and development prospects diverge.

Wherever countries have developed, there has always been a clear correlation between the improvement in living conditions and declining fertility rates. This process is part of the “demographic transition”, which to date is the only theory capable of describing the development path of every country in the world. This path always begins in the pre-industrial age, in which people still have many children. Owing to inadequate nutrition, poor hygiene and limited economic opportunities, many members of society die at an early age. For this reason the population grows barely or not at all. At some point, as agricultural productivity increases and diet, hygiene and medicine all improve, living conditions become more favourable and mortality decreases. But because the fertility rate initially remains high, the population suddenly starts to grow strongly. Virtually all countries have already passed this phase of strong growth, but some, especially in Africa, are still experiencing it today.

Falling fertility rates are an achievement of humanity

Only with a certain delay, as prosperity becomes more widespread and society as a whole more educated, do people begin to plan their lives more individually. At that point, fertility rates start to decline. After a while, population growth tapers off. Demographic change is therefore a sign of the success of Homo sapiens, the result of people becoming ever better off.

Is there in fact any more humane and efficient way to solve the problem of humanity growing on a planet of limited size than through an improvement in living conditions?

The hope that the demographic transition will be repeated 1:1 in the least developed countries has so far not been fulfilled. While the mortality rate has already fallen significantly in the poorest African countries, among other things through humanitarian development and aid programmes to provide clean drinking water, vaccination programmes and food aid – all motivated by the best of intentions – these outside interventions have had an unintended side-effect. For although, fortunately, they have prevented many people from dying, they have not brought about the socio-economic development needed to further improve life prospects and hence lower fertility rates.

For this reason, the prospect of a “demographic dividend” has so far opened up for only a handful of African states. Such a dividend can be reaped only if the number of children born falls significantly and when the last large cohorts reach working age. If a country succeeds in providing the large number of young people with sufficient qualifications and then with employment, economic development becomes inevitable and creates its own momentum. About one-third of economic growth in the successful Asian Tigers can be attributed solely to their having reaped the demographic dividend.

Time is running out

Africa must therefore ensure that it embarks on a path towards a demographic dividend as quickly as possible. But time is running out, because high population growth in Africa has already persisted for a long time and is significantly higher than the level of economic development permits. Progress is needed particularly in rural areas, because it is there that the population’s prospects are worst and, correspondingly, the fertility rate highest.

As a rule, economic development in other countries has typically begun with progress in agriculture, with improved production methods, higher yields and opportunities to process crops and livestock profitably into commercial-grade foodstuffs.

Sub-Saharan Africa can learn from the achievements of other regions in the world, such as Europe, which has succeeded over the past 100 years in advancing agriculture to a point where supplying the population with high-quality food is more than fully guaranteed. In the process of catching up, Africa should try at all costs to avoid repeating the mistakes that were made in Europe and elsewhere during the intensification of agriculture, namely, endangering the groundwater with fertilizers and pesticides and even causing the extinction of species as a result of the large-scale cultivation of monocultures.

The future demands major leaps

Sub-Saharan Africa can and must therefore leapfrog many of the methods and technological and logistical developments that once led to progress in Europe and take a productive but at the same time protective approach to agriculture from the word go. This goal can be described by using the term “sustainable intensification”. The continent must make the best use of the agrarian technology available today and reject anything that has turned out to be harmful elsewhere.

This use of modern means together with the renouncement of outdated intermediate steps, also referred to as “leapfrogging”, might help Africa close the major development gap not only in agriculture but in other economic and social spheres as well. The classic example of how this can be achieved is the use of the mobile phone. Instead of wiring the entire continent with copper lines in a process that would have taken many years and entailed enormous effort, Africans invested quickly and directly in mobile networks. As a result, today many regions of Africa are better networked than some rural areas of Germany. Moreover, mobile banking and cashless payments are more widespread than they are in Germany.

This study cites many examples of how and where sub-Saharan Africa could find itself in the fast lane of development. And while we are a long way from believing that this is the solution to all the continent’s problems, we are sure that agricultural productivity can be improved quickly and sustainably if the appropriate innovations are used.

It is clear that Africa urgently needs improvements in other areas, too. For this, both national and international actors will be required: Africa’s trading partners must allow Africa to protect itself from cheap agricultural imports and they must improve import conditions for African products. Development cooperation must harmonise projects and programmes and involve the private sector to make sustainable intensification socially acceptable. Most important, governments in sub-Saharan countries must put rural development higher on the agenda, invest in agricultural research and bring know-how to farmers. They need to promote private entrepreneurship and guarantee the land rights of farmers.

Africa has no other choice.

Berlin, June 2018

Reiner Klingholz
Director, Berlin Institute for Population and Development

THE KEY POINTS

Ample opportunities, huge challenges

Currently, Africa's agricultural sector is unable to feed its own populations, yet it has the potential to drive the continent's development. This may sound like a rather far-fetched hypothesis given that sub-Saharan Africa – the sole focus of this study – has the lowest level of development and the highest population growth of any region in the world.

In theory, however, the region has what it takes. About a quarter of the world's areas suitable for crop farming and animal husbandry are to be found on the African continent. It offers favourable climatic conditions for harvests, a large reservoir of manpower is available, and the governments of the 49 states between the Sahel and the Cape of Good Hope, along with international development cooperation agencies, have realised that the urgently needed development leap must begin in the agricultural sector, which has long lacked attention.

However, there are major practical challenges to be overcome: yield per unit area and labour productivity in agriculture are low to date. Eighty percent of farms in sub-Saharan Africa are family smallholdings. They tend to farm inefficiently, especially because they lack access to know-how and capital and do not have secure land rights. Few use modern production-enhancing means such as mineral fertilizers, irrigation or machinery. Sometimes they even damage the sensitive soil by using poorly adapted methods. Droughts, heavy rain and other effects of climate change are making it more difficult to secure the supply of food. While many people suffer from malnutrition or have poor diets, a middle class is emerging in metropolitan areas that has adopted "Western" eating habits and hence begun to suffer from "civilization diseases" such as obesity and its secondary effects.

Gradual change in Europe

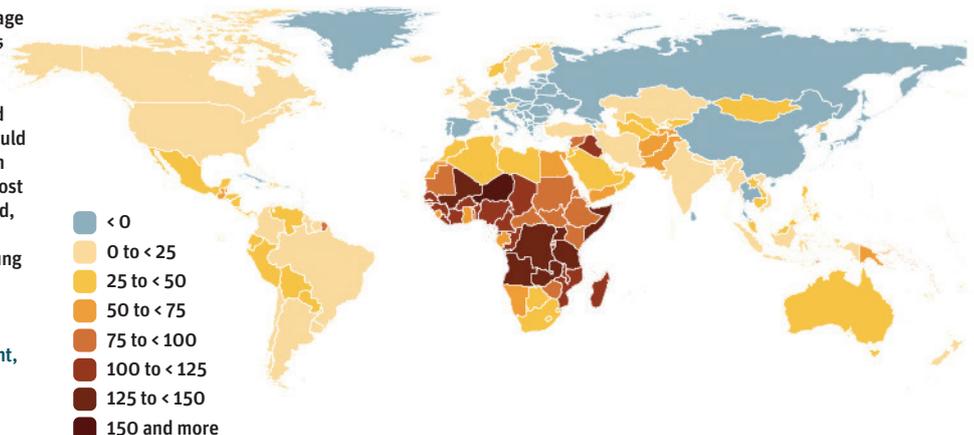
A glance at history shows that both in the early industrialised and later in the developing and emerging countries, the improvement of primary production always stood at the beginning of the socio-economic development process. In the pre-industrial era, farming in Europe was at a similar level to that of the majority of African smallholders today as far as the use of labour and agricultural aids is concerned, and the yields were comparably small.

Today, using energy and capital but with far less effort, European farmers are managing to obtain much more from arable land and animal husbandry than most of their counterparts south of the Sahara. But increasing intensification has also taken its toll on ecosystems and human health and made a huge contribution to human-induced climate change. In the course of these developments, agriculture has become ever more productive. Thus, farmers managed not only to feed

Persistent growth

In sub-Saharan Africa women have 5 children on average – 3.4 more than the average in the EU-28. Populations are therefore growing rapidly. According to forecasts by the United Nations, the number of people is likely to double in many countries in the region by 2050 and even to triple in some. In total, sub-Saharan Africa would then have 2.2 billion inhabitants, 1.2 billion more than today. This growth can scarcely be averted now, for most of tomorrow's parents have already been born. It could, however, be slowed down if more people, especially girls, gained access to education, since the longer young women attend school, the fewer children they wish to have and the more able they are to realise this wish.

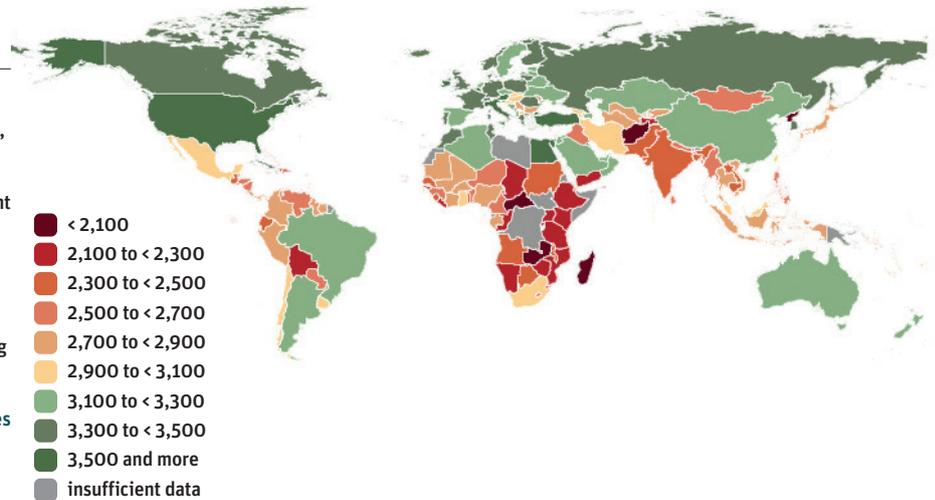
Forecasts for population growth, worldwide, in percent, 2018 to 2050
(Source: UNDESA¹)



African agriculture must become more productive

Since the early 1960s, the supply of food has improved in all regions of the world, except in Europe and Oceania, where it has been consistently good.² In some countries of sub-Saharan Africa, the amount of food available is still lower than the average minimum energy requirement of 2,100 kilocalories per capita per day. Agriculture must first of all ensure food security. If it then succeeds in developing to a point where it gets more people into work, thereby giving them prospects for the future, it can drive development throughout the entire continent and ultimately help to curb population growth in the long term.

Availability of food on average, by country, in kilocalories per capita per day, 2013
(Source: FAO³)



growing populations but also to generate income from agriculture – and the workforce was freed up. The latter, in turn, found employment in the upstream and downstream sectors of the agricultural economy, from agricultural machinery manufacturers to processing enterprises such as dairies, in industry in general and in the growing service sector.

Learning from experience: leapfrogging for Africa

In comparison with Europe, Africa has very little time left to make progress in agriculture and turn it into a driver of development. Population growth is particularly pronounced in rural areas, while the cities are growing mainly as a result of migration from rural areas. As long as high fertility rates continue to accelerate population growth, per capita economic progress will be ever more modest. That said, Africa does have the advantage that it can bypass some of the roundabout routes of development and build directly on the latest scientific findings and state-of-the-art technologies. This leapfrogging approach, i.e., omitting certain stages of technological development that have proved obsolete, may help agriculture onto its feet. To learn from Europe's experience means that African far-

mers must intensify, but in a sustainable way and without repeating Europe's mistakes. But first of all they must ensure food security. To do this, they need to organise themselves in order to gain better access to knowledge and resources and to open up markets for their products. The rural population must become active as entrepreneurs, processing and refining raw products themselves in order to prevent companies in other parts of the world reaping the added value thus produced. In this way, attractive jobs can be created in rural areas. Establishing an "agrifood" complex will ultimately be the conveyor belt for development in general.

Africa's farmers need support from both governmental and non-governmental development organisations in this endeavour. But above all, both farmers and domestic and foreign investors need governments to follow words with deeds when it comes to doing more for the development of agriculture.

Examples of good practice

The final and largest part of this study consists of nine case studies that show how the objective of sustainable intensification can be achieved, how value chains can be built and how Africans can drive change through

their own efforts – or, at least, which promising approaches exist for learning from both good and bad experience and for leapfrogging certain steps.

The selection of countries is limited for reasons of space, but we have taken care to choose countries that are as different as possible and to highlight examples from different agricultural and processing sectors. In Senegal, for example, a veterinarian has built a value chain for domestic milk. In Ivory Coast, a women's cooperative is refining raw cocoa to produce the finest chocolate. In Nigeria, a company is developing high-tech agricultural aids that even farmers with less capital can afford. In Zambia, a project is using fish breeding and the cultivation of soybeans to diversify agriculture and make it more attractive for young people. In Malawi, maize farmers are once again learning to appreciate the advantages of crop rotation. Another selection criterion was to track the most diverse possible initiatives on which the projects and activities described are based. The impetus to change sometimes came from start-ups willing to take risks, sometimes from scientific institutions and sometimes from international organisations.

1 | AMPLE OPPORTUNITIES, HUGE CHALLENGES

1.1 A vision of the transformation

Thesis: Although African agriculture is currently unable to feed the continent's populations, it has the potential to become the driver of development.

Development is essential

Sub-Saharan Africa has the lowest per capita income and the highest population growth of any region in the world. This brief statement sums up the region's problems of today and the challenges of tomorrow, for only if it promotes economic development and creates new prospects for its peoples can it escape the dual trap of poverty and high fertility rates. According to forecasts, the gross domestic product (GDP) of sub-Saharan Africa is likely to grow by 3.4 percent in 2018 and 3.5 percent in 2019; however, this falls far short of what is needed.

For a start, the projected growth is less than the 3.9 percent global growth forecast for each of those two years.¹ Poor regions, in particular, must achieve above-average results in order to catch up, not least since their growth figures come off a very low base. Otherwise, the gap between rich and poor will continue to widen.

Second, the population is growing so quickly that the per capita growth gains in many parts of the continent are modest or non-existent. This makes it difficult to consolidate the progress achieved to date. Even today, large numbers of young people, above all in the mushrooming urban areas, are flooding

a job market that is already overfilled and barely able to create new jobs.

Africa needs an economic transformation, a fundamental change. According to the African Center for Economic Transformation (ACET), a think tank, the African nations must make progress in five areas to bring about such change: they must diversify, become more competitive globally, boost productivity, improve technologies and ensure that as broad a segment of the population as possible benefits from the gains in prosperity.

Agriculture has a major role to play here. ACET's vision is "to create within a generation a modern, competitive, and environmentally sustainable agricultural sector that ensures food security, supports a middle-class lifestyle for a growing number of farmers, and powers Africa's economic transformation".²

The ACET researchers are not alone in having such a vision. The United Nations³, the Food and Agriculture Organization (FAO)⁴, the World Bank⁵, the Alliance for a Green Revolution in Africa (AGRA)⁶ and, not least, the governments of many African countries themselves are all likewise counting on the potential of agriculture not only to provide the local populations with sufficient food but also to become the driver of development in the region that stretches from the southern reaches of the Sahara to the Cape of Good Hope.

Ambitious goals, but still only meagre success

The growing awareness that the transformation of agriculture must get under way is evi-

dent in the Comprehensive Africa Agriculture Development Programme (CAADP), which the African Union approved in Maputo, the capital of Mozambique, back in 2003. The programme establishes the framework for reforming the agricultural policy of the member states. The goal is, first, to invest at least 10 percent of each national budget in agriculture and, second, to boost the productivity of the agricultural sector to such an extent that agricultural GDP grows by 6 percent annually. The governments are to strengthen the regional and national agricultural markets and ensure that exports of agricultural products increase. They are also to take steps to bring research and development in agriculture up to world standards, promote the efficient use of land and reduce rural poverty.⁷

Moreover, the development policy of the industrialised nations – which barely paid any attention to agriculture in poorly developed countries before soaring prices of many basic foods led to the global food crisis in 2007 – is now focused intensively on improvements. While many programmes and projects are aimed at combatting rural poverty and boosting agricultural productivity, in some cases there are not enough experts to implement them; as a result, the funds cannot be used as quickly as they are being made available.

The transformation is unlikely to fail owing to insufficient understanding on the part of the donors. Back in 2008, the World Bank devoted its annual world development report to the subject of "Agriculture for Development". Coining the catchy phrase "access to assets", the report demanded that African smallholders be granted access to capital funds.¹¹ That the African Development Bank

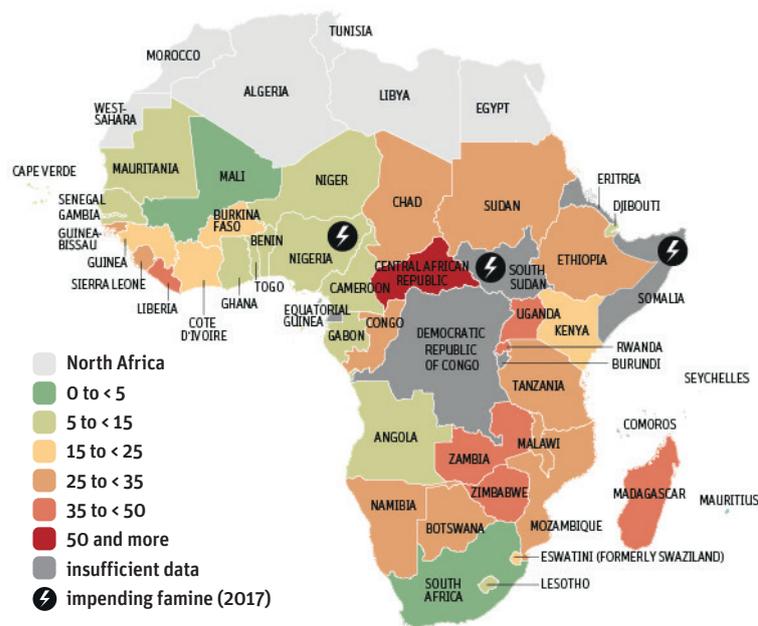
Where food is in short supply

Until the 1960s African agriculture was able to feed local populations on its own.⁸ Today, sub-Saharan Africa is more affected by malnutrition than any other region in the world. More than one-fifth of all people in Africa south of the Sahara have less food at their disposal than is needed to perform at least light manual work and to remain healthy.⁹ One reason for this is the low productivity of the agricultural sector.

The security of food is made more difficult by the harvest shortfalls due to drought and other effects of climate change. Starvation and malnutrition are especially serious in those areas where farmers cannot cultivate the land owing to conflicts and expulsions and where humanitarian aid cannot reach those in need.

Share of the malnourished in the populations of the countries of sub-Saharan Africa, in percent, as average for the period 2014–16

(Data source: FAO¹⁰)



intends to strongly promote the vision of the transformation is no accident: its president, Akinwumi Adesina of Nigeria, grew up in a farming family, studied agricultural economics and, as Nigerian agricultural minister, introduced a fundamental reform of the agricultural sector of his home country.¹²

However, the full realisation of the vision of change is still proving problematic. While 44 out of the 54 member states of the African Union have committed themselves to implementing the CAADP, only five had achieved the 10 percent goal by the end of 2015 – that is, 12 years after the announcement in Maputo of all the good intentions.¹³

Natural resource wealth

While raw materials such as oil, diamonds and ores are likely to continue to make a significant contribution to the GDP of many sub-Saharan countries in future, policymakers lose room to manoeuvre when revenue sources dry up owing to sudden falls in world market prices. The share of raw materials extraction in pan-African GDP has already

decreased.¹⁴ The development of the agricultural sector promises to have more lasting effects. Africa already possesses the most important resource required to this end: although the continent is currently home to just one-seventh or so of the global population, it has more than one quarter of the world's agricultural land at its disposal.¹⁵

The local climate offers favourable conditions, too. In the constantly humid tropics along the equator, soil and air moisture is consistently high. In the neighbouring seasonally humid tropical zones, rainy seasons are followed by dry seasons that can last between three and seven months – the farther the area is from the equator, the longer their duration. In the areas in the far south and in the north of Africa, the climate is subtropical or warm temperate, with hot summers and moderately cold winters and rainfall concentrated in winter along the Mediterranean and in summer farther south. The vegetation period is longer than in the temperate latitudes, for example in central and northern Europe. Only the desert regions of the Sahara and the Kalahari remain dry vir-

tually all year round. In principle, depending on the amount of rainfall and the availability of water during dry seasons, several harvests a year are possible in the other regions.

However, agricultural productivity is significantly worse than should be the case given the climatic and environmental conditions and is extremely low compared with that of other regions around the world.¹⁶ Sub-Saharan Africa is lagging far behind those other regions not only in terms of yield per unit area but also in terms of labour productivity.¹⁷

Some reports and studies suggest that Africa still offers almost endless possibilities to open up more farmland: according to estimates, more than half of the world's unused, potential arable land is to be found on the continent.¹⁸ A closer look reveals that the possible additional areas of land are limited mainly to grassland and forest that could be used for cultivation or to arable land that is lying fallow for various reasons.¹⁹ But for the time being, it is not necessary at all to open up any additional areas. If African farmers would only farm the existing arable land

more intensively, they could increase their annual production by 100 million tons of cereals or the corresponding amount of other crops and turn Africa into a net exporter of agricultural products. In this way, they would add another “corn belt” to global food supplies – that is, the equivalent of the region that produces half of the total US maize harvest – without having to use more land.²⁰ This potential should be realised.

1.2 The challenges

Sensitive soils and climate change

Why is agricultural productivity in Africa so low? One of the many reasons is to be found in the soil. For agriculture, soil fertility is a decisive factor. At the same time, soil and farming methods play an important role in the protection of water, air, climate and biodiversity.²¹ The natural properties of African soils impose limits on their use in agriculture – and if the land is farmed for too many seasons, the soil can be damaged to the extent that it becomes unusable.

As regards geology, Africa’s soils are mainly the product of the weathering of very hard rocks. This means that they tend to be coarse, they contain only very small amounts of fine clay particles and humus, both of which retain soil moisture, and they are deficient in nutrients. If the natural plant cover is removed to create fields – as has traditionally been the case with the practice of shifting cultivation in the tropics and continues to be done owing to population growth pressures – the crops quickly use up all the nutrients. If the farmers then allow these areas to lie fallow, it can take decades for them to regenerate. But it is more likely that the rain will wash away the last nutrients, that heat will expedite the decomposition of organic substances and the wind will blow away the remaining topsoil. What remains is a virtually sealed or eroded surface. Such “degraded” soils can be used again for agricultural purposes only at great expense and effort, if at all. Overgrazing and poorly adapted farming methods in drier regions can lead to soil degradation, too.

Land degradation is a problem worldwide. The most affected are the poorly developed countries and, within their borders, the poor

inhabitants of remote rural regions. New calculations based on remote-sensing data show that the worst-affected areas alone account for more than one quarter of the total land area of sub-Saharan Africa. Sixty-five percent of arable land and 30 percent of grassland areas exhibit impaired soil quality.²⁴ According to estimates, this affects 180 million people in sub-Saharan Africa and causes annual losses to the economy totalling 68 billion US dollars.^{25, 26}

Two factors are exacerbating the problem: population growth and climate change. The number of rural dwellers who are living on and from degraded land in sub-Saharan Africa rose by 38 percent from 2000 to 2010 while the total rural population increased by 28 percent. By comparison: the number of rural dwellers on degraded land in poorly developed countries around the world rose on average by just some 13 percent during this period and thereby recorded roughly the same growth rate as the total rural population.²⁷

Sub-Saharan Africa is especially susceptible to the effects of climate change.²⁸ In particular the many smallholders have virtually no

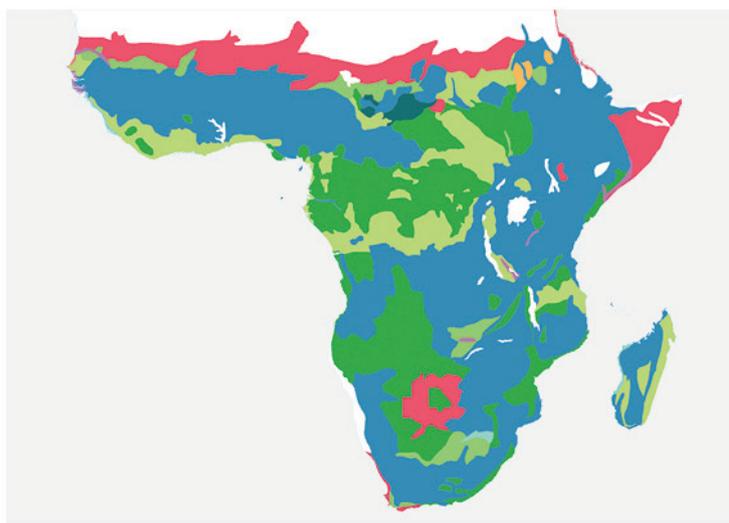
Where soils become worse

According to a study by international agrarian experts, up to 65 percent of arable land in sub-Saharan Africa is degraded in one way or another. This means that crops do not thrive sufficiently to produce enough food for the population. Climate change, poverty, population pressures and poorly adapted farming methods result in the continually worsening health of the soil. It is precisely the smallholders who suffer the most because they have few means with which to combat these problems.²²

Prevailing types of land degradation in sub-Saharan Africa

(Source: Montpellier Panel²³)

- | | |
|--|---|
| ■ loss of nutrients | ■ compaction |
| ■ water erosion | ■ waterlogging |
| ■ wind erosion | ■ stable natural |
| ■ contamination | ■ stable agriculture |
| ■ salinisation | □ not classified |



options for preparing themselves or adapting. The increase in the annual average temperature is already evident and by 2100 is likely to exceed that of 2000 by more than 2 degrees Celsius. As the temperature increases, so does water scarcity in those areas that are in any case dry. Pests, along with plant and animal diseases, become more widespread. Changes in rainfall patterns have likewise already become noticeable: the dry seasons are lasting longer, while rain either does not fall at all or falls in such quantities that floods destroy fields and buildings.²⁹ According to the latest report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), the combination of land degradation and climate change could reduce global harvest yields by an average of 10 percent and in some regions by up to 50 percent. The report goes on to suggest that Central and South America, sub-Saharan Africa and Asia will be most affected by the consequences.³⁰

Extensive land use

Agricultural area is defined as the sum of arable land that is being used or has been lying fallow for less than five years, permanent crops (including plantations) and permanent pastures (grasslands).³¹ In Africa, the share of agricultural land in the total land area is roughly as high as it is in Europe, namely, almost half. But in contrast with Europe, grasslands account for the lion's share – 77 percent – of the total agricultural area of sub-Saharan Africa, while arable land makes up just 20 percent and permanent crops a mere 2 percent.^{32,33} This division is a result of adaptation to the natural properties of the soil.

Often, it is sedentary or nomadic shepherds who use the grasslands to let their at times huge herds of livestock graze and move on with their animals when all the grass has been eaten in one area. Beyond providing for their own needs and those of the local communities, they do little to market their milk or meat, not least because infrastructure for slaughtering, refrigerating, transporting

and processing is lacking. In any case, the types of cattle common in Africa produce only meagre yields. Thus, while, all in all, there may be a large number of animals on large expanses of land, this usage is not very productive. Moreover, the situation is aggravated by the fact that around one third of potential grazing lands are degraded and the increasing number of droughts has led to the more meagre growth of fodder.³⁴

The use of arable land tends to be extensive, too, meaning that productivity-enhancing means such as fertilisers or irrigation are seldom deployed. The Green Revolution, which from the 1960s onwards spurred the dramatic growth of yield per unit area and labour productivity in agriculture in large parts of Asia and Latin America, left almost no traces in sub-Saharan Africa.

The Green Revolution came about amid fears that agricultural production in poorly developed countries might soon be unable to keep pace with the rapid growth of populations and that, as a result, there would be famines. With the support of the US Rockefeller Foundation, scientists set about cultivating seeds of the most important food plants that would lead to higher yields and increased resilience against disease. Using the classic method of crossbreeding a strain of short-stalk rice with a long-stalk but extremely high-yielding one, they created a new strain that, thanks to its shorter stalk, remained more upright under the weight of abundant ripe grains. With this “wonder rice”, farmers in Asia were able to increase the yield per hectare from 1–2 tons to up to 10 tons – also thanks to intensive farming.³⁵ This means that alongside improved seeds for rice, maize and wheat, the success of the Green Revolution is to be attributed to a whole package of related measures: fertilising with the three nutrients essential to promote plant growth – nitrogen, phosphorus and potassium – the irrigation of fields, chemical plant protection, mechanisation and further training for farmers in efficient farming methods based on scientific research.

But this approach has also led to undesirable developments. The excessive application of fertilisers and pesticides threatens ecosystems as well as the health of animals and human beings. Owing to the increase in irrigated areas, agriculture is now using an estimated 70 percent of global freshwater reserves, which could prove problematic precisely in those regions with limited access to clean drinking water.³⁶ In regions with a high evaporation rate, irrigation without sufficient drainage of the fields causes soil salinisation. Moreover, because the Green Revolution focused on increasing the yields of rice, wheat and maize, the diversity of plants and species cultivated in agriculture has declined. And, as a result, diets have become less balanced, while malnutrition has increased significantly.³⁷

Poor and left behind

Sub-Saharan Africa has experienced neither the successes nor the negative impacts of the Green Revolution. Why is that the case? One suggested explanation is that the introduction of new technologies failed owing to the range of farming systems, the shortage of water and “inappropriate agricultural policies and misguided philanthropic interventions”.³⁸ What is certain is that little has changed to this day in the traditional structure of agriculture south of the Sahara: now, as in the past, farming is carried out mainly by family smallholdings. Most smallholders are poor and their output provides, above all, subsistence – that is, the means to support themselves. They have almost no access either to the capital with which to be able to invest in improvements or to the means and methods with which to increase productivity and open up sales markets for their products. In many remote regions, there are few routes that farmers could use to transport products to the market in the next larger settlement – and thereby expand production beyond meeting their own needs – and stock up on fertilisers and other such supplies.

Eighty percent of farming enterprises in sub-Saharan African are family smallholdings. Almost all households that are engaged in agriculture farm less than five hectares of land; three-fifths of them work less than one hectare even.³⁹ Larger operations are to be found on land that settlers from Europe had once acquired – in Kenya and in the southern part of the continent, namely South Africa, as well as in Zambia and Zimbabwe.⁴⁰

Both large and small farming enterprises are involved in the production of cash crops for export, for example, coffee and sugarcane. For example, many smallholders work as contract producers for larger enterprises or as members of producers' cooperatives. But, above all, smallholders cultivate African staples such as manioc (cassava), yams, sorghum and other types of millet as well as maize, rice and wheat. The majority of farming enterprises thereby provide for their own needs and those of the local community. The reason why their output is not sufficient to provide for the needs of the entire popu-

lation is not because the smallholders have only small plots to farm; rather, it is because they do not farm efficiently enough and, moreover, often destroy their own livelihoods owing to a lack of know-how and capital.

Farming with the simplest means

Conditions differ from country to country, but African family smallholdings mostly have the simplest means at their disposal and do much work by hand or at best with oxen to pull the ploughs. Besides growing crops in their fields and gardens, family enterprises also keep a few hens, pigs or cattle so that they can occasionally eat meat, drink milk and obtain fertiliser for the fields. The smallholders retain seeds from the last harvest or exchange them among themselves. Plant diseases and pest infestations can lead to harvest shortfalls of up to 30 percent.⁴¹ And even if the harvest is good, part of it is often lost owing to excess moisture, mould or rodents, since storage and refrigeration facilities are lacking. In the case of fruit, the post-harvest

losses are estimated at up to 56 percent.⁴² African smallholders have little with which to protect themselves against potential yield losses through drought or flooding. In 2014, only 650,000 farmers in Africa were insured against agricultural risks, compared with 33.2 million in India alone. Moreover, the poorest farming households cannot fall back on savings or the incomes of family members employed in other sectors to cushion the losses; instead, they have to depend on food aid.⁴³ In addition, they often lack information about the market prices for various agricultural products and how they vary according to season and from year to year.

High risks impede investment

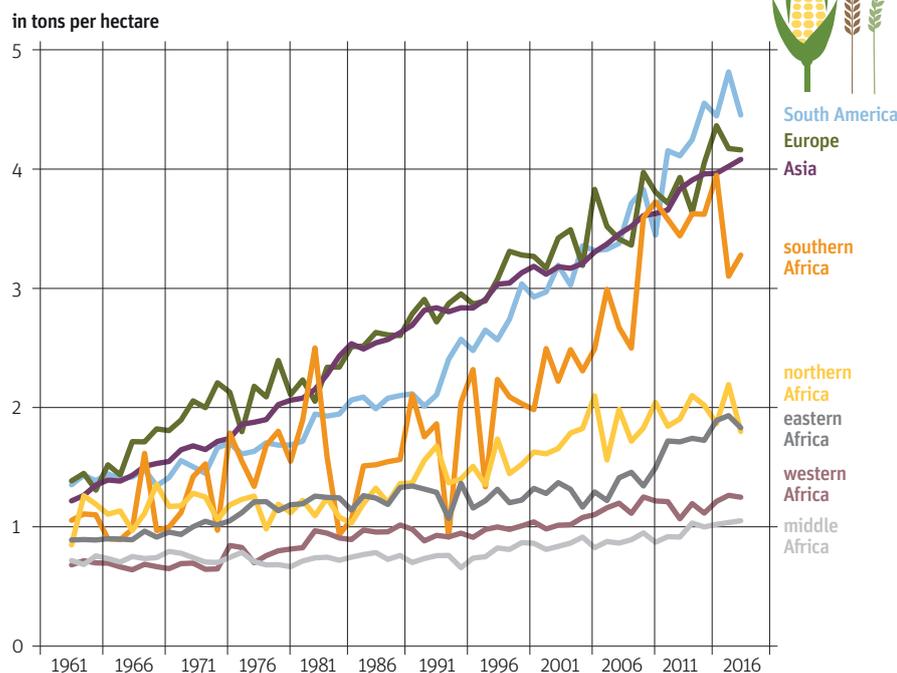
Thus, smallholders carry the full risk of harvest shortfalls and market price fluctuations. As a result, their overriding concern is to survive in the short term rather than to think commercially and reap business profits in the long term. And this is what determines their decisions about which plants to cultivate

Where the Green Revolution failed to take place

Since the beginning of the Green Revolution in the 1960s, farmers on the African continent have achieved only small increases in their yields, compared with their counterparts around the world. It is only in the southern part of Africa that progress approaches that evident in South America, Europe and Asia. In particular, South Africa, which has many larger enterprises, found it easier to apply the main tenets of the Green Revolution. Nonetheless, in the southern part of the African continent there have been sharp falls in yields owing to droughts.

Combined yields per unit area for wheat, maize, rice and other crops in various regions of the world, in tons per hectare, 1961–2016

(Data source: FAO⁴⁴)



and whether it is worth investing their scarce funds in improved seeds or fertilisers. In some countries, women perform between a quarter and more than half of the work, but it is mostly the men who make the decisions.⁴⁵

Moreover, the smallholders' willingness to invest is inhibited by the fact that the land they are farming rarely belongs to them. In some countries, including Ethiopia, the land is owned by the state, which grants the farmers (as well as foreign investors) rights of use only.⁴⁶ Historically, in many parts of Africa, land is communal property, whereby almost every household has the right to use a given area for agricultural purposes. In Western and Middle Africa, above all, these ancestral rights apply to an estimated 90–95 percent of arable land, most of which is communal property. However, the traditional system, which serves as the basis for the livelihood of rural dwellers south of the Sahara, has major disadvantages. First, it deprives the smallholder of the possibility of obtaining customary bank loans since they are unable to offer any collateral. Nor can they lease or buy any additional areas of land on which to produce surplus supplies. At the same time, they cannot lease or sell the land they have been allocated. This is because the traditional system leaves open the question of who ultimately decides about communal property and its usage. Because in recent years demand for land has increased and pushed up land prices, there are now more and more legal disputes. In Ethiopia, at least one third of civil cases are about land rights; the equivalent figure in Ghana is one half.⁴⁷ In the past, large-scale investors in commercial agriculture have contributed to these disputes because local communities did not have a say in the distribution of land among investors or because the compensation provided was insufficient or did not reach the people who had previously farmed the land.⁴⁸

How “typical” smallholders in sub-Saharan Africa live and work

Tingoli, Botingli and Kpalung are three villages in the Northern Region of Ghana, which is characterised by savannah populated at intervals with trees. Some 80 farming households are to be found in the three villages. Besides the head of the household – usually male – there are an average of 14 and a maximum of 30 family members and other close relatives in the biggest household. They live on a farm of sorts with small houses. The fields belonging to the smallholdings encircle this “compound”. On average, one household farms almost four hectares but frequently does not constitute an economic unit. As a rule, the young men and women have their own fields but help out on those of the head of the household.

The “daily bread” consists of maize, manioc (cassava) and yams. Maize grows on about half of all the arable land, the remainder is a mix of crops, garden products and perennials such as cooking banana plants and mango trees. When preparing the fields for cultivation, the farmers leave two natural types of tree to grow because of their potential usages: the shea and néré trees. For this reason, they are to be found on all the arable land. Smallholders who have less than two hectares generally grow enough to feed only themselves. If they do produce surplus products, they sell them to travelling buyers. Households with larger areas of land cultivate cash crops such as rice, peanuts, soybeans and black-eyed peas. Some achieve more than 80 percent of their household income through the sale of such products.

Almost every household has a few hens. These end up in the cooking pot on special occasions or, at times when money is

really short, are sold for a few cedi at the market in Nyankpala, which is 10 kilometres away. The better-off farmers have goats, sheep or cattle, some of which they sell at the market, as well as bulls to pull their ploughs. However, most of the households rely on additional income from non-agricultural activities to get by – that means, to be able to pay the children's school fees and have enough money for medication, personal hygiene products, fuel for their motorbike and mobile telephone bills and to buy food – oil, fish, tomato puree, sugar and vegetables.

There is no irrigation. The smallholders of the three villages fertilise the fields using dung from their cattle, which graze on the remains of the harvest. If there is no precipitation during the rainy season, the harvests are even more modest than usual. Mineral fertilisers, improved seeds and pesticides are, in fact, all available: Ghana has liberalised the market for these production-enhancing products and there are enough village shops selling them. But most of the small-scale farming households have neither the savings nor the access to credit with which to be able to buy them.

Another problem is migration. Young adults leave the villages not only to move to the towns or to work in the country's goldmines, but also because they have often failed to gain access to land. They are missed, above all, when there is a lot of work to be done, for example, during ploughing and harvesting. In these three villages in the northern part of Ghana, farmers and neighbours help one another. A small number are able to employ paid workers or contractors.⁴⁹

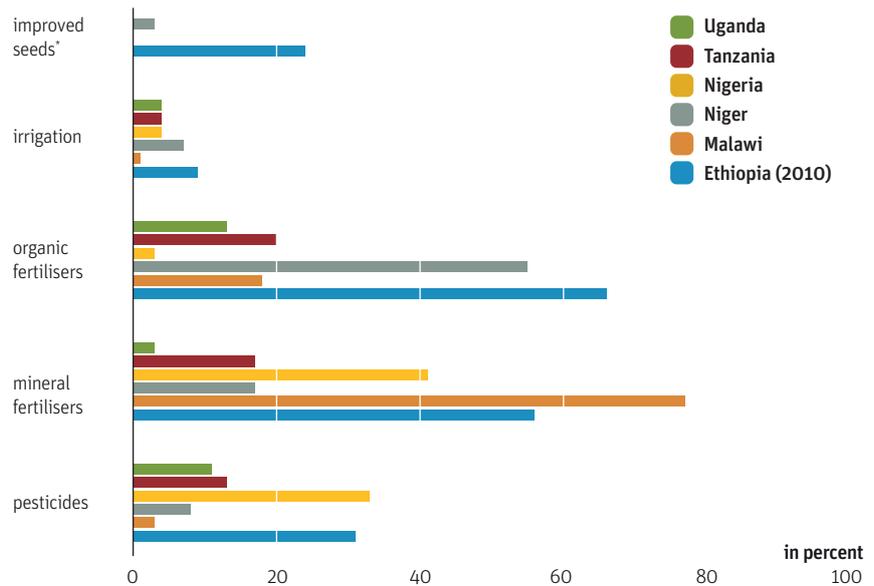
Varied use of production-enhancing means

According to a survey of 22,000 farming households in six African countries, less than one-tenth of such households apply artificial irrigation. Fertilisers, improved seeds and pesticides are used by households to a widely differing extent and often individually rather than as a complete package. Households in Ethiopia fertilise more than those in Uganda and Malawi. Accordingly, Ethiopia achieves cereal yields that – at 2.5 tons per hectare – exceed those in Uganda and Malawi with 1.9 tons and 1.4 tons per hectare, respectively.⁵⁰

Share of households engaged in agriculture that use modern farming methods, in six African countries, in percent, 2011

(Data source: World Bank LSMS-ISA⁵¹)

* data for two countries only



Nothing grows without water and nutrients

African smallholders depend largely on rain to meet the water needs of their crops. During the dry season, they often allow their fields to lie fallow. This means that while there is sufficient food around the time of the harvest, they have to buy basic staples at higher prices if their supplies start running out before the next harvest is ready.⁵² If they were to channel water onto their fields from reservoirs, springs or ponds, they could harvest several times a year and achieve higher yields. But in sub-Saharan Africa, only around 4–5 percent of arable land is watered artificially, and most of this irrigation is undertaken by the larger enterprises.⁵³ By comparison: in the emerging and poorly developed countries of South Asia, 39 percent of all arable land is irrigated and in the Middle East and North Africa 33 percent.⁵⁴ For their part, farmers in Malawi irrigate just 3 percent of arable land, even though the country is home to Africa's third-largest freshwater lake (Lake Malawi).⁵⁵ According to estimates, sub-Saharan Africa excluding South Africa uses only 10 percent of the available potential for

irrigation, whereas North Africa has tapped into 80 percent of available reserves – but has already begun to access groundwater supplies in some parts.^{56,57}

One reason for the low usage is that most irrigation systems are capital-intensive. But smallholders seldom use other product-enhancing means and methods either: this is because commercial seeds, which give higher yields, mineral fertilisers, which permit a more targeted supply of nutrients than does dung or any other organic fertiliser, as well as pesticides and machinery all have to be mostly imported and cost money. In Ethiopia, Malawi and Nigeria, state subsidy programmes have allowed local farmers to make use of mineral fertilisers. For millions of smallholders in other African countries, who live on less than two US dollars a day, these products are unaffordable. And even if some are able to afford them, they often lack the know-how to use them in an efficient and environmentally safe way. There are far too few agricultural advisers who could offer them support. Moreover, most people in the rural regions of sub-Saharan Africa have not attended even primary school. 200 million can

neither read nor write and would be unable to get to grips with instructions on product usage, not to mention a specialist book.⁵⁸

As regards the mechanisation of agriculture, sub-Saharan Africa continues to lag well behind the rest of the world in this area too. In South Africa, there are on average 43 tractors per 100 square kilometres of farmland, in Zimbabwe around 36, in Kenya 27, in Zambia 21 and in all remaining countries of sub-Saharan Africa about 10. By comparison: in Chile there are 425 tractors per 100 square kilometres, in Brazil 116 and in India 128 performing some of the work that in Africa is still often undertaken by draught animals and people.⁵⁹

Weak value chain

Productivity must increase if agriculture is to become a driver of development. As soon as farmers start producing more than is required to meet their own needs, they can sell the surplus. With the proceeds, they can buy the food that they cannot produce themselves, which allows for a more varied diet; and, moreover, they can provide their

children with clothes and school materials. If productivity further increases and households manage to save money, they will have taken an important step towards escaping poverty. Over time, households become no longer dependent on every helping hand at harvest time. The freed-up workforce can be deployed at the enterprises that emerge in rural areas during the development process and create more value than do raw agricultural products. These include grain mills, slaughterhouses, dairies, shops selling agricultural supplies, factories and repair shops for agricultural equipment and machinery, among many other things.⁶⁰

So far, agriculture in sub-Saharan Africa has limited itself mainly to supplying raw products. Even when those products remain inside the country, there are few possibilities to process or refine them domestically. For example, cereals frequently have to travel long distances before they can be ground and packaged. Even in the case of the so-called cash crops, such as cocoa or cotton, the producers are only just able to command the respective market price at the time for these raw materials. The biggest gains are reaped by market participants outside the continent who produce the chocolate or clothes and then sell them to the end-user. To date, Africa south of the Sahara is largely lacking this value chain. For people living in rural areas, there are hardly any employment opportunities beyond agriculture. They miss out on the jobs and incomes that are created when African fruits are processed into juice, or when milk from African cows is made into yoghurt. Often, processed products have to be imported using hard currency.

With this vast reservoir of manpower simply waiting for jobs to emerge along the agricultural value chain, Africa possesses a valuable resource. This should be used to push ahead with the transformation.

Until now, however, informal and irregular employment has dominated the labour market of sub-Saharan Africa, a situation

to which the family smallholdings have significantly contributed: it is estimated that 60–80 percent of those employed are working on an informal basis; their share in GDP is between 50 percent and 80 percent.⁶¹ Out of 10 workers, only four earn more than 3.10 US dollars a day.⁶² Social security along European lines is virtually non-existent. And the state is losing out on tax revenues.

Owing to population growth, another 180 million or so people will enter the job market of the African states south of the Sahara between 2018 and 2030.⁶³ At the same time, population growth will remain especially high in rural areas. Here it is primarily young people who are affected by unemployment or have to endure precarious employment conditions. They frequently associate working in agriculture with poverty and drudgery. Many dream of finding employment in one of the towns, but jobs are in short supply there, too.

There is only one way to escape this dilemma: people living in rural areas must be given the opportunity to earn an income. This will open up new prospects for them: they will be able to build a livelihood for themselves and will gradually feel more confident that they have a future where they are now living. If that happens and progress towards sustainable development becomes evident, fertility rates will decline in the medium term and the demographic pressure will ease. Birth control begins only when people are in a position to plan their future. This was to be observed in all early industrialised and emerging countries (see p. 19).

Double burden

Another factor contributing to low labour productivity is that the rural population frequently suffers from contagious diseases. HIV/AIDS, malaria and other infectious diseases continue to weaken the working-age population in particular. Cholera and other epidemics that could be avoided through better hygiene and access to clean drinking water are fatal, above all, for children – not

least if they are under- or malnourished and therefore especially vulnerable.

Malnourishment is not the same as starvation. In many places, poor people meet their calorific needs mainly by eating maize meal or polished rice; however, these are low on micronutrients, that is, vitamins, trace elements and minerals, which are important for development and health in general. This “hidden hunger” leads to growth and development disorders in children, weakness in adults and the increased risk of disease. Many African countries are trying to improve the situation by making it a legal requirement that maize be enriched with Vitamins A and D or by distributing dietary supplements.⁶⁴ But this is simply a drop in the ocean.

At the same time, middle classes are emerging in the urban areas of sub-Saharan Africa that tend to adopt Western dietary habits. This group likes to buy industrially processed food and drinks, which is mostly imported and, compared with freshly prepared meals, has a higher salt, fat and sugar content. As is clearly evident in the early industrialised countries, this inevitably leads to an increase in obesity and the associated “diseases of civilisation” – non-communicable diseases such as high blood pressure, cardiovascular diseases and diabetes, as well as the increased risk of certain types of cancer and premature death. Agricultural economists have shown that there is a recognisable correlation between this increase and the growing market share of supermarkets in Africa.⁶⁵

Thus, the paradoxical situation emerges in which under- and over-nourishment exist side by side. Africa as a whole carries a double burden of disease: the number of children under five who are overweight rose twofold from 1990 to 2014 from 5 million to 10 million; and whereas the number of stunted under-five year olds in the developing regions of Asia and South America declined, it continued to rise in Africa – from 47 million to around 58 million.⁶⁶

1.3 Leapfrogging – taking the direct route

To sum up, Sub-Saharan Africa must develop if it is to stop suffering from persistent population growth. Agriculture can play a major role here. But to do so, it must, first and foremost, increase its productivity. The conditions are favourable for it to succeed in this endeavour: farmers living and working south of the Sahara can learn from the experience of the early industrialised and emerging countries during their development from agrarian to modern industrial and service-oriented societies.

In the pre-industrial age, farmers in Europe were at the same level as the majority of African smallholders today as regards the use of manpower and resources and had similarly low yields. In the meantime, thanks to the use of energy and capital, they get far more from their land and livestock than most of their counterparts south of the Sahara – and with significantly less manpower input. However, increasing intensification is negatively affecting ecosystems and people's health. And it is also having a huge impact on man-made climate change.

Time is running out for sub-Saharan Africa to transform its agriculture. But the region has the advantage of being able to skip what at times are the long, circuitous routes to development and make direct use of the latest scientific knowledge and the most modern technologies.

“Leapfrogging” is the economic term for skipping certain stages of a process.⁶⁷ The most obvious example of leapfrogging technological development phases is the leap into the mobile era: Africa was easily able to forgo building the expensive infrastructure for fixed-line telephony, including in the most remote regions, as Europe had done. Instead, it went straight to the mobile network, which allowed modern means of communications to spread rapidly throughout the entire continent.

This leap is also helping agriculture onto its feet: mobile phones allow even those farmers in remote rural areas to be reached without any problem and at little expense so that they can receive information, advice and the means to protect themselves against risks – information technology, geo-information systems, satellites and databases, among other things, make all this possible.⁶⁸ Moreover, microelectronics, which have recently become affordable for African countries, too, can help farmers make more targeted use of water or purchased fertilisers and thereby not only save money but also reduce the environmental impact.⁶⁹

What is more, Africa can also leapfrog everything that has turned out to be undesirable developments, above all those that have negative effects on the environment, the climate and people's health. That is why the vision of the structural transformation of African agriculture almost invariably includes the advice to make this process as sustainable as possible.

The second chapter of this study examines how European agriculture has developed and what can be learned from the successes and drawbacks of this development. The third chapter looks at the various ideas and approaches for the great leap forwards of agriculture south of the Sahara. To highlight the huge range of possibilities and permit comparisons, there follows immediately below an overview of important indicators of agriculture in sub-Saharan Africa and the European Union.

1.4 Agriculture – a comparison

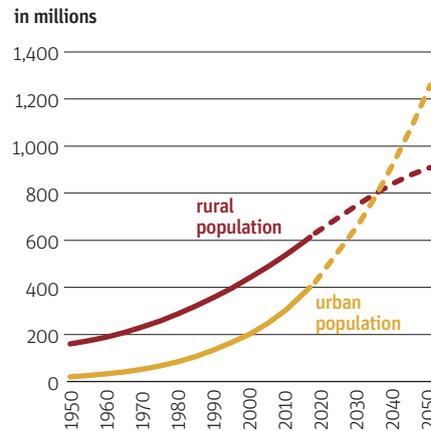
Despite urban growth, rural development remains important

The global trend of more and more people migrating to the cities is also evident in sub-Saharan Africa. Nonetheless, the rural population continues to grow because of the high fertility rates. Nowhere is the difference in fertility rates as marked as in Ethiopia: in this East African country, women in rural regions have 5.2 children on average whereas the fertility rate among women in the cities is less than half that level, at 2.3 children per woman.⁷⁰ In Germany, the fertility rates for urban and rural regions are the same – around 1.5 children per woman.⁷¹

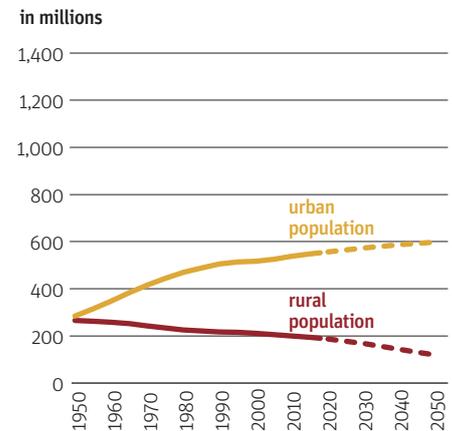
Urban and rural population in sub-Saharan Africa and Europe (geographical), in millions, 1950–2018, forecast to 2050

(Data source: UNDESA⁷²)

Sub-Saharan Africa



Europe



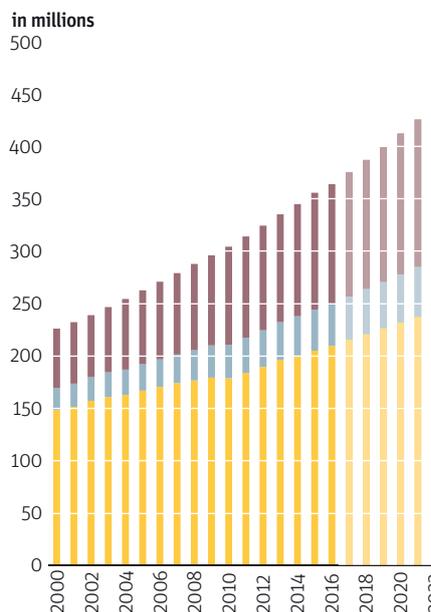
Hardly any jobs left in European agriculture

In sub-Saharan Africa, those working in the primary sectors of the economy – that is, agriculture, forestry and fishing – account for well over half of all those employed. Only just over a third work in the service sector, including trade in agricultural products. And a mere one-tenth is employed in industry. In the European Union, 95 percent of those employed work outside the agricultural sector.

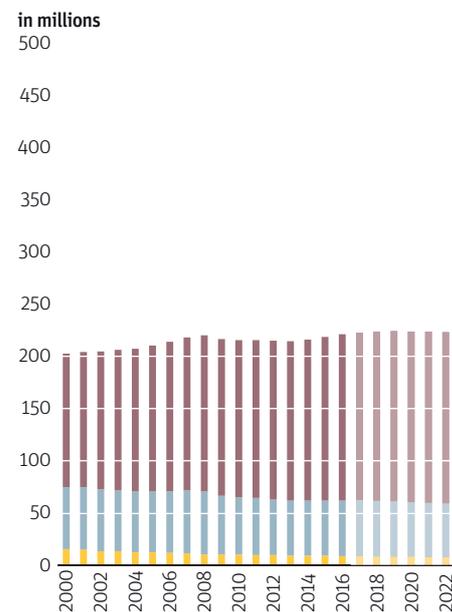
Number of employed in agriculture, industry and services in sub-Saharan Africa and in the EU-28, in millions, estimates: 2000–16, forecasts: 2017–22

(Data source: ILO⁷³)

Sub-Saharan Africa



European Union



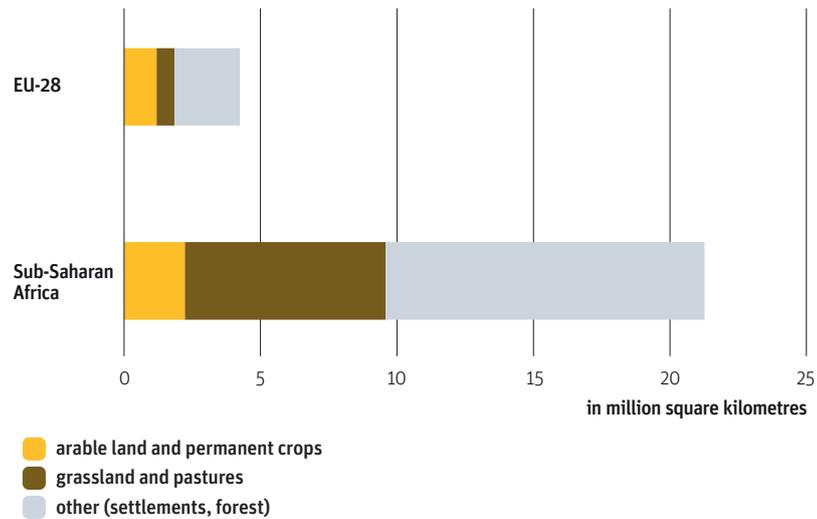
- services
- industry
- agriculture



Much more land south of the Sahara

The total land area of the European Union excluding water bodies is just roughly one-fifth that of Africa south of the Sahara. In both regions, almost half of the total land area is agricultural land. But in terms of both natural conditions and the type of usage, there are huge differences: in sub-Saharan Africa, less than one quarter of agricultural land is used for arable farming or the harvesting of perennials such as cocoa or coffee. Grassland and pastures account for the largest part – three-quarters – while in the EU they account for just a third of all land used for agricultural purposes.

Land use in sub-Saharan Africa and the EU-28, in million square kilometres, 2015
(Data source: FAO⁷⁴)

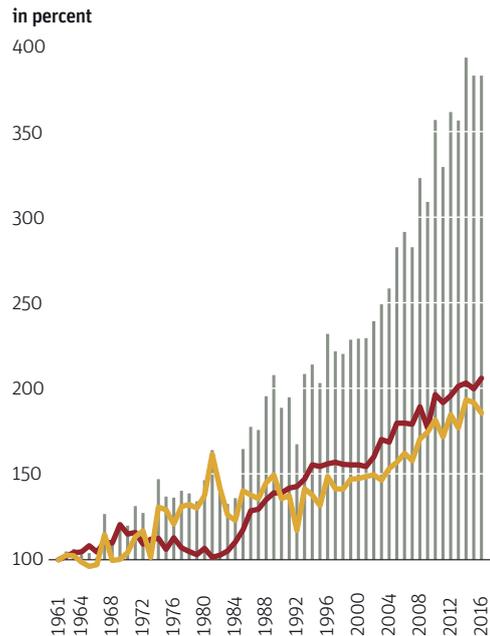


Different reasons for the increased production of cereals

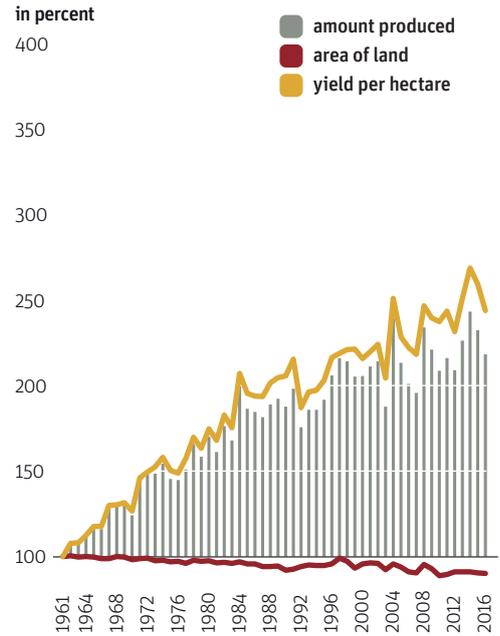
Since the 1960s, both the European Union and sub-Saharan Africa have boosted production of economically useful plants included in the category of cereals, such as maize, millet, sorghum, oats, rice, rye and wheat. In the EU, this has been achieved by intensification alone, while the area of land used has, in fact, decreased. Today, African agriculture produces almost four times as much grain as in 1961 and has to feed four times as many people with it. Meanwhile, the area of farmland has doubled. Progress made in productivity is regionally concentrated: farmers in South Africa, in particular, are farming their land more efficiently and thereby following the European model – with at times considerable environmental costs.

Development of cereal production, area and yield per hectare of cereal acreage, in sub-Saharan Africa and the EU-28, 1961–2016, 1961=100 percent
(Data source: FAO⁷⁵)

Sub-Saharan Africa



European Union

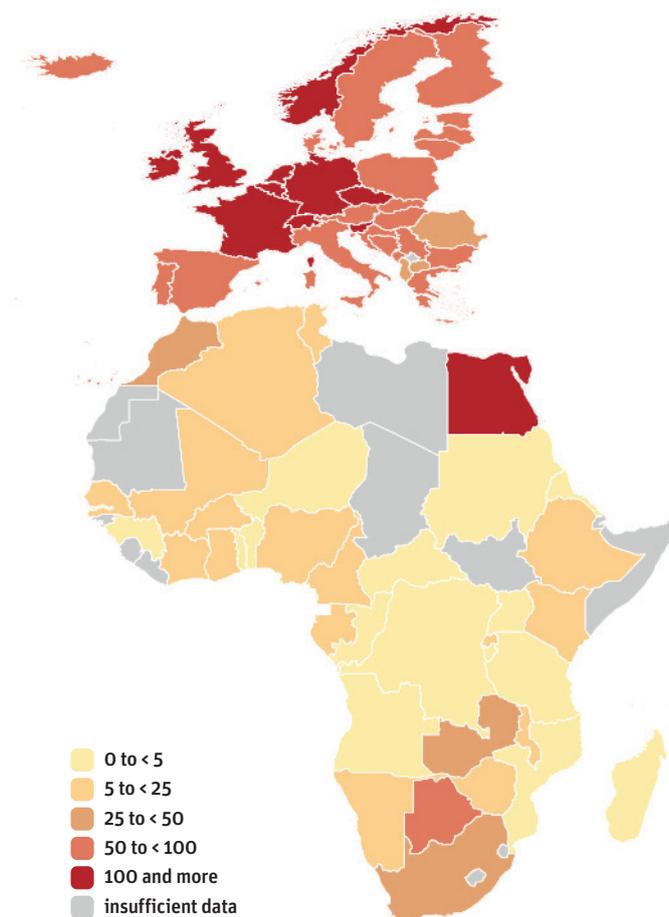


Europe fertilises more than Africa

Livestock farming produces large amounts of liquid and solid manures that, as so-called farmyard fertilisers, contribute to keeping in circulation the nutrients that are essential for plant growth: nitrogen, phosphorus and potassium. The contents and composition fluctuate, however, whereas they are precisely determined in industrially produced mineral fertilisers. In Europe, the use of farmyard and mineral fertilisers increases the amount of food produced. But, at the same time, the high nitrogen input has a negative impact on the soil and groundwater. To this day, sub-Saharan Africa has experienced neither the advantages nor the disadvantages of large amounts of fertilisers.

Average nitrogen input through mineral fertilisers on arable and permanent-crop land, in kilogrammes per hectare, 2015

(Data source: FAO⁷⁶)

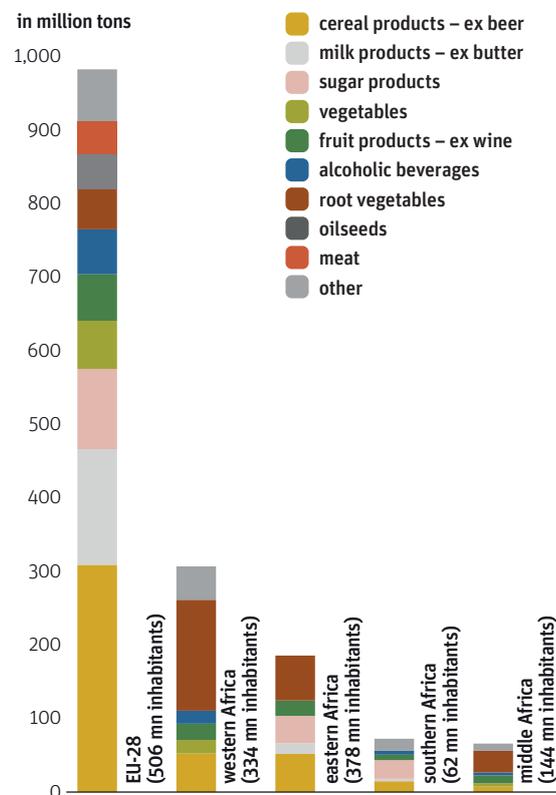


Manioc in Africa, cereals and milk in Europe

Although sub-Saharan Africa has five times as much agricultural land as the European Union and in 2013 was home to almost twice as many people, it produces less food than the EU. African farmers grow mainly starchy tubers such as manioc and yams and, above all, maize and sorghum among cereals.⁷⁷ The total output of cash crops like tea, coffee and cocoa, which are mainly for export, is marginal. European food production is more diverse.

Production quantities of food, raw and processed, by group, in million tons and population in millions, in the EU-28 and the regions of sub-Saharan Africa,* 2013

(Data source: FAO⁷⁸)

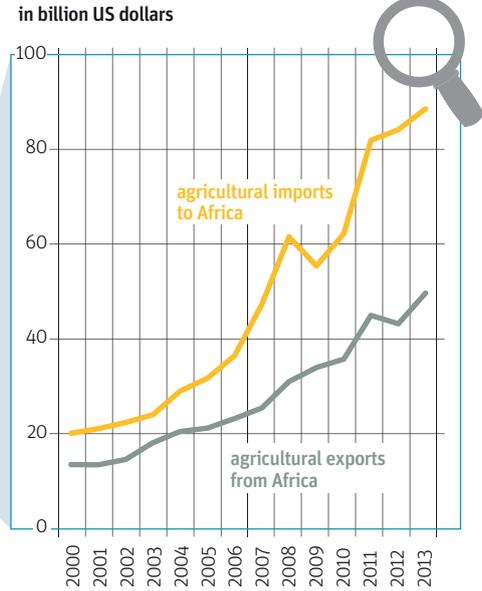
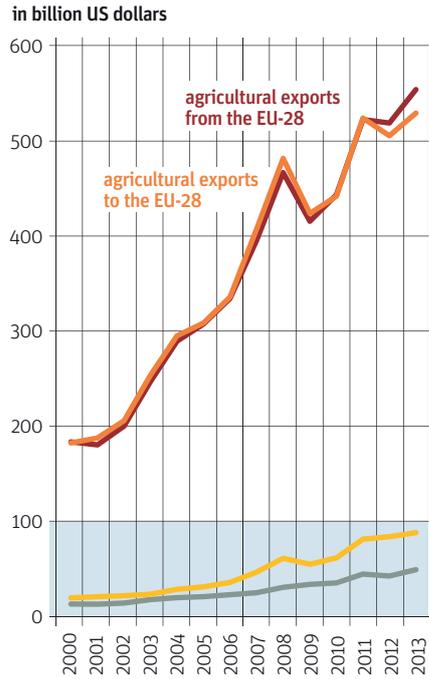


* **western Africa:** Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo; **eastern Africa:** Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Ruanda, Seychelles, Somalia, South Sudan, Uganda, Tanzania, Zambia, Zimbabwe; **middle Africa:** Angola, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, Sao Tome and Principe; **southern Africa:** Botswana, Lesotho, Namibia, South Africa, eSwatini (formerly Swaziland)

Negative trade balance in Africa

The African states are net food importers. In 2013, the countries south of the Sahara spent almost 90 billion US dollars on agricultural imports, especially rice.

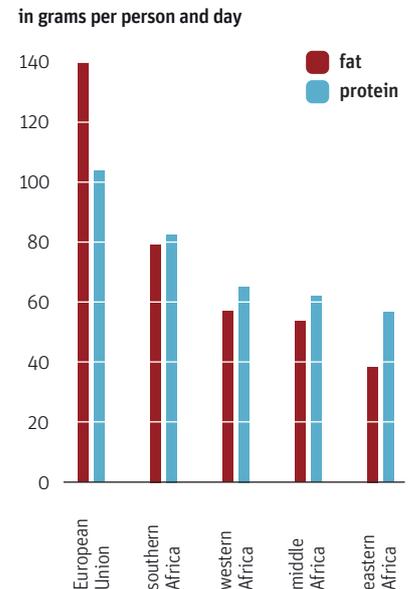
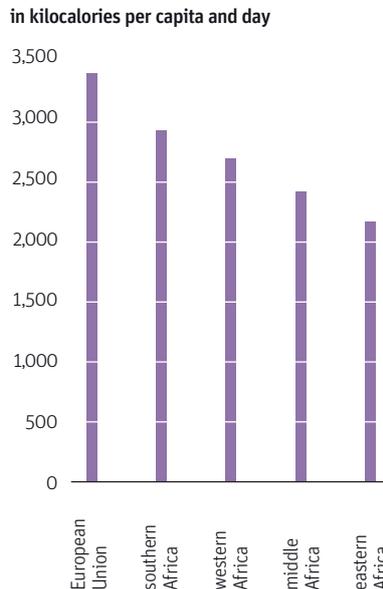
Value of agricultural exports and imports from and to Africa (geographical) and from and to the EU-28, in billion US dollars, 2000–2013
(Data source: FAO⁷⁹)



Poor food situation, especially in East Africa

Since sub-Saharan Africa produces less food than the European Union and the gap cannot be closed through imports, the per capita supply of food is lower in sub-Saharan Africa than in Europe. However, there are major regional differences. Whereas the populations of southern Africa have access to almost as many calories and almost as much protein as Europeans, the situation in eastern Africa is much worse.

Total food availability in kilocalories per capita and day (left), and fat and protein in grams per capita and day, for the EU-28 and for southern, western, eastern and middle Africa, 2013
(Data source: FAO⁸⁰)



2 | CHANGE IN EUROPE

Thesis: In Europe, a modern agricultural and food economy guarantees the security of food supply to the population. The intensification of food production has, however, taken its toll on the environment. Knowledge of both the advantages and the undesirable side-effects of intensification could enable strategies for the sustainable development of sub-Saharan Africa to be developed.

2.1 Plenty of time for transformation

How agricultural societies develop

Historically, structural change in agriculture has always been an important, if not *the* chief factor everywhere in the world driving the rise out of poverty and economic development – the only exceptions being city-states like Singapore and Hong Kong. Fundamentally, the process of transformation begins with an increase in per capita productivity in agriculture brought about by farmers’ using more efficient methods. This enables them not only to feed the growing population but also to generate income and free up workers. People looking for jobs migrate from the countryside to urban centres. This human capital, together with private and state investment, is a prerequisite for the development of industry and a service sector.¹

In the course of this process, the countries that began to industrialise early – in the second half of the 18th century – and the Asian Tigers in the 20th century underwent the so-called demographic transition: with economic development living conditions improved and mortality decreased, making

the population soar. Population growth did not slow down until – with some delay – fertility rates declined. During this phase of the demographic transition, the proportion of the population of working age grew for a period. In other words, there were more people contributing to the economy while at the same time having to provide for fewer children and older people. This favourable ratio continued until society began to age. If countries managed within this timeframe to employ the working-age population and ensure it was better qualified, they succeeded in turning the “demographic bonus” into a “demographic dividend” – an economic development with its own dynamic. To do this, however, governments needed to invest in education and the creation of jobs as well as to ensure a healthy population and good governance.²

Differing levels of expenditure on food

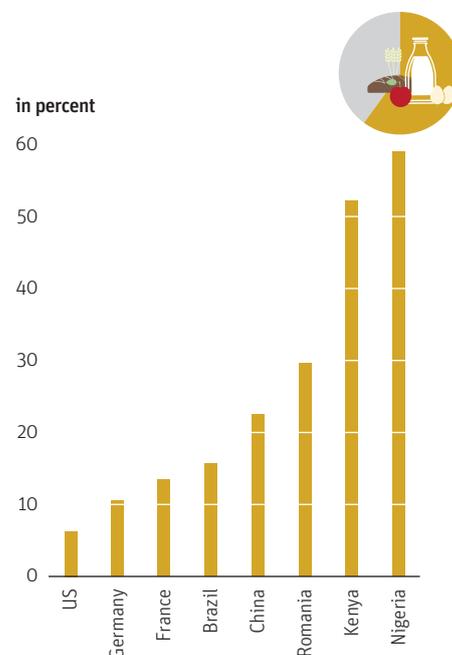
If in the process of development an ever greater share of the population earns ever more, then it is no longer forced to spend a large proportion of its income on food but can afford to buy other basic necessities. In Germany, households now spend only around one tenth of their budget on food and beverages, while in Nigeria the equivalent share is well over half.

Expenditure on food and non-alcoholic beverages as a share of all household expenditure on goods and services, selected countries, in percent, 2016
(Data source: USDA³)

Hard work, meagre returns

The early industrialised countries of Europe had a lot of time to realise this transformation and to arrive at a point of development where agriculture now produces enough to largely provide for the population while requiring fewer and fewer labourers and at the same time accounts for just 4.3 percent of EU gross domestic product.

At the dawn of the modern era, agriculture in Europe meant hard work under precarious conditions – in many ways comparable with the situation of African smallholders today. Yields were modest and subject to fluctuations depending on the weather. Animal husbandry was limited as long as winter fodder was not secured. Arable lands were quickly exhausted. The productivity of three-field

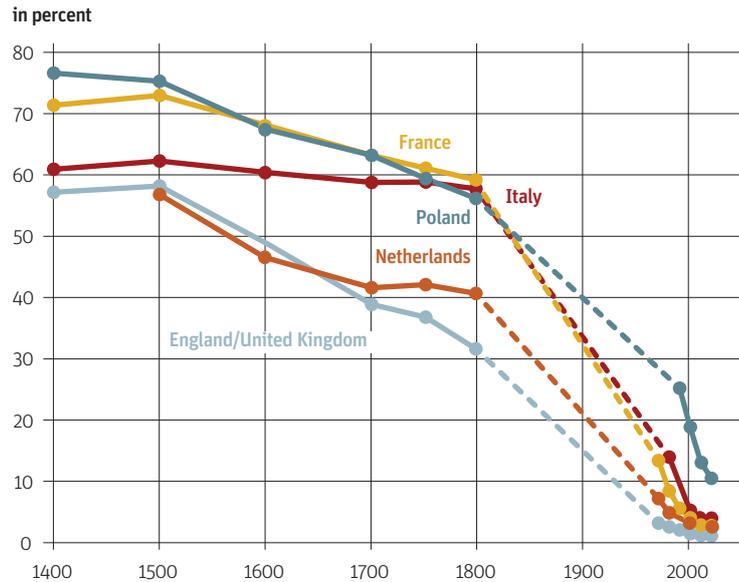


Dwindling employment on the land

As yields and labour productivity rise, agriculture undergoes a structural change during which the share of the population employed in agriculture shrinks. This happened particularly early and quickly in England, the cradle of industrialisation.

Historical share of the total workforce employed in the agricultural sector, 1400–1800 and 1970–2016, in selected regions of Europe, in percent (1970–1990: national estimates; 2000–2016: EU Labour Force Survey)

(Data source: Allen⁵, ILO⁶)



crop rotation, whereby summer and winter wheat were cultivated alternately while the third field was left fallow so that the soil could recover, improved after farmers began to sow peas and beans instead of leaving the land fallow. The legumes improved the farmers' diet and fertilised the soil because they were able to fix nitrogen from the air and thus supply both themselves and the soil with this important nutrient. Heavier ploughs, which turned the soil and used horses instead of the slower oxen as draft animals, brought further improvements.⁴

The pioneer: England

The modernisation of agriculture began in England. There the medieval dependency and ownership structures were reordered much earlier than on the Continent. Newly developed land, dispossessed church estates and the commons traditionally used by village communities fell into private ownership. Former lords of the manor now had their ancestral properties cultivated by tenants who had to increase their yields in order to pay the rent. This set a series of innovations in motion. The cultivation of turnips enabled cattle to be kept in sheds over the winter and

the cow dung was used to fertilise the fields. Wheat and barley brought higher yields per unit area than rye.⁷ Potatoes provided more and cheaper calories per hectare than cereals. They also contained more nutrients and only had to be cooked rather than ground before consumption, which made them the ideal staple food of industrialisation.⁸ Simple, horse-drawn seed-drills had already been in use since the beginning of the 18th century, and later horse-drawn hoes and devices for threshing and winnowing grain were introduced. Soon manufactories emerged that produced such machines.⁹ The systematic selection of livestock was likewise a pioneering achievement of agriculture in England. The farmer Robert Bakewell (1725–95) bred sheep, which until then had been kept mainly for their wool, specifically to produce a higher meat yield. He was among the first to rent out his best breeding rams to other farmers.¹⁰

In the course of these developments, those who had previously produced food solely for their own families became farmers with business acumen. They supplied the cities with food, met the increasing demand for meat and dairy products and exported wool to the Continent. The building of roads, ports

and other infrastructure supported trade. The farmers were able to afford to pay labourers and at the same time set money aside for investments. Money thus came into circulation and capital accumulated. Perhaps the most important aspect of the English "agricultural revolution" was that it paved the way for the industrial revolution, which began in England around 1760. By making efficient use of the factors of production, the agrarian economy was able to produce more food for the growing population and simultaneously increase the share of the population working in coal mines, ironworks, textile mills and other factories, including many who were no longer able to make their living from the land.¹¹

The achievements of English farmers gradually spread to the European Continent. The productivity gains in agriculture in the 19th century by far exceeded population growth – contrary to the expectations of the British cleric and economist Thomas Malthus. In 1798, he had prophesied famine because he had wrongly assumed that agricultural production could increase only linearly while the number of people would increase exponentially.¹²

The road to modern agriculture

The emergence of agronomy in the 18th century had paved the way for systematic improvements. Researchers and engineers went on to use ideas and inventions to lay the foundations for the kind of innovations without which modern agriculture would be unthinkable: targeted fertilisation, better varieties, protection against plant and animal diseases and mechanisation.

Seed: Ever since the early days of arable farming, farmers had engaged in selective breeding, also known as artificial selection. This involved selecting the seeds from the most productive and resistant plants for the next sowing. The overwhelming majority of farmers continued this practice until the beginning of the 20th century, when the laws of inheritance determined by Gregor Mendel in 1865 were rediscovered.¹³ Breeders were now able to cross varieties more systematically to generate crops with new characteristics, and it became possible to create hybrids, which brought higher yields, initially above all of maize. Since, however, this applies only to the direct descendants of hybrids generated from inbred lines, hybrid seeds must be newly procured before each season in order to be able to continue using their improved characteristics. Since the 1980s, molecular biology has considerably accelerated the conventional breeding process, making genetic engineering possible, i.e. the direct insertion of new characteristics from other varieties or even from entirely different species into the plant genome., In this way, maize can be made resistant to herbicides, diseases and pests or drought-tolerant. The cultivation of genetically modified food and crops is controversial, and in many countries the cultivation of such crops and their use in food is prohibited.¹⁴

The research departments of the seed companies are developing better varieties that thrive even under changing environmental and climatic conditions and facilitate

the work of the farmers. Such innovations are certainly of significance for future food security. At the same time, concern is growing about the consolidation process and the possible reduction in competition in the commercial seed sector. By 2016, five global corporations – almost exclusively chemical companies with long experience in the production of pesticides – had achieved a share of more than 50 percent of the global seed market through acquisitions. Their disproportionately high market share is attributable mainly to the increasing proportion of genetically modified seeds they produce. This is more expensive than conventionally bred seed and sold mainly by the sector's giants because they have the funds for the costly development and approval process. There are still a large number of medium-sized and smaller providers in the formal seed sector that come mainly from the agricultural sector.¹⁵

Fertiliser: By the 19th century, it was already well known that plants do not absorb organic compounds from the soil but simple inorganic salts such as nitrates or phosphates. But only in 1913 did it become possible to manufacture ammonia from atmospheric nitrogen on an industrial scale. In the meantime, farmers had increased their yields as much as threefold using guano from Peru, a mixture of deposited bird excrement and weathered limestone. Later Chile saltpetre from South America became an additional supplier of nitrogen, and new deposits of potash salts were discovered.¹⁶ The “artificial fertilisers” manufactured from ammonia and the complex fertilisers developed from them – compounds of the three elements essential for plant growth: nitrogen (denoted as N in the periodic table), phosphorus (P) and potassium (K) – today form one of the main pillars of productive agriculture. However, their production requires energy. In addition, unlike nitrogen and potash, the raw material phosphorus can be viably exploited only to a limited extent.¹⁷

Plant protection: Farmers began combatting pests, weeds and plant diseases at an early stage using toxic substances in order to prevent crop failures. In the 1930s, the first artificial insecticides, chlorinated hydrocarbons (CHCs), came onto the market. They proved to be so hazardous to the environment and human health that they were banned. Today, a wide range of biological and chemical agents for the prevention and treatment of diseased crops is available to farmers. Seeds for cereals are usually treated to protect them from fungal invasion until after germination. Herbicides enable the ubiquitous unwanted wild plants (aka weeds) to be kept in check. On the one hand, although plant protection agents can help to avert financial losses, pests and wild plants are increasingly developing resistance to them, rendering these agents ineffective. On the other hand, even the latest products developed by industry disturb ecosystems if used regularly (see p. 24). Their use is therefore strictly regulated.

Animal husbandry: The rediscovery of the Mendelian laws of inheritance also changed the livestock industry from around the 1930s onwards. Breeders could now aim for higher yields through targeted crossings, and cattle could be bred either as dairy cows or for beef. Thanks to embryo transfer, breeders can now increase the number of offspring of especially productive cows and select their characteristics based on so-called breeding values, ranging from “duration of useful life” to temperament. In European agriculture, high yield varieties have become prevalent, suppressing the original genetic diversity of livestock. By using concentrated feed, farmers have managed to increase the yield of their pigs, chickens and cattle to previously unimaginable levels.

Mechanisation and rationalisation: Steam engines were never widely deployed in agriculture because they were too expensive and complex to use. Even the tractor equipped with an internal combustion engine managed to replace the horse as a work animal

in Europe only after the Second World War. Combine harvesters and other machines that performed several operations replaced not only work animals but also manpower. Thus, the rationalisation of European agriculture took its course.¹⁸ Compared with the pre-industrial age, agribusinesses employ very little labour. They are, however, both capital- and energy-intensive. In addition to investments, annual operating costs are incurred for fuel, electricity and wage labour as well as for water, seeds, fertilisers, herbicides and pesticides, purchased concentrated feed, veterinarians and more besides.

The agricultural and food industry: In the course of industrialisation, companies increasingly took over the processing and preparation of raw agricultural products and created additional non-agricultural jobs, which required a variety of qualifications. Early innovations included packaged rather than open butter, enabling it to be sold more easily in the cities, while stock cubes and canned vegetables allowed foodstuffs to be

preserved, reducing domestic chores. Thus, new jobs emerged increasingly higher up the value creation chain, which required more highly qualified workers. Nowadays, a range of companies of all sizes are engaged in processing raw agricultural products: they grind, wash, portion, mix, pasteurise, cook, extrude, package and market, to list just a few steps in the processing chain. The largest share of the proceeds from sales flows not to the producers but to the food industry. In Germany, both down- and upstream agricultural sectors generate more gross value than agriculture itself.¹⁹ It is therefore misleading to focus only on the few jobs that Europe’s job market offers in farming. Rural enterprises form the basis for the entire system of agricultural and food production, and these constitute a significant employment and economic factor.

Agricultural policy: Policymakers must respond to the fact that in the course of the transformation process, rural communities come under strong pressure to adapt and modernise. Prices are falling and the growth in

farmers’ incomes generally lags behind that in other sectors of the economy.²² For this reason, agricultural policy in most industrial countries today supports agriculture with a variety of instruments. In the European Union, the subsidies introduced in the context of the Common Agricultural Policy (CAP) in 1962 to support prices for certain agricultural products led to massive overproduction. In the face of “butter mountains” and “milk lakes”, the system was reformed. Today, EU farmers receive mainly direct payments that are no longer tied to the quantity they produce but are calculated according to the farmed area and tied to the fulfilment of environmental and animal welfare requirements. On average, direct payments account for around 40 percent of farmers’ incomes – and almost half of the EU budget.²³

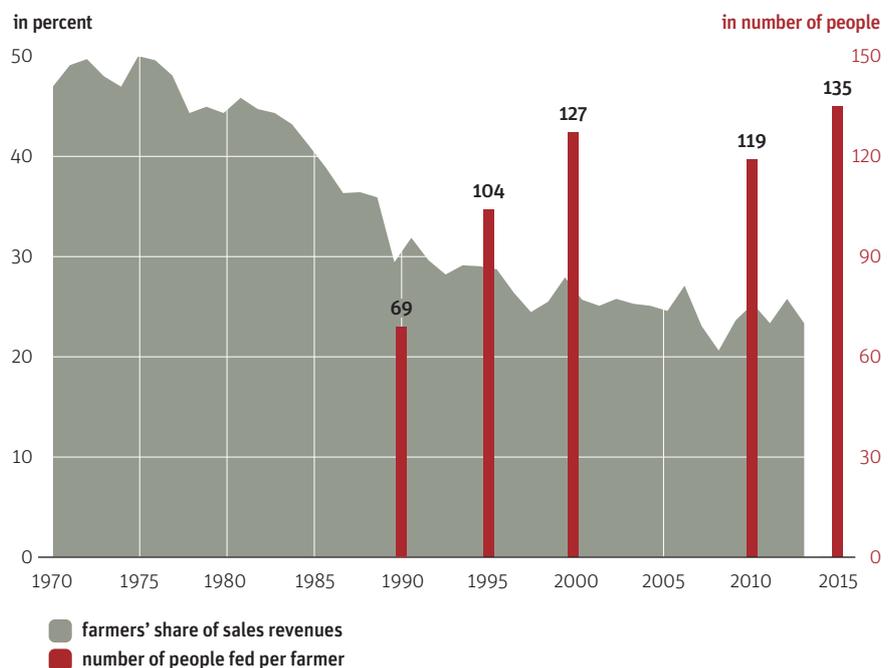
A look back at the historical development of Europe shows that in the early phase of the transition from agrarian to modern methods of production, protectionist measures such as subsidies, customs duties and import quo-

A smaller share for farmers

Today, a farmer in Germany feeds 135 of his fellow-citizens – almost twice as many as at the time of reunification. Yet his share of the proceeds has shrunk: of every euro that consumers spent on bread, potatoes, sugar, meats, dairy products and eggs in 2013, the farmer received only 23 cents. The lion’s share goes to the companies that process and market agricultural produce. The farmer’s share of revenues remains lowest for bread and cereals and highest for dairy products.

Share of sales revenues for food of domestic origin received by farmers in the former West Germany and from 1990/91 in Germany as a whole, in percent, 1970–2013, and the number of people whom a farmer in Germany feeds (ex products obtained with foreign fodder) for selected years

(Data source: German Farmers’ Association²⁰, Thünen-Institut²¹)



* Up to and including 2008, the data refer to the economic year, thereafter to the calendar year; the figure for 2014 is an estimate by the German Farmers’ Association.

tas helped to create a stable domestic market as well as income and purchasing power. Today, there are no customs duties within the single European market, while for imports into the EU there is a standardised system of import duties.²⁴ Subsidies for some export commodities have, however, led to market distortions vis-à-vis non-EU countries. The EU exports more agricultural products than it imports. And for both imports and exports, developing and emerging countries are the EU's most important trading partners. In total, the EU imports more agricultural products from developing and emerging countries than do the US, Canada, Japan, Australia and New Zealand combined – especially products that do not grow in temperate zones – and it does so, moreover, duty-free or at low duty rates.²⁵

2.2 A success story with downsides

Ever more is no longer possible

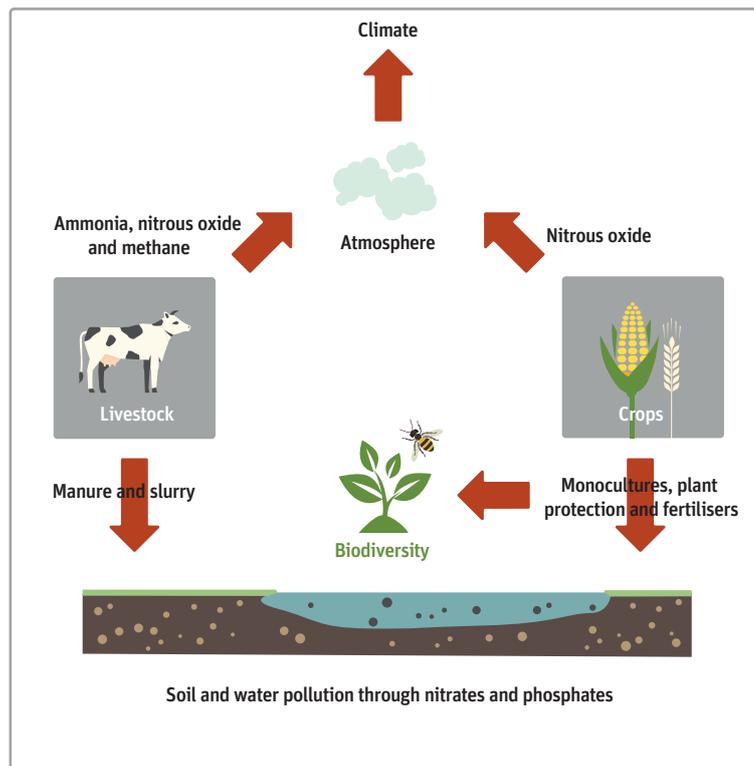
Agriculture, whether traditional, conventional or organic, is always an intervention in nature.²⁶ In some respects, agriculture in Europe is currently reaching its limits. First and foremost, the space for further expansion is lacking. Europe's farmers, from smallholders to the agro-industrial enterprises, farm almost half of the EU land area.²⁷ Through the cultivation of energy crops and the expansion of settlements and transport routes, former or potential areas for food production are being lost.²⁸ Germany loses 70 hectares of fertile and healthy arable land every day through construction – the equivalent of 98 standard football pitches.²⁹ Moreover, productivity can scarcely be increased any further in the existing cultivated areas.

Above all, though, the production of the food that ends up on our plates is barely sustainable. Today, the agricultural and food sector is a “major source of environmental pollution in Europe”, as the European Environment Agency (EEA) puts it. This is partly due to its huge energy needs. In 2013, the entire supply chain, from the production of agriculture and fisheries to the food and beverages industry all the way to the transport of food to the shops, accounted for well over a quarter of

Humans, nature and agriculture

Nature and agriculture are mutually dependent. Since time immemorial, food production has changed the landscape and nature. Conversely, agriculture depends on nature – on soil, water, biodiversity and other “services” provided by nature, such as the pollination of crops by insects. Sustainability is therefore in agriculture's own interest.

Diagram of food production
(Own diagram)



final energy consumption in the EU.³⁰ At the same time, the sector consumes enormous amounts of water. On average, agriculture in the European Union uses 44 percent of the drinking water from the public water supply. In northern Europe, farmers generally get by with little irrigation; nevertheless, in some regions agriculture accounts for more than 30 percent of water consumption. In southern Europe, with its dry climate, agriculture can consume more than two thirds of the total.³¹ In the vegetable-growing areas of Andalusia, the groundwater level is already beginning to sink.³²

In addition, according to the EEA, pollution by pesticides and fertilisers from agriculture is “one of the main causes of poor water quality” in some parts of Europe.³³ The problem with fertilisers – regardless of whether they are mineral or organic – is that the plants absorb only about half of the nitrogen contained in them. A certain proportion is washed out as nitrate into the groundwater. In Germany, agriculture is the main cause of high nitrate concentrations in the groundwater.^{34, 35}

How arable land and cattle affect the climate

Unused nitrogen from fertilisers contributes to environmental pollution in other ways, too: some of it evaporates as gaseous ammonia (chemical formula: NH_3) and becomes concentrated in the air. If ammonia from slurry and manure is included, agriculture in Germany accounts for 95 percent of total emissions of this air pollutant, which promotes the formation of particulate matter and, as a precipitate, contributes significantly to the undesirable concentration of nutrients in bodies of water and natural terrestrial ecosystems.³⁶ Moreover, some unused nitrogen from fertilised arable land escapes into the atmosphere as nitrous oxide (N_2O), which has 300 times more impact on the climate than the flue gas carbon dioxide (CO_2).

What is more, methane generated by agriculture has a greenhouse effect that is 25 times that of CO_2 . Methane mainly comes from the stomachs of ruminants such as cattle and sheep, where it forms out of the microbial degradation of plant cellulose, as well as from animal excrement stored under exclusion of air, as is the case on large cattle farms. In 2015, France had the largest number of cattle in the EU – 19 million – and was the largest emitter of methane, followed by Germany, Britain and Spain.³⁷ The same year, agriculture contributed around 10 percent to the total emissions of greenhouse gases of the EU-28. Although emissions have fallen in absolute terms since 1990, agriculture continues to be the main source of nitrous oxide and methane.³⁸ In 2015, 80 percent of nitrous oxide emissions and around 58 percent of the total emissions of methane in Germany came from agriculture.³⁹

Diversity is decreasing

Structural change in European agriculture has altered landscapes. Hedges, trees and strips of flowers have disappeared in many places and, along with them, the habitats of many animals and plants. The demand for cheap food together with urbanisation is increasing the pressure on land, as evidenced by steadily rising lease prices for arable land. The practice of farming monocultures arose out of efforts to manage the available areas as efficiently as possible. But this would be inconceivable without the widespread use of plant protection agents. Monocultures of maize, for instance, which starts to grow relatively late in the season, would not be possible if herbicides were not used to deal with the competition from wild plants.

But that has an impact on ecosystems. Even years after they were banned, long-lasting insecticides such as the chlorinated hydrocarbon lindane can still be found in the soil and water.⁴⁰ And even more modern insecticides and herbicides have become the focus of public debate about sustainable agriculture because of their possible harmful effects on

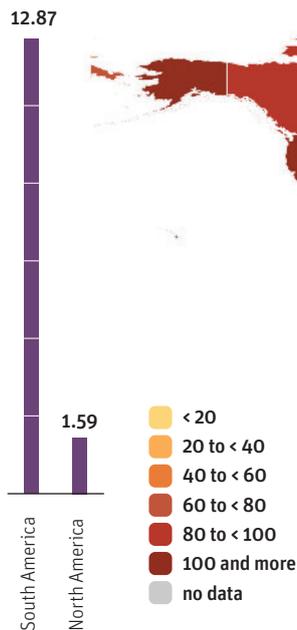
human health, on soil organisms and on other “non-target organisms” such as bees. Yet many crops, especially fruit and vegetables, depend on pollination by honey bees and wild bees.^{41, 42} A decline in the diversity of the wild plants in and around fields reduces habitats for insects. Birds that eat insects are finding less food and their numbers are hence likewise threatened.⁴³ Yet biodiversity in the field of agriculture would help to mitigate the problem of species developing resistance. The more frequently plant protection agents are used and the higher the dosage, the greater the probability that the target-species will become resistant to them and that the agent will therefore lose its effectiveness, much like the bacterial pathogens against which antibiotics no longer work. As researchers have shown, the effect of this evolutionary process weakens if a given environment is inhabited by many different species, including predators and species competing with pests.⁴⁴

Of the many other detrimental effects of intensification, we mention just one other here: raising large numbers of livestock indoors, whereby pigs or chickens held in confined spaces and physically impaired are fed concentrated feed such as soybean meal – often imported – to make them reach their slaughter weight as quickly as possible because breeders aim to get the maximum yield out of them.⁴⁵ According to the Scientific Advisory Board for Agricultural Policy of the German federal government, “in view of social change and new scientific evaluation criteria the current conditions under which most farm animals are kept will not be viable in the future”.⁴⁶

Side effects not included in the price

What the previous points all have in common is that they are not reflected as so-called externalities in the prices that consumers ultimately pay for food. It is true that, as taxpayers, consumers do contribute to the direct payments that farmers receive on condition that they adhere to the EU's high environmental, animal welfare and consumer

in million hectares



protection standards and that are designed to enable them to take care of “valuable cultural landscapes and natural resources”.⁵⁰ But in practice, in the competition for market share major retail chains exert enormous pressure on farmers to produce at low prices.

This leads to absurd developments. For example, the growing of vegetables under plastic in the once poor southern Spanish province of Almería has generated a certain degree of prosperity since the 1970s.⁵¹ The plantations provide year-round affordable peppers, tomatoes and aubergines to supermarkets across Europe and beyond. But they can do so only because they employ largely disenfranchised migrants at rock-bottom wages to work in the “sea of plastic”. Another example: since EU milk quotas ceased to exist, European farmers have made no bones about producing surpluses according to the principle of “quantity is what counts”. By 2017, EU storage facilities contained almost 400,000 tonnes of milk powder, the ultimate end storage product of the milk industry.⁵² In the absence of domestic sales markets, it is exported to non-EU countries – including those in Africa. And if farmers are unable to

sell the milk they have produced using large volumes of capital, labour and fodder, it is fed to animals. An absurd cycle in which animal-derived foods are produced with considerable effort and subsidies, only then to be used to feed animals. This raises the question of whether it is possible to produce such huge quantities and still comply with all environmental and animal welfare regulations.

Abundance but little appreciation

Europe need hardly worry whether its populations will get enough to eat, especially since the aging and, in some places, shrinking of the population is leading to a fall in demand. What is worrying, however, is that the abundance of mainly industrially processed food along with a lack of exercise and, to some extent, predisposition has become a health risk. The number of overweight and obese people, defined by a body mass index (BMI, weight in kilograms divided by height in metres squared) of, respectively, more than 25 or more than 30, is increasing. In some EU member states, the prevalence of obesity has more than tripled since the 1980s. It is estimated that around 7 percent of national

More money, more meat, more land

The wealthier a society is, the more often meat and meat products appear on the table. But this has not only side effects for human health but also a considerable impact on the environment and the climate. To produce one kilocalorie of meat, animals must be fed between five and thirty times the kilocalories of plant matter. In order to grow the necessary fodder, the intensive livestock industry in Europe claims additional areas of land outside its geographical boundaries. For all agricultural products that depend on feeding animals with imported soya, an honest price ought to reflect the growing areas abroad and the nitrogenous fertiliser without which soya, for example in Brazil, would not grow.⁴⁹

Average meat consumption (including possible household waste) in kilogrammes per capita and year by country, 2013 (see map) and areas of more than 1 million hectares that the EU uses in other regions of the world to grow soya, in million hectares, average 2008–10

(Data source: FAO⁴⁷, WWF⁴⁸)

health budgets are spent on the treatment of diseases related to overweight.⁵³ In 2014, in the EU-28 about 45 percent of women over 18 were overweight, and more than a third of those were obese. Fifty-nine percent of men over 18 were considered overweight and of those, more than a quarter were obese.⁵⁴ Since the end of the 1990s, children and adolescents have likewise become much heavier.⁵⁵

Prevention campaigns, which recommend, among other things, eating the so-called “five a day” of fruit and vegetables and less meat, fat, sugar and salt, have so far had little success. Attempts to make the food industry take responsibility by creating more transparency about ingredients and calorie levels are still in their infancy. Some EU member states have resorted to imposing a sugar tax on sweet drinks to reduce consumption.

If more people in Europe were to eat according to their actual calorie needs, consume only moderate amounts of meat and attach more importance to freshly prepared food, this would not only be beneficial to their health: it would also reduce environmental pollution from agriculture. And this effect would be even stronger if less food were thrown away or left to rot, for example because it does not comply with norms. Excess supply and low prices have resulted in consumers appreciating agricultural produce less – whether fresh or processed. In Germany alone, approximately 15 million tonnes of food end up in the rubbish bin each year.⁵⁶ In 2012, an estimated 88 million tonnes were squandered in the EU-28; that is about 173 kilogrammes per capita. More than half of this waste is probably generated by households.⁵⁷

2.3 Which is the right path to more sustainability?

Organic not necessarily better

Attempts to counteract these trends and make Europe’s food supply more sustainable have been under way for some time now. Thus, the share of organic farms is rising in most EU countries, and the demand for regional, animal-friendly and environmentally sound food is likewise increasing. This is happening quite slowly, however, and began only when the negative impact of intensification and industrialisation percolated down to people outside the agricultural sector and to normal consumers. Farmers in sub-Saharan

Africa, by contrast, need to find the right solutions straight away if they are to leapfrog Europe’s undesirable developments.

But what are the right solutions? There are a number of different answers to this question. It is clear that industrial agriculture, with its enormous use of chemicals and energy, cannot serve as a model for sustainability – i.e. an agricultural economy that meets the growing need for food without endangering finite resources.⁵⁸ Yet making European agriculture completely organic, as some people have called for, is likely to be difficult. According to a review of 150 studies and meta-analyses, the benefits of organic agriculture for the environment and the climate compared with conventional agriculture are less obvious if the comparison is in terms of production units rather than per hectare of arable land. For without mineral fertilisers and pesticides, organic farming cannot increase the yield to the same extent that conventional farming can, which means that more arable land is required to produce the same amount of food. Ultimately, an analysis of 164 comparative studies came to the same conclusion. Depending on which product group and which environmental impact was considered, the one of the other system came out better. The answer was clear only on two indicators: organic farming – apart from the cultivation of vegetables – is consistently superior in terms of energy consumption; but when it comes to land use, it is generally worse than conventional agriculture.⁵⁹

In reality, even strictly organically farmed crops cannot do without chemicals such as copper sulphate. Conversely, the use of herbicides before sowing in the so-called no-till farming method can have ecological advantages. The dead plant matter forms a mulch layer, which protects the soil from erosion, making ploughing unnecessary. The soil thus remains fairly loose. A mulch layer can also be formed by green manure crops such as phacelia or catch crops, which suppress wild plants and can be mown and shredded before sowing.

Smarter and more efficient farming

What are the consequences for Europe? While there are indeed different schools of thought, as a study by the European Environment Agency says, all of them would emphasise the importance of innovation as a catalyst for change – and not just one single ground-breaking innovation, but many different ones. That is, “technological, social, institutional and organisational change as well as changes in behaviour”. In other words, the whole of society needs to be get involved, from consumers to producers and from suppliers to policymakers. The goal must be to reconcile the desire for low environmental pollution, food security and viability of rural communities.⁶⁰

For farmers, that means, above all, using the factors of agricultural production intelligently and efficiently. Take energy, for example. So far, on average 70 percent of agriculture in the EU relies on fossil fuels such as oil and gas for the energy it requires to drive tractors, combine harvesters and other machinery. Power for the ventilation of stables or hay lofts and for milking or drying accounts for 16 percent. Yet, only 8 percent uses renewable energy sources. In addition, farmers can optimise their energy consumption not only directly through savings, wherever possible, but also indirectly by using fertilisers and pesticides systematically and sparingly, since their production and transport uses energy, too.⁶¹ To save on fertilisers means to decrease greenhouse gas emissions – and to reduce operating costs. Thinking more in terms of cycles, as organic agriculture aspires to do, can help as well.

Pesticides can be used more sparingly, too. Integrated plant protection entails natural mechanisms for controlling pests as well as the use of synthetic agents – in “economically and ecologically reasonable” quantities. This includes the use of seeds that have been bred to be resistant to infestation.⁶² Appropriate crop rotations or generally growing a greater variety of crops and species reduces

susceptibility compared with monocultures.⁶³ Insects can be caught with pheromone traps or combatted using the push-pull method, which involves growing plants alongside crops whose natural messenger substances repel (“push”) insects or attract (“pull”) their natural predators. As in the case of all biological methods for disease and pest control, such plants must be precisely matched to the crop and growing area in question.⁶⁴ And like all methods discovered so far or to be developed in the future, the push-pull method depends on research being done into both the life cycles of the pests and the biology of the crops as well as into how the two interact with all possible environmental factors.

Recently, digitalisation, too, has permitted a more protective treatment of resources. Animals receive their food according to their individual needs. Robots milk cows or clean stables. Sensors tell farmers if the milk-cooling machine is working properly or if the soil is too dry and needs to be watered. “Smart” agricultural machinery uses satellite navigation and networking to help farmers optimise the timing and scope of tasks such as tilling the soil, sowing, crop management and harvesting.

Without knowledge no change

All these high-tech methods require a great deal of professional expertise and advice if they are to meet the goal of “reducing the consumption of water, fertilisers and pesticides to the necessary minimum and thus optimally exploiting the yield potential – and with a lower environmental impact to boot”, as an agricultural journal put it.⁶⁵ Likewise, biological methods work only on the basis of knowledge, experience and understanding of how things are related.

Whether in Europe or Africa, the key to change is to broaden the information base, to conduct research and develop and exchange knowledge between theoreticians and practitioners.⁶⁶ According to the World Agriculture Report from May 2009, scientific findings

and new technologies combined with the experience and knowledge of practitioners on the ground provide the best basis for minimising the negative effects of agriculture on the environment, for helping poor smallholders out of poverty and for eradicating hunger. Europe has a good chance of generating improvements and innovations thanks to its many research institutes and companies. In the early industrialised countries, there are 65 times more scientists per million residents than in Africa and far more money – both private and public – flows into agricultural research.⁶⁷

What follows from all this for sub-Saharan Africa? As described, the available areas of agricultural land can scarcely be expanded – unless this is done at the expense of forests and other natural habitats. If the region is to feed its growing populations through its own efforts, then both large and small farms on existing areas will need to become more efficient, smarter and more sustainable and will have to farm more according to cycles. And at the same time, they must seek to make more out of their products and to generate more revenue from them.

3 | LEARN FROM EXPERIENCE

Thesis: The smallholder-dominated agriculture of sub-Saharan Africa presents an opportunity to achieve higher yields via an intelligent and efficient use of resources and thereby to initiate the structural change required to turn it into a driver of development. If it makes this leap, Africa will be able to benefit from Europe's experiences and innovations.

3.1 Great leap forward in small steps

Change must come from farmers themselves

To recap: While many of the spontaneous and controlled developments and upheavals in European agriculture have slashed the number of farms and rural jobs, many jobs have emerged in the industries related to primary production and will do so sooner or later in other economic sectors as well. The farmers who remain have a below average, albeit secure income owing to huge subsidies. The transportation, distribution, sale and processing of their products are all assured. The agrarian and food economy supplies food in unprecedented quantities, quality and variety at affordable prices – prices that do not, however, factor in the costs of the damage to ecological systems.

Generally speaking, in sub-Saharan Africa, farmers are unable to supply the population with sufficient food because they have so far failed to make the necessary changes and innovations and because effective governance has been lacking. Many governments of sub-Saharan countries keep prices for staples

artificially low – a widespread practice in under-developed regions in general – in order to protect their populations against fluctuations in world market prices. This makes it more difficult for farmers to obtain decent revenues from their products and to establish a foothold in their own markets. As described in Chapter 1, African smallholders are cut off from changes or innovations not least because of a lack of roads, power supply and other fundamental infrastructure and hence they also lack access to information.

In places where in recent decades the situation of the rural population has improved, the impetus usually came from outside. International development aid, as development cooperation was known until the 1980s, contributed significantly to creating the fundamental conditions for such improvements. As a result, in many places the rural population now has at least access to clean water and better health care. These usually simple hygiene and medical measures together with food aid, which reached not only conflict zones but also other areas, ensured that the population's state of health improved and that children, in particular, died less frequently of infectious diseases at an early age. There was, however a flip side to the success of these laudable efforts: namely, it unintentionally contributed to strong population growth. This was because a declining mortality rate was not accompanied by progress in socio-economic development in whose wake fertility rates normally fall.¹ While this does not mean that this aspect of development cooperation was wrong, it shows that cooperation, whether state, private or corporate, must always keep the whole picture in mind and be aware that

in the long run, support from the outside must equip people with the skills for independent socio-economic development. The aim of both government and non-government development cooperation must be to make itself superfluous as soon as possible.

Various models

What does this mean for the changes that must take place in African agriculture in order for it to drive development? The frequently cited model of China is rather unsuitable for demographic reasons. The income differences between the countryside and the cities likewise drive rural inhabitants in China into urban conglomerations. Owing to the Chinese one-child policy, however, these people are comparatively few in number and the urban economy is able to employ them. By contrast, the rural population of Africa is still growing rapidly and the cities do not offer sufficient employment opportunities.² Brazil cannot be a model either, because its success has come at a high price. Owing to a large-scale Brazilian-Japanese development and settlement programme for the Cerrado, which has the largest variety of species of any Savannah landscape in the world, Brazil has gone within the space of a decade from being a net food importer to the world's biggest exporter of beef, poultry, sugar cane and ethanol and the second-largest soya exporter.³ But the expansion of agricultural land is threatening the ecosystem of the Cerrado. Back in 2010, the Brazilian Institute of Geography and Statistics (IBGE) warned that without protection and monitoring the natural vegetation would be "simply eradicated" within a short period.⁴

Nor can Europe serve as a model, but it does point to some ways out. To a large extent, agriculture in Europe is still in the hands of small and medium-sized enterprises. In areas immediately surrounding the farms there are a large number of upstream and downstream enterprises offering employment. For some time now, it has been customary for farming enterprises to specialise, for example in dairy or vegetables, or to diversify by offering “holidays on the farm” or pursuing other side-lines. At the same time, converting to exclusively organic production has become more common. In addition, the social discussion about the negative effects of intensification and the wrong turnings that have been taken in food production is comparatively advanced, at least in Western Europe. Integrated solutions reached the practical testing stage some time ago and new ones are constantly being devised. All of this is the result of a kind of evolutionary process that began in the pre-industrial age and helped drive industrialisation and has continued to accompany development right up to the age of service-based economies. This process cannot be reconstructed in one fell swoop, but it can be undertaken in smaller, ecologically and socially tolerable steps⁵ – in which Africa can benefit from both the good and bad developments that Europe has experienced over time.

Food security first

Sub-Saharan Africa must first manage to provide its own populations with sufficient supplies of staples. This means above all that it must increase productivity in the cultivation of grain and starchy tubers such as manioc. What is more, structures are required to enable smallholders to organise themselves in order to gain better access to know-how and resources and possibly to pool land and work together. The next step entails growing marketable products and moving beyond subsistence farming – for instance, by having shared facilities at which to store and market the harvest in order to obtain better prices.

Beyond that enterprises must also diversify and supply regional markets with good-quality products, which to date have often been imported, including vegetables, chicken and fish from aquaculture. Over time and with increasing entrepreneurial spirit, enterprises will emerge that might, for example, produce manioc flour and then manufacture other products out of it locally. Such value chains create a larger number of jobs, and more attractive ones to boot. Little by little income is generated and development promoted.

3.2 How African farmers can become more productive

Intensify, but in a sustainable manner

Intensification must not take place at the expense of environment and climate. The experience of Europe and the Green revolution has taught us this. Africa has the chance to do things better and to produce more using fewer resources but making more efficient use of them. The American authority for development cooperation, USAID, coined the term “sustainable intensification” in 1996. In a strategy paper, USAID recommended that African farmers use capital and operating resources in a way that would simultaneously raise productivity and protect the environment and water as well as improving the fertility of the soil in the long term.⁶ Sustainable intensification means assessing the four most important production factors in terms of usage and overheads: water, soil, biodiversity and land.⁷ This goal can be pursued in different ways and using a variety of methods. Of particular note is the “climate-smart” approach to farming, because African agriculture suffers to a greater extent than its European counterpart from frequent droughts, heavy rain and flooding. Climate-smart is a method of farming that increases productivity and income and not only reduces greenhouse gas emissions as much as possible but also builds up adaptability and resistance to the effects of climate change.⁸

But what does sustainable, “climate-smart” intensification entail in concrete terms? We have already described some suitable agricultural practices in the preceding chapter. For example, farms that combine crop farming with animal husbandry can bring the nutrient cycle full circle and save on mineral fertilisers. This has proved a successful model for protecting the soil in Savannah landscapes.⁹ In many places, insecticides can be replaced by biological methods; these can be natural products or traps which, for example, attract cotton moths with molasses. Or clever use can be made of messenger substances from various, specially cultivated plants to repel harmful insects or to attract their predators.¹⁰ This “push-pull” method was developed by scientists at the International Centre of Insect Physiology and Ecology in Kenya in the 1990s. Thousands of East African farmers were able in this way to improve their maize harvest markedly.¹¹ Meanwhile, smallholders in southwestern Ethiopia have successfully been combatting the maize stem borer pest since 2013, as well as the parasitic weed striga, using purely biological methods.¹²

Protect the soil – and still harvest more

The direct seed method already mentioned has several advantages. Not having to plough saves energy and protects the soil. The mulch layer retains humidity, promotes the growth of soil organisms and makes it more difficult for weeds to grow as well as protecting against wind erosion. In addition, it cools down the atmosphere locally, because the field radiates less heat compared with the naked earth. In Zambia the Conservation Farming Unit (CFU), an independent association, advocates this “conservational” cultivation method. The farmers get more out of their fields simply by not, as was customary previously, churning up the soil through hoeing, ploughing and using cultivators but instead making grooves or indentations in the soil in which to sow the seed. And productivity rises still further if the farmers diversify – that is,

cultivate other crops, preferably legumes, either alongside or in alternation with the main food staple, maize. This is, in fact, a well-known method. But in Africa it has been forgotten in many places or else suppressed through false incentives. According to the CFU, the willingness of the farmers to grow legumes depends on whether there is a market for them and what price they can obtain,

in the case of Zambia also on state interventions to promote the cultivation of maize.¹³

As part of conservation farming, mineral fertiliser can be used particularly efficiently and sustainably if it is not scattered over the whole field surface but planted in the form of small capsules in the seed hole – a recess that also makes it possible to use water spa-

ringly – either at the same time as the seed or three to four weeks later, when the seedlings start to grow towards the light. This “micro-dosing” method was developed by researchers at the Niger branch of the International Crops Research Institute for the Semi-arid Tropics (ICRISAT) in the 1990s. In Niger, Mali and Burkina Faso, the researchers trained 25,000 smallholders in this method, and in some cases the latter managed to more than double their yield of millet and sorghum. In Zimbabwe, too, a programme supported by ICRISAT scored considerable successes.¹⁴ The scientists point out, however, that the technology has not yet become widely used because access to it and the relevant training are lacking.¹⁵

Malawi: Sustainable intensification

“Maize is life,” they say in Malawi. A thick mash called nsima made out of maize flour is the staple in this small, densely populated, landlocked country in southeast Africa. Maize grows on 70 percent of Malawi’s arable land. The state programme of subsidies for improved fertiliser and seeds has contributed to an increase in yields.

But there are still many more improvements to be made. Maize is cultivated as a monoculture by most smallholders. Were they instead to use adapted agricultural methods and alternate maize with legumes, they could save on nitrogen fertiliser (see p. 20). Scientists are currently working together with smallholders to put this into practice in a project of “Africa RISING” (whereby RISING stands for Research into Sustainable Intensification for the Next Generation). Supported by the US authority for international development (USAID), scientists are studying how in three regions of sub-Saharan Africa, smallholders, particularly women, can improve their food and income situation and at the same time conserve natural resources.

In two districts of Malawi, scientists from the International Institute for Tropical Agriculture (IITA) are involved in a field research project that is experimenting with how to optimise the cultivation of pigeon peas and peanuts as intermediate crops on smallholder farms of between 0.4

and a maximum of 2 hectares. Combining maize with these two kinds of legumes has several advantages. After one “maize year”, both crops are sown at the same time at the beginning of the rainy season, normally in December. The peanuts are ready for harvest the following April, the pigeon peas in July. Thus the plants do not have to compete for nutrients, water and light while they are growing. In the intermediate year, the farmers harvest two crops on the same land and enrich the Malawian diet with vegetable protein. The harvested plant material serves as natural nitrogen fertiliser for the following maize season and at the same time protects the soil against erosion. Now Africa RISING is ensuring that farmers get quality-certified legume seeds, which they can subsequently reproduce themselves. The farmers involved were convinced of the advantages of cooperation with scientists, says Regis Chikowo, project coordinator for Malawi. And the Malawian government found the system so good that it advocates extending it to the whole country.¹⁶

GOOD PRACTICE

For a “greener” Green Revolution

These few examples illustrate that there is no single right way. Some approaches kill several birds with one stone. For example, terracing hilly terrain protects against soil erosion and makes irrigation easier. Some advantages can be gained only at the cost of a disadvantage. Moreover, many methods have not widely proved viable under the different climatic and soil conditions of sub-Saharan Africa. The following incomplete selection of topics serves to demonstrate that there is no shortage of ideas and models for African farmers to engage in sustainable intensification but that frequently there is a lack of local expertise, investments and political framework conditions.

Seed: “Seed is to agriculture what microchips are to information technology.” This was how the recently deceased Harvard development expert Calestous Juma, a native Kenyan and author of a book on agricultural innovation in Africa, described the central role of improved varieties for increasing productivity.¹⁷ After all, improved seeds for cereals bred via traditional methods was how the original Green Revolution began. In the 1970s and 1980s, most sub-Saharan African countries were preaching the introduction of “modern” high-yield varieties via state

institutions. But to no avail. And even in the 1990s, when many governments campaigned for privatisation and the liberalisation of the seed market, the majority of African farmers continued to retain seeds from each harvest for the next growing season.¹⁸ This is mainly because smallholders can otherwise never be certain whether they will be able to obtain seed, and above all, whether they will be able to afford it. The seed industry offers mainly hybrid seeds, which have to be purchased repeatedly and grow best in combination with mineral fertiliser. Without improved seeds, farmers have no chance whatsoever of achieving higher yields.

Yet if the continent's food supply is to be secured, it is vital that an efficient African seed sector develop that links informally gathered experience and knowledge with the innovations of the commercial system, which are based on scientific advances.¹⁹ According to Juma, there is currently little reason to be concerned that global companies could take over control in Africa. While these companies are active in most African countries, the market is, in fact, dominated by local start-ups, which are well placed to improve the livelihood security of neglected rural communities. However, these need better access to credit as well as more research and qualified personnel.²⁰ In addition, a distribution and marketing system must be established that

ensures not only that farmers receive high-yield, quality-controlled seed adapted to local conditions at affordable prices but that they use it in an appropriate way. If reliable political framework conditions permit planning security, an agricultural value creation chain will emerge that could give a boost to rural areas.²¹ Since 2003, the Seeds of Development Program (SODP) has supported 25 domestic seed companies in eight African countries to network with one another, train staff and do market research.^{22,23}

Irrigation: In Benin, a funding project being carried out by ICRISAT has improved the quality of life of female vegetable farmers. Thanks to a solar-powered drip irrigation

Zambia: How agriculture can become marketable and attractive to young people

GOOD PRACTICE

Three times a day, Charles Shawa sets off from home, passes by the gardens and fields belonging to his family and makes his way to the artificial pond in which he keeps fish. There he makes sure that everything is as it should be. "We've diversified and connected everything," the young man explains. The water from the pond is used to irrigate the surrounding fields. The hen droppings provide nutrients that promote the growth of algae, which is used to feed the fish so he has to buy less feed. "In the end, the number of fish I have will increase and my expenses will decrease."

Charles chose agriculture as his main subject at secondary school. It was there that at the beginning of 2016 he came across Yapasa, a joint project of the Food and Agriculture Organization (FAO) and the International Labour Organization (ILO) in Zambia that is funded by Sweden and supported by the Zambian government. The aim of the project, which runs until the end of 2018, is to offer 3,000 young women

and men living in rural areas employment opportunities through improved value creation chains for soybeans and fish and at the same time tackle widespread malnutrition with these protein-rich products.

Zambia has many rivers and lakes. Some 55,000 people live from catching, processing and selling fish. But demand is increasing and the population is growing, so some bodies of water are already overfished. This is where the project comes in: thanks to the abundant water available, native fish can be bred with the help of aquaculture. Moreover, soya is the most important source of vegetable protein used in fish feed.

Yapasa helps local entrepreneurs who breed stocking fish, produce fish feed or process and market fish to build up their businesses. This is not always an easy task. For example, banks are reluctant to give credit to inexperienced young entrepreneurs. And that leads to a vicious circle:

poor farmers are unable to borrow money to invest, which means that innovation falls by the wayside and the smallholders remain poor. But Charles has broken out of that cycle. A private firm employed him, together with 30 other young women and men, as a fish producer and lent him the equivalent of around 1,200 euros at favourable conditions so that he could invest in the construction of a pond and buy the necessary equipment, feed and baby fish for the first stocking of the pond. Charles has reached an agreement to supply fish to another local firm. And with the proceeds from the fish sales, he is gradually paying off the loan. The aim is that within two years, the young Yapasa participants will be independent so that other young rural inhabitants can join the business and the potential suggested by the project name realised: Yapasa means "the plan has worked".²⁴

Ethiopia: Putting biological wealth to use

GOOD PRACTICE

The region at the Horn of Africa holds a resource that is of major importance for feeding the populations not only of the continent but of the whole world. It is home to an extraordinary diverse range of wild varieties of important crop plants, including durum wheat, emmer, barley, pearl millet, sorghum and coffee. The wild varieties contain genes that are of inestimable value for the cultivation of more robust and adaptable strains. To preserve this the Ethiopian Biodiversity Institute (EBI) has been collecting samples since 1976 for the oldest and largest plant gene bank in Africa.²⁵ This resource was left unused for a long time. In the mid-1990s, Reinhard von Broock, agrarian biologist and senior adviser to the German seed producer KWS Saat SE, had an idea: If the samples were systematically examined, Ethiopian farmers could use the knowledge gained to grow and multiply high-yielding and robust seeds that were suited to the natural habitat.

Since 2011, this idea has been realised through a project that is part of a programme being carried out in partnership with Ethiopia's Agricultural Transformation Agency (ATA) and which also includes the construction of an agricultural further training centre. Through this programme, the German Ministry of Food and Agriculture (BMEL), together with its public and private partners, wants to contribute to achieving a sustainable increase in the productivity of Ethiopian agriculture.

This is urgently needed. Ethiopian primary production employs more than 80 percent of the population and is an important economic factor – above all, thanks to the export product coffee.²⁶ But farmers

are unable to feed the rapidly growing population because they do not farm efficiently enough and frequently lack access to farming equipment. Family-run smallholdings produce less than one ton per hectare of the dwarf millet known as teff, one of the staple foods in Ethiopia.²⁷ Moreover, frequent droughts and soil erosion make the farmers' lives more difficult still. Ethiopia, which is one of the poorest countries in the world, has to import food even though it has the potential – thanks to its soils, which number among the best in the world, and what is normally sufficient precipitation, to become the bread basket of northeast Africa.

To increase productivity, improved seeds are essential, along with irrigation, mechanisation and further training. Until now, farmers have sowed the seeds that they held over from the previous harvest. Ethiopia's commercial seed sector was poorly developed, compared with that of Kenya and Uganda, for example, and fully state-run. Moreover, Ethiopia strictly abides by the international Biodiversity Convention and has a restrictive policy regarding access to materials from the national gene bank for cross-breeding in order to create new strains and has not yet regulated that process at all. Thus, there was a positive response to the idea of implementing the FAO's Global Plan of Action for Plant Genetic Resources for Food and Agriculture,²⁸ designed to boost plant breeding and give farmers themselves the opportunity to reproduce improved seed and sell it to other smallholders. In the meantime, various farming cooperatives have been very successful in these endeavours – and this is absolutely legal because Ethiopian regulations on registering and “putting

into circulation” new varieties of seeds and plants explicitly provide for an “informal sector” alongside the formal one. But more recently, the Ethiopian government has been working on new legislation governing seeds. In the course of this process, the transformation authority, the ATA, has realised that it makes sense and has been able to convince others that it is in the country's interests to allow not only state and commercial organisations but also enterprises run by the farmers to produce and sell seeds locally.²⁹

And that is what has happened. Today the cooperatives – both those already existing and those that have emerged under the ongoing BMEL programme – are able to expand their production. Moreover, they now have better opportunities to certify their seeds, i.e. have them examined for grade purity and germination capacity and obtain a quality seal. Until now, only state institutions, of which there are too few and which still work slowly, were allowed to do so. In each region, the government has begun to establish a certification laboratory with test sites. Certification is not obligatory and requires an additional fee, but it is worthwhile both for producers and buyers. “Farmers are prepared to pay the high price if they can be sure that they will obtain higher yields with the seeds,” Reinhard von Broock has found. “Because in this way, they will have much more income than they have additionally invested.”³⁰

Genetic engineering to combat malnutrition and promote sustainable intensification?

The idea that genetically modified seeds could solve Africa's productivity problem in one fell swoop is controversial. But in fact the cultivation of genetically modified crops could actually further sustainability: it does away with the use of insecticides, for example in the case of chick peas that have a built-in defence against the maruca moth, a notorious pest that thrives on pulses and frequently destroys half the harvest.³¹ Or in the case of transgenic maize, which with the help of a bacterial gene is resistant to the autumn armyworm, which was recently introduced to Africa.³² However, cotton farmers in Burkina Faso have had bitter experience with genetically modified seeds: thanks to a bacterial gene that provides defence against the voracious bollworm and which the manufacturer introduced into the local strain of cotton, they have better harvests but no longer of the famous high-quality fibre which previously brought them a good profit.³³

Among those considered especially beneficial are genetically modified food crops with trace elements and vitamins that are normally not present in important food crops or only in tiny amounts. Such crops allow not only ensure basic food security but also combat "hidden hunger" (see p. 13). For example, "golden rice", which thanks to an inserted foreign gene forms the Vitamin A precursor beta-carotene in the grain, could protect children living in underdeveloped regions from gradual blindness, growth disorders and weakened immune systems, all of which are consequences of an unbalanced diet deficient in Vitamin A. But to this day farmers have been unable to cultivate golden rice on a large scale, above all because owing to fundamental criticism of GM foods, there have been massive protests against its cultivation. So far, no country has registered golden rice as biosecure.^{34, 35} Recently, Australian

researchers developed a transgene "golden banana" with a higher carotene content. Their colleagues in Uganda are currently researching how to apply the technique to a local variety of banana.³⁶

Other ways work, too

Meanwhile, bio-enrichment is also possible using traditional cultivation methods. Within the framework of the large-scale international programme "HarvestPlus", scientists have succeeded in creating various food crops with a higher content of those micronutrients in which the poor are often deficient. Since 2011, manioc enriched with Vitamin A has been cultivated in Nigeria. In 2012, the programme led to the development of "golden" maize in Zambia and iron-enriched beans in Rwanda. And in Uganda and Mozambique, more than 60 percent of farmers are cultivating an orange-coloured variety of sweet potato developed by HarvestPlus scientists. Above all, children and women benefit from this intake of Vitamin A.³⁷

Africa's "orphans" in plant cultivation

The recently discovered CRISPR/Cas "gene scissors" and modern sequencing technologies that allow the sequence of DNA building blocks to be decoded both quickly and inexpensively are paving the way for new possibilities in plant cultivation. With the gene scissors, the genome can be precisely "edited"; thus, manipulated plants in which no foreign DNA has been inserted cannot be differentiated from the usual crossbreeds.

In future, DNA sequencing will facilitate the application of a modern, non-genetic cultivation method. Using artificial DNA segments or so-called genetic markers,

traditionally generated crossbreeds with the desired properties can be identified quickly and in a targeted manner and then further cultivated. Until recently, research has decoded mainly the genomes of economically important crops such as rice, maize and wheat. Now, an international consortium with headquarters at the World Agroforestry Centre in Nairobi plans to decode the genomes of 101 food plants that are commonly eaten in Africa but are largely overlooked by breeders. For this reason, they are dubbed the "orphan crops". Manioc, sweet potatoes and yams are just some of the species to which the researchers of the African Orphan Crops Consortium (AOCC) will devote themselves. Many are naturally rich in vitamins, micronutrients, antioxidants and other health-promoting substances. But according to the AOCC, there are huge differences in content and composition because farmers rarely use standardised seeds or ones that have improved on the wild variety.

One of the first plants whose code researchers cracked is finger millet, which, in the form of porridge or bread, forms part of the daily diet of many Africans. For each of the 101 planned species, the scientists will draw up a genetic map of 100 varieties, i.e. variants within a species that have slightly different traits. From the data sets, they will be able to determine which DNA segments are responsible for the formation of certain properties. Their research findings will be made freely available so that growers can enable smallholders to cultivate varieties of bitter melon, plantain and breadfruit that are higher yielding and richer in nutrients.^{38, 39}

system, the women no longer need to spend five hours a day bringing water to their fields in buckets. They can use their strength and working hours more efficiently and thereby harvest and earn more.^{40,41} Where there is water nearby, fields can be irrigated with the help of treadle pumps and muscle power. Invented in Bangladesh, treadle pumps have proved useful in many places in Africa.⁴²

Jain Irrigation Systems, an Indian enterprise and partner in the “Grow Africa” programme of the African Union, is pursuing a business model that is sustainable for African smallholders, too. Jain sells simple, water-saving drip and sprinkler systems and supports customers not only to amortise those systems but even make a profit out of them. Beside irrigation devices, Jain therefore also supplies seeds and fertiliser as well as providing credit for their purchase, technical advice and advanced training in all aspects of raising productivity. Finally, the company buys the fruit and vegetables its customers produce and processes and markets those products.^{43,44}

Mechanisation: For many young people in the countryside, particularly women, agricultural labour is too strenuous. It therefore needs to become less labour-intensive and less exhausting. Tractors and machinery replace muscle power through fossil energy and create more jobs in production and supply – provided they are created in the country – in trade, rental businesses, repair and technical advice. The machines commonly used in Europe are, however, rarely suitable for African conditions. At the International Maize and Wheat Improvement Center (CIMMYT) in the Ethiopian capital, Addis Ababa, which is a member of the Consulting Group for International Agrarian Research (CGIAR), engineers have developed simple machines that can be adapted to African conditions and have produced them at their own manufacturing facility. In the context of a mechanisation programme, local CIMMYT partners are training young people locally as agribusiness service providers, equipping them with the

requisite technical know-how. Once they have finished their training, they receive a set of equipment consisting of a two-wheel tractor, a trailer for transport, a water pump and a thresher and sheaf-binder for harvesting. From the income they generate as contractors for farmers, they must deposit 80 percent of the investment sum into the bank account of a local micro-financing institution of the regional Chamber of Agriculture within two years. In this way, other service providers can receive credit. They must finance 20 percent themselves. In pilot projects in Ethiopia, Tanzania, Kenya and Zimbabwe, this model has proved successful.^{45,46} But there are also programmes that provide financial support for individual farmers; these not only use their machines on their own fields but also rent them out to other smallholders, which allows them to pay off their loan. In addition, they teach the farmers the necessary skills to handle the machines, which they themselves have acquired in the course of the programme, in a rational way that conserves resources.⁴⁷

Digitisation: Africa’s leapfrogging with respect to mobile phones has led to several other major leaps. While Europe continues to use cash, poor African rural inhabitants in particular, who usually have no bank account, are already accustomed to making transactions via mobile phone. Ingenious people are continually developing new mobile services for these devices, which, among other things, help smallholders to farm better and more sustainably, for example, by getting advice via text message from “iCow”, while “M-farm” gives them an overview of current market prices and thus improves their negotiating position vis-à-vis middlemen. For its part, the Nigerian government sends electronic vouchers via text message to organise the distribution of subsidised fertiliser and seed.

Information and communications technology (ICT) is already changing agriculture in Africa and it will do so to an even greater degree in the future. For example, the Uganda Coffee Farmers Alliance (UCFA), which brings to-

gether approximately 54,000 smallholders, has trained some staff to record the volumes supplied by each producer in the area under cultivation precisely, quickly and simply and to convey this information to the central clearing house via smartphone.⁴⁸ Satellite, soil and weather data permit real time monitoring and can, for example, forecast precipitation volumes. This enables farmers not only to receive advance warning of adverse conditions but also to insure themselves against losses incurred through hail, drought or livestock epidemics.⁴⁹ ICT can make an important contribution to ensuring that ideas and new technologies for sustainable intensification reach African smallholders even in the most remote regions – as long as the necessary infrastructure and the educational prerequisites are there. Otherwise there is a danger that the so-called digital gap will widen still further.⁵⁰

3.3 The framework must be right

Self-organisation

How can as many smallholders as possible gain access to all these ideas and innovations or vice versa? How will they manage to find the money to invest and acquire the knowledge required to develop an entrepreneurial mind-set or, as contracting parties, assume a better negotiating position? Advice and networking via mobile services are a good start. But it is better to network face to face, pool resources or found cooperatives. Just as poor farmers in Prussia and Austria in the 19th century did at the suggestion of the social reformer Friedrich Wilhelm Raiffeisen. He had recognised that it was not dispensing charity that would help them overcome their woes but rather helping them to help themselves. The cooperatives collected savings deposits from their members from which each member in turn could take out a loan at favourable conditions. They organised the common purchase of seeds and fertiliser in order to be able to negotiate more favourable

Mobile phones widespread, electricity rare

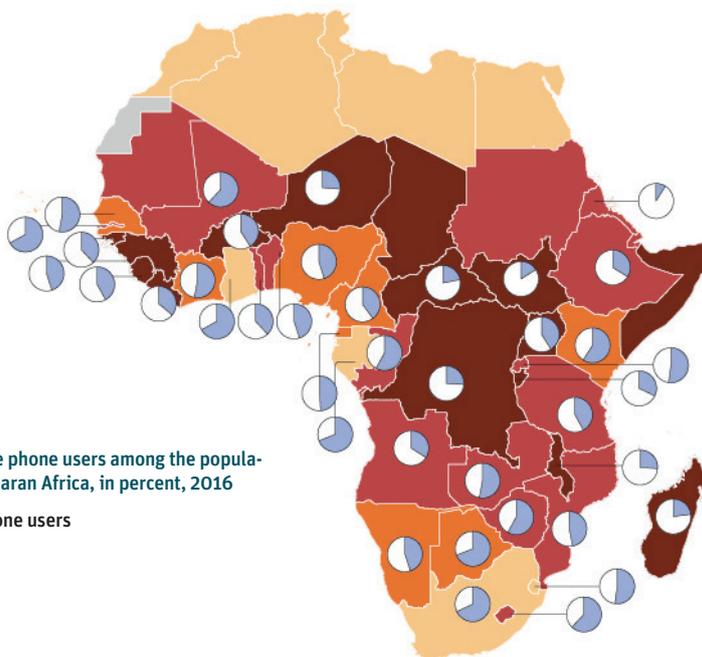
In the rural areas of sub-Saharan Africa, only one inhabitant in four is connected to the power grid. Mobile phones, by contrast, have spread rapidly. Today, 420 million people or 44 percent of the population in sub-Saharan Africa use a mobile phone. By 2020, it is likely to be 535 million. That means that around half of all Africans would then have at least one mobile phone contract. Smartphones, too, are becoming ever more common. In the last two years alone, their number has doubled to nearly 200 million.⁵¹

(Data source: International Energy Agency⁵², GSMA⁵³)

share of households with access to electricity, in Africa, in percent, 2016



share of mobile phone users among the population of sub-Saharan Africa, in percent, 2016



Kenya: Income security, even during droughts

The smallholder Jane sowed her maize on 15 March – the magical date that marks the beginning of the rainy season. But this year, the longed-for precipitation was too late and too meagre. The expensive seeds went to waste and, with no harvest, Jane would be unable to buy new ones next year. She was fortunate, though, to number among the first 200 maize farmers in the district of Laikipia in central Kenya who in 2009 got involved in the experimental project Kilimo Salama – Swahili for “more secure farming” – and insured their seeds. Two weather stations had shown that the amount of precipitation was below the threshold that Kilimo Salama had previously determined with the help of an indexation model. This meant that the insurance conditions had been met. The pioneers of the project were reimbursed for 20–80 percent of the value of their lost seeds. Jane was able to repeat sowing and bring in the harvest after all.

Kilimo Salama was a project of the Syngenta Foundation for Sustainable Agriculture and the Global Index Insurance Facility (GIIF) of the World Bank from which Agriculture and Climate Risk Enterprise (ACRE) emerged in 2014.⁵⁴ From 2009 to 2017, it allowed more than one million smallholders in Kenya, Tanzania and Rwanda to insure food crops worth 75 million US dollars against weather-related risks. The system works as follows: On the basis of weather and other indexation models, ACRE develops special insurance products tailored to meet the needs of smallholders and passes them on to professional insurers whose previous clients were mainly large-scale farming enterprises. These companies do not market the insurance products directly to the smallholders themselves because most of the latter know little about them and are likely to shy away from what they assume are high costs and a lot of paper work. Instead, ACRE makes use of the marketing structures of seed and fertiliser producers.

The trained salesmen offer the smallholders insurance along with the seeds. If the client decides to take out the insurance, the salesman sends the mobile phone number to ACRE and within five minutes the farmer receives information about his/her insurance policy without having had to fill out a single form. If the harvest fails, the farmers do not have to wait for an inspector or valuer to assess the damage. Using historical and satellite-based data, ACRE draws up a weather index. Deviations from this index determine whether the smallholder is reimbursed for his/her seeds. And that is transferred directly to the M-PESA account of the client through which he/she paid the insurance premium.

The potential for index-based insurance products such as those of ACRE is huge. Local business, European insurers, international donors and the governments of many African countries have already realised this and are prepared to invest in the development of this value chain.

Kenya: How a mobile service is linking smallholders

Kaptumo, a village in a sparsely populated region in west Kenya. One morning, the farmer Clara wants to milk her two cows. But it is already the third consecutive day that one of the animals has had trouble standing up. What can she do? The only person whom she could ask for advice is the official inseminator, but he is always on the move and hard to reach. Then Clara remembers the WeFarm network, to which she sends a text message. In just 10 minutes, she receives an answer on her mobile phone from another WeFarm member. The sender, who is a smallholder too, knows what the problem is: the cow could be suffering from a calcium and phosphorus deficiency that weakens the bones. Another WeFarm member responds: the remedy is to be found in fodder that contains minerals; the best and cheapest is to be obtained from barley sprouts, which will germinate in trays of water within a few days. Clara immediately procures seeds and grows her own “hydroponic” fodder. It does not take long for the cow to stand up alone again and Clara, a single mother to five children, has learned something that has a positive effect on the productivity of her small farm.⁵⁵

A sick animal, pest infestation, soil erosion or intermediaries who purchase the smallholders’ harvested crops at below market prices are just some of the challenges that smallholders have to deal with each day. But since they began using the text messaging service WeFarm, which was developed by two British development workers, more than 600,000 farmers in Kenya and Uganda no longer have to face these challenges alone. The service is based on the idea that there is no problem for which another smallholder somewhere or other has not already found a solution.

WeFarm is just one of many mobile phone platforms that are changing the daily lives of Africa’s smallholders. They enable small-scale successes such as that enjoyed by the smallholder Clara. At the same time, they offer the potential for larger-scale improvements, as researchers at Harvard and Stanford have shown. Simple reminders such as “Don’t forget to clear the land of weeds this week,” which were sent by SMS to Kenyan smallholders, led to the sugarcane yield increasing by more than 11 percent.⁵⁶

In Kenya, mobile phone services are generally very popular. One reason for this is “M-PESA”. Ten years after its launch, the mobile payment system is allowing 18 million Kenyans to make payments or transfer money via text message – something they were unable to do previously as most Kenyans do not own a bank account.⁵⁷ In the meantime, not only has Kenya become the world market leader in mobile banking; M-PESA has acted as a catalyst for subsequent innovations that have been developed by members of the start-up scene in the Kenyan capital, Nairobi, which also goes by the nickname of Silicon Savannah.⁵⁸

The WeFarm representative for Kenya, Jamila Abass, is among those driving such innovations. She grew up in a village on the border with Somalia as the daughter of smallholders. Her parents were so poor that they did not even have the eight dollars needed for the entrance examination for the secondary school. Thanks to support from relatives, the talented pupil was able to continue her education and went on to obtain a university degree in computer science. Jamila combined the skills she had acquired with her knowledge of the

everyday reality of poor rural households. Before joining WeFarm, she developed the app and text message service M-Farm, which allows smallholders to obtain better deal for their harvests.⁵⁹

In principle, every piece of information is just a couple of clicks away with the new mobile phone services. But if they are to improve conditions for smallholders, the latter must learn to trust that information. With its social network for small-scale farmers, WeFarm has paved the way for this to happen: the exchange among smallholders takes place on an equal footing. Thus, the initial successes could be consolidated and the user community expanded. It helped that WeFarm, which started out as a pilot project of a British foundation, has meanwhile secured further funding. Today, WeFarm has developed into a social enterprise whose goal is to link smallholders all over the world and to become self-supporting in the long term.

Nigeria: High-tech for poor farmers

Ndubuisi Ekekwe grew up in a village in southern Nigeria as the son of farmers. More than one tenth of all children in the world who have no access to primary education live in Nigeria. However, Ekekwe was an excellent pupil who went on to study electronic engineering in Nigeria and the United States. After obtaining a doctorate from Johns Hopkins University in Baltimore, he developed special sensors for a US company. He has received patents for various inventions, and lectures and carries out research at a US and a Nigerian university. And he has founded several firms, including one in Nigeria for data-driven agricultural technologies aimed at helping, in particular, African smallholders with little capital to increase their productivity. “Zenvus” developed,

among other things, simple and inexpensive “Smartfarm” sensors, which look like mushrooms and are stuck into the ground. The mushroom stalk measures humidity, temperature, acidity and nutrient content and the mushroom cap sends the measurement readings to the main sensor, which, wireless and solar battery-run, collects them and forwards them to a cloud server. On the basis of complex models, the farmer can receive information about the state of his cultivated land on his mobile phone or computer, if he has one, via a free app. In the same way, the company offers advice and information about financing possibilities, market prices and distribution channels for agricultural products, among other things.

GOOD PRACTICE

Whether this technology will become widespread remains unclear. But Ekekwe has a vision: to transform African agriculture through technology. It would be a huge step forwards if, in the areas of pest control, sowing, soil cultivation, irrigation and harvest, farmers could refer to analyses of climate and soil data to ensure the rational use of labour and resources that are in short supply. In this way, young people, too, could be motivated to opt for employment in agriculture. But before that can happen, according to Ekekwe, the necessary infrastructure must be created.⁶⁰

prices. Thanks to central storage depots and the common marketing of their harvests, they could wait in times of excess supply and low revenue until prices rose again. Over time, a rural savings and credit bank was established in nearly every village. At the same time, the cooperatives bred more efficient varieties of working animals, shared the use of expensive machines, built and operated slaughter houses and dairies and converted surpluses into tradable products such as cheese. Self-organisation in the cooperative movement saved the farmers from poverty, gave them a strong market position and paved the way to intensification and modernisation. Beside the savings banks and cooperative banks a whole series of enterprises in upstream and downstream sectors emerged, many of which still exist today.

Traditional systems to deposit small sums in a common pool and to lend each member of the group in turn a larger sum are recorded as having existed in West Africa since the 15th century. In some places they continue to exist to this day.⁶¹ Such informal micro-saving and credit funds can provide an income, particularly to female smallholders. The formation of cooperatives and other such organisations puts the system on a broader and more reliable footing. The forced state promotion of cooperatives in the early decades after independence did not, however, bring as much progress as expected. Particularly in the countries of sub-Saharan Africa, in which socialist governments tried to force the farmers to form collectives, this type of organisation still has a bad reputation among many rural inhabitants today.

Where, however, cooperatives have been formed voluntarily and on a profit-oriented basis, they have often succeeded in improving living conditions. In countries such as Uganda, cocoa, coffee and tea growers, who produce their crops for export, have formed cooperatives. But cooperatives are useful in the production and marketing of food for the local or internal African market, too. Many cooperative umbrella associations all over the world, including the German Cooperative and Raiffeisen Association, are running projects in Africa in order to train farmers and young cooperative managers in personnel and organisation development.⁶² In 2008, a survey found that the agricultural cooperative movement in Africa was weak and fragmented but experiencing an upswing. For the majority of those involved, mainly the poor, the cooperative is the only institution that protects them reliably against market risks and improves their social conditions.⁶³

Support from above and outside

If the vision of an Africa that within a generation could feed itself and create a “modern, competitive and ecologically sustainable agrarian sector” is to become reality, then the political will has to be there. In the past, African governments’ national development plans have failed to recognise the significance of agriculture as a provider and driver of structural change, as the economist Peter C. Timmer concluded. Unlike in East and Southeast Asia, both state and private investments in Africa have virtually all targeted urban centres rather than aiming to increase rural productivity.⁶⁴ Nevertheless, now, after a century of neglect, a lot has been set in motion by politicians determined to bring about change, Calestous Juma concludes. In his book *The New Harvest*, Juma has collected information about a large number of programmes, initiatives and plans.⁶⁵

The following describes just the most important ones. The New Partnership for Africa’s Development (NEPAD), a framework development programme launched by the African Union in 2001 with its headquarters in Johannesburg, focuses inter alia on agriculture. To implement this programme in the agrarian sector, the Forum for Agricultural Research (FARA) was founded with headquarters in the Ghanaian capital, Accra. This was followed in 2003 by the Comprehensive African Agricultural Development Program of the African Union mentioned at the beginning of this chapter. This obliged national governments to spend 10 percent of their budget on the agrarian sector. In 2011, the African Union together with NEPAD and the World Economic Forum founded the Grow Africa Partnership as a platform designed to bring together governments, domestic and foreign agrarian investors as well as smallholders.⁶⁶

The member states of the African Union committed themselves in the framework of the CAADP to annual economic growth in agriculture of at least 6 percent and to spending at least 10 percent of their budgets

on that sector. In 2014 they also pledged in the capital of Equatorial Guinea, Malabo, to eradicate hunger on the continent, to halve poverty via the transformation of agriculture and to triple internal African trade in agricultural goods and services by 2025. Years were spent stock-taking, putting together strategy documents with priorities, so-called Compacts, and both national and regional agricultural investment plans. By spring 2015, 41 member states had signed Compacts, 33 of them had developed national plans and four out of eight regional economic communities had developed regional plans.⁶⁷

Nevertheless, despite all the declarations of intent, pledges and plans, progress has remained extremely modest. Initially there was some ambiguity about task distribution between the supervising institutions NEPAD and AU, and in several countries some wrangling between ministries over competencies. This, along with badly coordinated programmes running in parallel or the (erroneous) expectation that donors could be mobilised with the assistance of the CAADP, are just some of the reasons why implementation has been so sluggish.⁶⁸

Still no sustained success in Malawi

In 2005, the small state of Malawi became the first African country to increase its agrarian spending to 16 percent of the budget. At that time, over half of the population had to make do with less than the equivalent of one US dollar per day, while a quarter did not have enough to eat and a third no access to clean water. Nearly 80 percent of the employed population worked in agriculture, over half of them below the subsistence level. Repeated droughts, soil degradation and misdirected privatisation policies had led to low yields and high prices for the staple maize.⁶⁹ Instead of asking for food aid, Malawi’s then president, Bingu wa Mutharika, took over as head of the Ministry of Agriculture, had improved seed and fertiliser imported and, using vouchers, distributed them at highly subsidised prices to smallholders. Within two

years, the farmers had doubled their maize production – among other reasons, because it had rained again. In this way the country was able to cover its internal requirements and even had a surplus to export. The programme was later extended to include training courses and investments in irrigation, and the private sector became involved, too. Moreover, the World Bank is supporting the country in its efforts to implement new agrarian and seed policies.⁷⁰

However, Malawi’s farmers are still cultivating their maize fields in a largely unsustainable way and they have to contend with the loss of nutrients and erosion (see p. 8).⁷¹ Malawi is still one of the poorest nations in the world, but there are grounds to hope that the country will achieve its demographic bonus. In 2005, when the agrarian programme began, the fertility rate was about 6.5 children per woman, which meant the number of inhabitants would have doubled within 23 years.⁷² Now women in Malawi have 4.6 children on average.⁷³

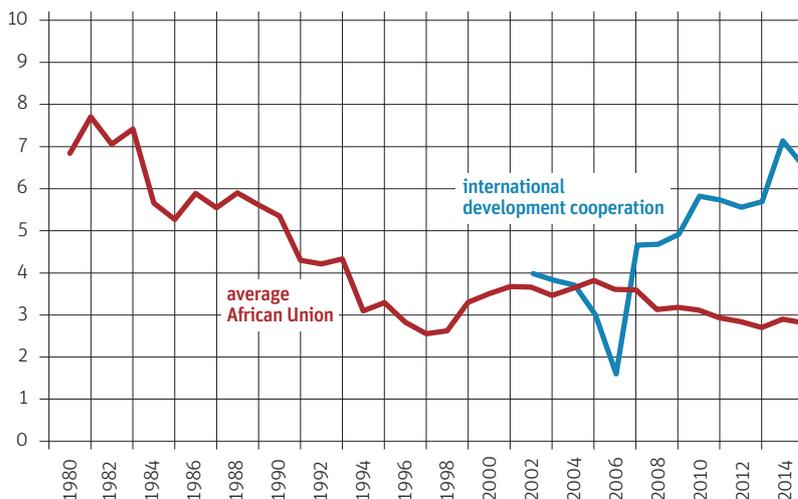
More co-operation is imperative

International development cooperation agencies and the major donors are among those funding many programmes and initiatives to further sustainable intensification and the structural transformation of African agriculture, in particular, in order to achieve the first of the 17 UN sustainable development goals: a reduction in poverty⁷⁴ – and offering people the prospect of a future in their homeland. The governmental development organisations have for some time expressly been trying to involve investors from the private sector and to initiate projects in so-called public-private partnerships (PPPs). Governmental development co-operation programmes in the EU member countries, however, run parallel to one another with little coordination and target different areas, as an independent study showed. Better coordination would not only save administrative costs but also use funds more efficiently.⁷⁵

Pledges not kept

Since the global food crisis of 2007/2008 – caused essentially by the rise in world market prices for important staples – international development cooperation has put more money into agriculture, while expenditure by African states on the agrarian sector has remained persistently low. In theory, farmers could benefit from higher market prices because these would bring them more revenue. But to do so they would have to produce considerably more food than they need for their own requirements. The lack of appropriate state investment means that this scarcely happens in Africa.⁷⁶

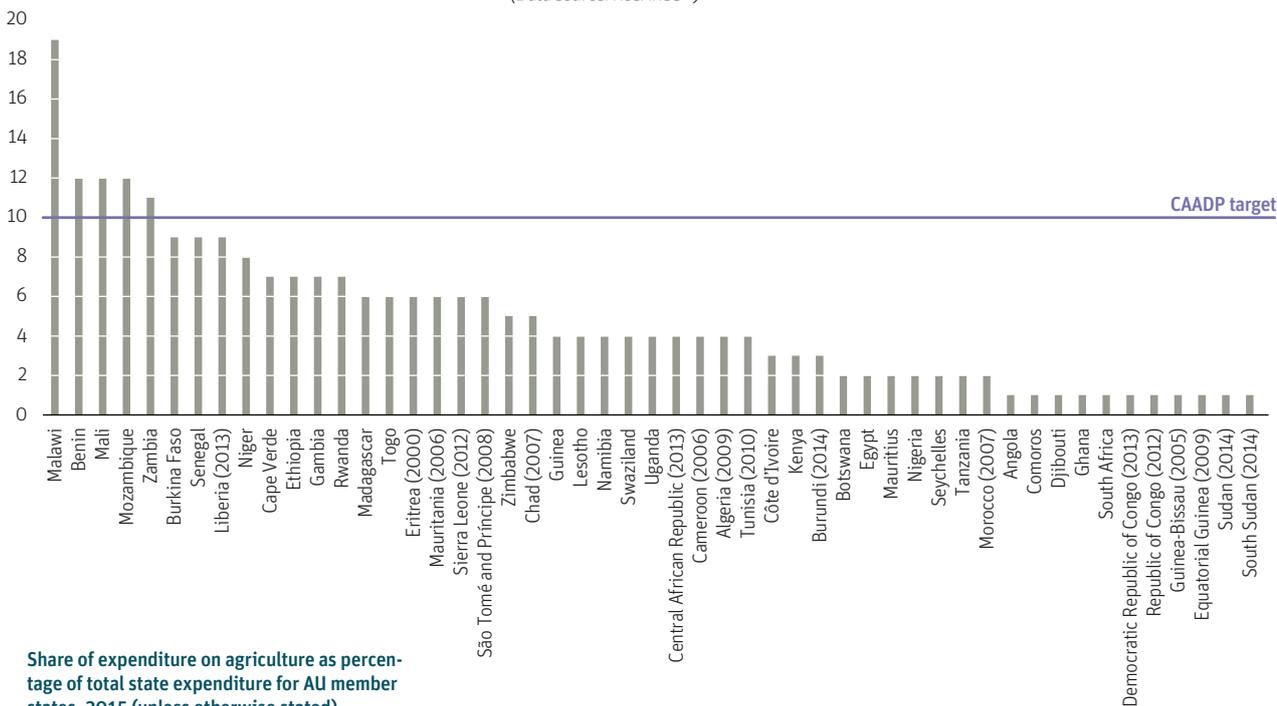
in percent



Share of expenditure on agriculture as a percentage of total state expenditure by the countries of the African Union (AU), 1980 to 2015, and share of funding for agriculture as a percentage of total funding provided by state international development cooperation, 2002 to 2015.

(Data source: ReSAKSS⁷⁷)

in percent



Share of expenditure on agriculture as percentage of total state expenditure for AU member states, 2015 (unless otherwise stated)

(Data source: ReSAKSS⁷⁸)

A mixed picture in Tanzania

The impact of the enormous flows of cash and expertise that both governmental and non-governmental organisations have channelled into the sustainable development of agriculture in sub-Saharan Africa, will, however, be limited if policy does not follow a coherent strategy. A study of Tanzania serves to illustrate this point.⁷⁹ Sub-Saharan Africa's fourth-largest country in terms of population in fact offers optimal conditions for the transformation. On the one hand, Tanzania has plentiful land and water reserves, a favourable climate for agriculture – temperate in the uplands, tropical on the coast – as well as relatively well-developed traffic routes and a large port at Dar es Salaam. What is more, peace, democratic reforms and progress in economic growth have made the republic a “favourite” of Western donors and investors. Five percent of all development aid for Africa goes to Tanzania and this has led to progress in the agrarian sector, among others. The Tanzanian government has outlined a number of plans and programmes for eradicating poverty, for developing the agrarian sector and for promoting partnerships between the public and private sectors under the Kilimo Kwanza (Agriculture first) programme.

Existing economic communities

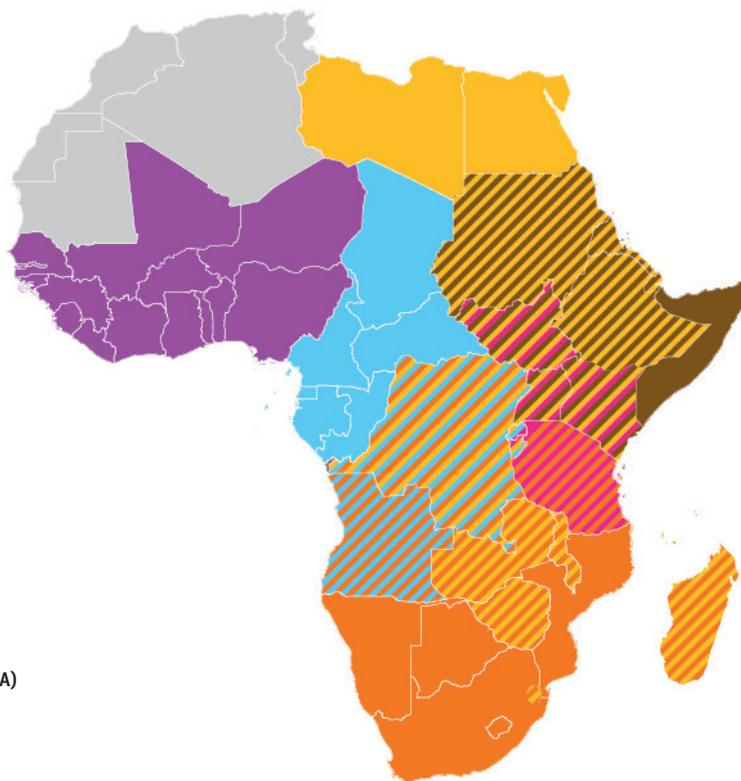
Six regional trade partnerships in Africa are modelled on the EU. Their aim is to promote regional trade in sub-Saharan Africa and to ensure stable internal African markets. Until now, cross-border trade has been obstructed by the still high practical and institutional barriers and the lack of infrastructure. The export of agricultural products from the countries of sub-Saharan Africa takes on average six days longer than in any other region of the world.⁸⁰ An Africa-wide free trade zone (CTFA) is planned but will not go into effect until 2019 at the earliest.

(Own diagram based on World Bank⁸¹, UNDP⁸²)

-  Common Market for Eastern and Southern Africa (COMESA)
-  East African Community (EAC)
-  Economic Community of Central African States (ECCAS)
-  Intergovernmental Authority on Development (IGAD)
-  Economic Community of West African States (ECOWAS)
-  Southern African Development Community (SADC)

Initiated by the G7 and funded by the World Bank, the Southern Agricultural Growth Corridor of Tanzania (SAGCOT) has been set up by the government within the framework of this programme. The official target is to encourage investment in smallholder agriculture on one-third of the total areas of farmland with the help of public-private partnerships and to facilitate access to commercial markets for smallholder farmers. Commercial enterprises have, however, used state land that was previously farmed collectively by smallholders, giving rise to some conflicts.⁸³ At the same time, smallholders in the SAGCOT area have undergone training in “farming for business” and are encouraged to cultivate beans, sugar peas and other vegetables that will bring them far more revenues on foreign markets than the so-called cash crops.

The results of all these efforts are mixed. While there are indeed examples of the successful integration of smallholders into the value chain of large agro-enterprises and food companies, other projects are faltering at best, the above-mentioned study concludes. The fact is that the fields of smallholders have become ever smaller through repeated divisions, and the country's poverty rate remains persistently high. Improvements in living conditions have been evident mainly in the urban conglomeration Dar es Salaam, but there is little sign that this trend will reach rural areas in the foreseeable future.⁸⁴ One indicator of the country's sluggish development is the fertility rate, which has dropped only slightly in the past two decades and, at 5.7 children per woman, augurs the prospect of continued high population growth.⁸⁵



What is to be done?

What the governments of the countries between the Sahara and the Cape of Good Hope must do to bring about sustainable development in agriculture can be summarised in several points:

1. Invest in rural infrastructure: Power supplies, transportation routes and telecommunications are fundamental prerequisites for connecting farmers with markets. Where there is a lack of transport and opportunities to obtain information, smallholders will have to put up with middlemen dictating prices. Adequate healthcare is likewise a precondition for better living conditions in rural areas. Preventive medical examinations, vaccinations and medical advice can in themselves reduce child mortality, which is still high in some places. Only if fewer children die will fertility rates decline in the long term.

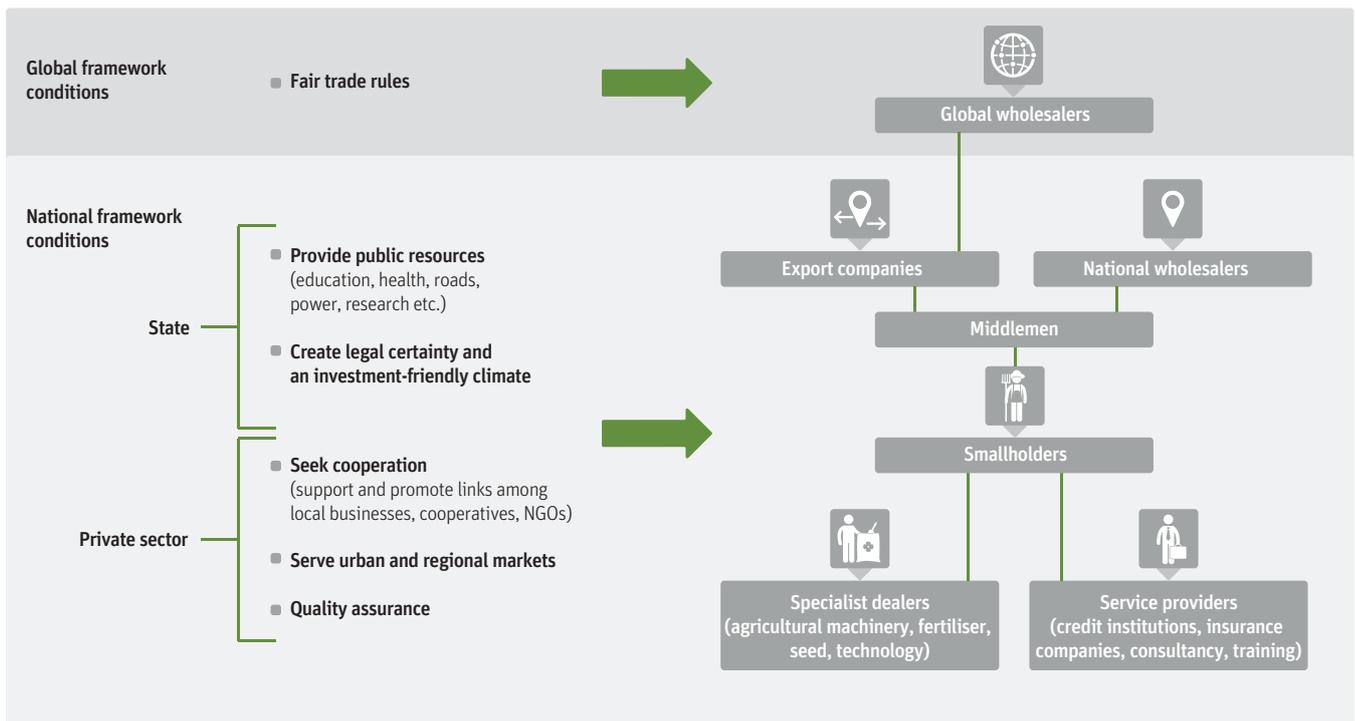
2. Invest in education, research and knowledge transfer: Basic formal education, which enables people to understand how things are interconnected and thus put new information into context and increase their knowledge, is still lacking in many places. An enlightened society is more readily able to change ingrained thinking and behavioural patterns, for instance, with respect to diet and health risks, but also as regards the cultivation of crops and animal husbandry methods. Research and development at universities and institutes contributes significantly to innovations for the sustainable intensification of agriculture. But Africa is losing many qualified people because they find better prospects of conducting research or founding companies elsewhere. Research cooperation and the establishment of university clusters could put a brake on this “brain drain” and keep much-needed professionals in the country.

3. Promote entrepreneurship and value creation: Governments cannot create jobs in industry, but they can promote consulting opportunities or incubation centres for start-ups and generally provide an investment-friendly environment, so that it is easier both for inventive locals and investors from outside to found companies and establish

Link smallholders with markets

To gain better access to urban and regional markets, smallholders need support – and in the best-case scenario this will come from several sources. National governments have a duty to provide schools, health-care, transport routes and power grids. Farmers’ cooperatives, NGOs and state development cooperation can act as intermediaries between different participants in the market and thus help smallholders to raise their productivity and negotiate high prices for their harvest.

(Own diagram after Parshotam⁸⁶)



value chains. In the current Ease of Doing Business Index of the World Bank, the island republic Mauritius and Rwanda are the only sub-Saharan countries among the first 50 of 190 places; most other countries in the region find themselves at the bottom of the scale.⁸⁷ Every intervention that paves the way for private investors must, however, take account of the smallholders in the region and improve their socio-economic situation.⁸⁸

However, this primarily entails creating jobs and income opportunities in the first place. At present the tendency is more towards informal employment, which is not fundamentally wrong. Particularly for women, young people and low qualified workers, the opportunity to engage in small-scale unregistered business and thus make a little money offers an alternative to unemployment.⁸⁹ The African Development Bank has identified institutional weaknesses as one of the reasons why the informal job market in sub-Saharan Africa dominates (see p. 13). Others are high

taxes and non-transparent taxation systems, complicated or obstructive regulations for business enterprises and uncertainty concerning private property.⁹⁰ Yet governments must receive tax revenues, not least in order to combat corruption. In the long term, the goal must be to turn as many insecure or informal employment relationships as possible into formal employment.

4. Open up markets in a regulated manner:

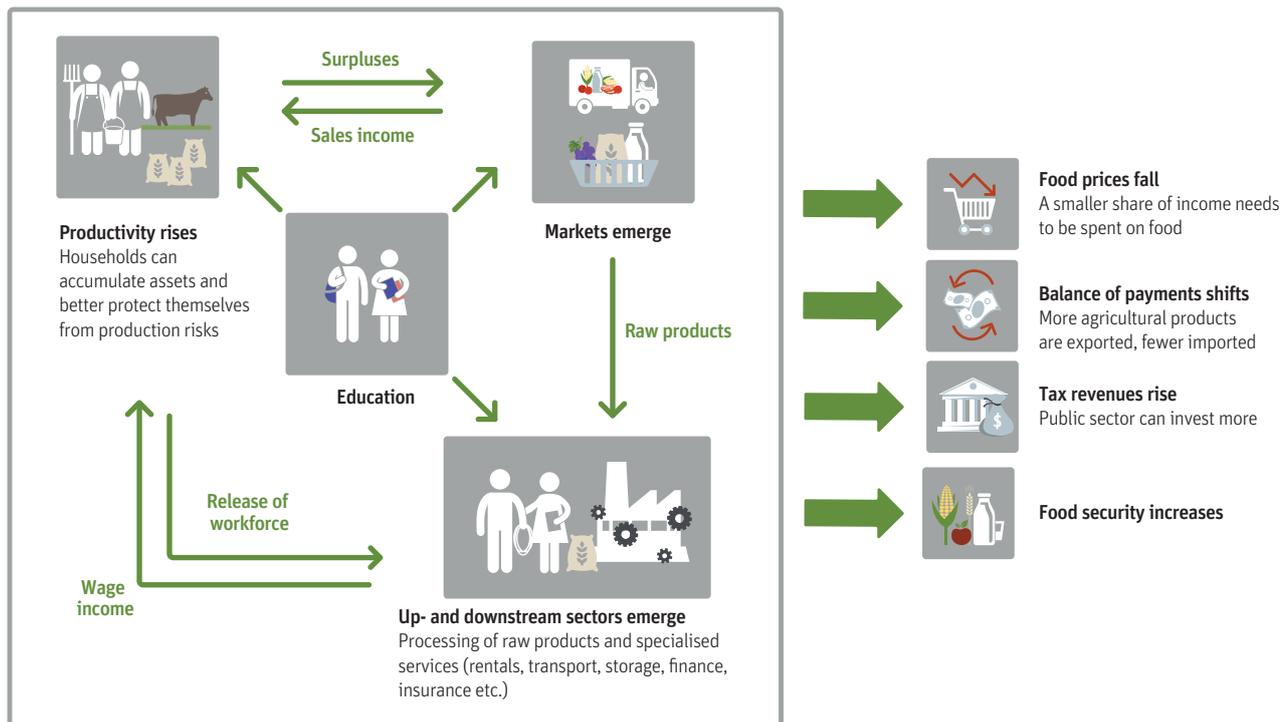
Experience, not just that of Europe, has shown that in the early stage of the transformation it makes sense for countries to temporarily protect their markets in order not to expose farmers suddenly to global competition.⁹¹ The state must, for example, shield agriculture from competition from cheap imports of milk powder and other products from the EU and at the same time negotiate better conditions for the import of African products into the European single market.⁹²

However, governments must also respond flexibly to changes and remove customs barriers when it is important to open up regional markets and permit inner-African cross-border exchange.⁹³ An association of countries with conditions similar to those of the European Union and which develop a common strategy and an internal market

How agriculture can drive development

The transformation begins when farmers raise their productivity and gain access to markets, where they can sell their surpluses and cash crops. At the same time, jobs emerge in the up- and downstream sectors of agriculture. In the course of this process, the number of people employed in agriculture itself declines, while developing industrial and service sectors create formal employment. If this trend continues and people gain security and prospects for the future, then population growth declines in the long term. It is the latter that is currently making it difficult for sub-Saharan Africa to consolidate the progress it has made in economic development.

(Own diagram after ACET⁹⁴)



only partly open to the outside can create incentives to increase agricultural productivity in Africa, too, and ensure competition and affordable consumer prices. There have been some initiatives in this direction recently, but it is still unclear whether they will work.

5. Clarify land rights: Smallholders need land to ensure their livelihoods. Practices such as buying up commonly used land, expropriations or the forced conversion from grazing to arable land lead to conflicts and obstruct development. Governments must clarify property rights, rights of disposal and rights of usage so that farmers invest and intensify, conclude lease or purchase contracts or organise themselves collectively. They should also establish gender equality because women, who play a key role in subsistence farming, are excluded in many countries from owning land. Ethiopia, Kenya, Rwanda and Uganda have already changed their corresponding legislation.⁹⁵

Ethiopia and Rwanda have made keeping systematic records of land rights possible thanks to the use of simple mapping methods.⁹⁶ In a pilot project Uganda has introduced a computerised land register system based on survey and geo-informatic data.⁹⁷ In 2017, following the end of the civil war, which was partly about land rights, Mali issued a law on agricultural land. Supported by the Tenure Facility, an NGO, local commissions have been formed in order to solve ongoing property and usage disputes by mutual agreement.⁹⁸

6. Create a basis for trust: In the long term, the transformation will succeed if farmers, private investors, development cooperation organisations and donors can rely on a transparent policy with a recognisable strategy. On the world map of the NGO Transparency International, which groups nations according to the extent of perceived corruption, nearly all African countries are classified as fairly to very corrupt.⁹⁹

Côte d'Ivoire: Where women manufacture native chocolate

GOOD PRACTICE

Exquisite pralines and bars in fancy packaging can be bought at “Instant Chocolat”. Axel Emmanuel Gbaou, the 35-year-old director of the company, originally worked as a banker but underwent training as chocolatier. With the trained eye of a businessman, he recognised that: “Côte d'Ivoire is the world's largest producer of cocoa beans. But we export almost the entire harvest and leave it to foreign companies to reap the value added from the refinement process.”

As chocolatier, Gabou has risen through competitions to become the national champion in his area of specialisation and runner-up in the pan-African championship. As entrepreneur, he wants to go even further: Africa should increasingly process its own products and not only enjoy chocolate “made in Africa” but market it worldwide.

Instant Chocolat, which he founded with two friends in 2014, is only the beginning. Since 2017, the company has been working with the “Ecoya” women's cooperative based in a village near the capital of Yamoussoukro, which produces first-class cocoa. Instant Chocolat organised training and helped obtain loans to buy machines and refrigerators. The women roast the fermented, hand-picked beans and process them into couverture, the basic product for the professional manufacture

of baked goods, desserts and confectionery. The plan is to establish dozens of such cooperative manufacturers, preferably run by women, in the rural areas of the Côte d'Ivoire, which are aiming for larger gains than simply those from the sale of beans. For it is women who carry the main burden of working in the country's plantations, as Oussou N'Goran, the president of the Côte d'Ivoire's association for female cocoa and coffee growers, says: “They remain invisible, however, while the men are always the owners and pocket the money.”

The time is ripe. Demand for chocolate is growing worldwide, but so is the awareness that low prices for these sweet delicacies have their dark side: child labour, very low wages and price pressure through speculation on the world market. Recently, there have been a large number of initiatives involving the participation of the chocolate industry and retail chains whose aim is to ensure fairer conditions for smallholders and workers on cocoa plantations. Instant Chocolat is working directly on the ground. Not long ago, Gbaou's company launched “Le chocolatier ivoirien”, which offers a new brand manufactured using fairer production practices. It has been a roaring success: in the first month, orders were received for a total of 10,000 bars from six African countries as well as from France, Slovenia and the Antilles.¹⁰⁰

Ghana: How smallholders become competitive

GOOD PRACTICE

Cashew trees are easy to grow and, thanks to their root structure, provide protection against erosion. That is why at the end of the 1990s, foresters in West Africa planted cashew trees on land threatened by erosion. But hardly anyone knew what to do with the fruits they yielded. Now and again, children would eat the fruity tasting cashew “apples”. The kernels hanging on these apples and enclosed in a hard shell mostly rotted.

All that has since changed. Worldwide, there is a growing appetite for the kidney-shaped kernels. Demand is growing annually by up to 10 percent, while production is increasing only slightly. World market prices are correspondingly high – and smallholders can profit from the boom.

This they owe to the “ComCashew” initiative of the German Ministry for Economic Cooperation and Development, the Bill and Melinda Gates Foundation and various private business partners. The initiative was launched in 2009 with the goal of increasing the competitiveness of cashew producers in the West African countries of Côte d’Ivoire, Ghana, Burkina Faso and Benin as well as in Mozambique in East Africa and developing local value chains. The trigger was the realisation that while, all in all, Africa produced 38 percent of worldwide output of unshelled cashews, only around 3 percent of that production was processed on the continent. This essentially meant that shelling, preparing and sorting took place mainly in countries such as Vietnam and India. Moreover, it had been shown that African farmers could produce larger amounts if they farmed efficiently: with 250– 430 kilogrammes per hectare, they were achieving only a quarter to just under a third of the yield that was possible in India, Vietnam and Brazil.¹⁰¹

The potential was especially large in Ghana as only a small number of its farmers knew about the true value of the nuts. Back then, Victoria Ataa, for example, sold water in plastic bags at the side of the road because she could not earn enough from her fields to feed her five children and to pay school fees. One of her customers told her about the huge demand for cashews – he was the chairman of the Association of Ghanaian Cashew Farmers. But how should the widowed smallholder proceed? Ataa found out what she needed to do in several training courses run by the ComCashew initiative in which she was given advice about planting, cutting and maintaining the trees that were now growing on her fields. The yield grew from five sacks initially to 16 sacks per season. Through the training she received, Ataa knows precisely what price she can demand for her produce. The smallholders sell directly to firms that are associated with the ComCashew initiative.

“We advise and train at all levels,” says project leader Rita Weidinger from the German Society for International Cooperation (GIZ). The team has helped African scientists to develop improved varieties and provide large numbers of saplings.

GIZ employees have advised companies that process the smallholders’ harvest into a quality-assured export product. They have supported them in drawing up a business plan, put them in touch with creditors and educated them in matters related to hygiene and management. Finally, the project team has also advised government ministries on the development of national strategies on the basis of which the governments of five countries now support the cashew sector.¹⁰²

The impact of the initiative has been evaluated and the results are impressive. Around half a million smallholders in the five countries – of which around one third are women – have received advice to date. On average, they have been able to raise the annual household income by the equivalent of 600 US dollars; that corresponds to a twofold increase in cashew revenues. In the five countries, some 60 small and medium-sized firms are involved in processing cashew nuts. Almost 6,000 jobs have been created during the course of this development. Since 2009, Africa’s share in global production has risen to 56 percent, while its share in processing has grown from 3 percent to 10 percent.¹⁰³ For these tangible results, the ComCashew initiative received the 2016 Innovation Award of the OECD Development Assistance Committee.

Not only are cashew trees easy to grow; they have other advantages. They do not require much work and to date have been barely afflicted by pest infestations. And the harvest falls exactly during the “famine period” between the sowing and harvesting of other crops, when poor farmers have no other income and often not much to eat either. Cashews offer the opportunity to diversify.

“These trees have changed my life and made me a happy woman,” says the Ghanaian farmer Victoria Ataa. Using the income from the sale of cashews, she has been able to build a new house, buy several cows and send her oldest son to university in Accra. He studied agriculture and today teaches at a technical college in the capital city. His advice to his mother: “Plant more cashew trees. They are the future.”¹⁰⁴

Tanzania: Fertiliser from rubbish – a private start-up initiative

GOOD PRACTICE

The young industrial engineer Ahad Katera has shown one way in which the diverse challenges in Africa can be dealt with: his company, Guavay, successfully processes municipal rubbish into fertiliser for use by gardeners and farmers.

Katera came up with the idea in 2014. He was in his second year at the University of Dar es Salaam, Tanzania's largest city, where he had grown up as the son of a construction materials dealer. One day, the students received an email inviting them to apply to attend a seminar for future entrepreneurs. Katera was among those chosen.

Together with volunteers from the student-run Cambridge Development Initiative in England, the seminar participants looked for innovative and marketable solutions to social challenges. One problem was pressing: in the city of some 5.5 million residents, around two thirds of the rubbish is fruit and vegetable waste – peel, and over-ripe and rotten produce. That waste is not collected and quickly gives off a foul odour in the warm climate.

Together with three friends – a marketing student and two microbiologists – Katera, who was 22 at the time, developed a business model for organic fertiliser and founded the Guavay start-up. On the site of a rubbish dump a little way outside the city, he had a large building erected to serve as a production facility. Here employees crush waste products from a nearby market and pile them up. Sixty days later, bacteria, fungi and worms have turned the stinking mass of waste into an earthy-smelling organic fertiliser that is put into sacks and delivered under the marketing name of Hakika (Swahili for “secure”). The

purchasers are mainly small-scale fruit and vegetable farmers as well as landscape gardeners in Dar es Salaam, where a growing middle class is driving demand. That means the market for garden fertiliser is stable. Guavay also supplies small and medium-sized organic farmers and thus is able to profit from the high growth rates in this sector. The farmers value the fertiliser, which not only provides organically bound nutrients but also retains moisture in the soil, reducing the amount of irrigation needed.

Guavay offers solutions to three problems that at first glance have little to do with one another. First, the waste problem of the growing urban areas: while in 2000 less than one quarter of the Tanzanian population was living in towns and cities, that share had grown to one third by 2015.¹⁰⁵ More people means more rubbish. Without functioning waste management, this will become a major problem. Out of every one million tons of the biowaste that accumulates annually in Dar es Salaam, just 40 percent is collected. But if good use is made of the waste – for example, as organic fertiliser – private rubbish collectors and local communities have an incentive to take the abandoned waste to the Guavay factory.

The second challenge is the low productivity of Tanzanian smallholders. “Much of the soil in Africa is degraded,” explains Katera. “Before we can talk about food security, we have to tackle soil security.” It is here that he sees an opportunity. If he can succeed in expanding production from 10 tons a month at present to up to 50,000 tons annually and to organise transport at a reasonable cost, he could supply many farmers in the country with organic ferti-

liser – at prices below those of imported mineral fertiliser. So far, the entrepreneur has been able to raise capital totalling the equivalent of half a million US dollars for further expansion. Currently, Guavay is working together with universities to further develop the product, for example compressing it into pellets or enriching it with organic nitrogen. Two firms in Rwanda and Uganda have already shown interest in adopting the Guavay method of dealing with municipal organic waste. By going independent, Ahad Katera has already solved the third problem for himself: many African graduates cannot find a job. He long toyed with the idea of becoming an entrepreneur, he says; but when he was looking for role models on the Internet, he found only American, and virtually no African, ones. The university seminar played a decisive role in his taking the plunge. Katera wants to inspire others with his success story. For he is certain about one thing: “Now is the best time to become an entrepreneur in Africa. Technology is everywhere.”¹⁰⁶

Senegal: Domestic milk vs imported powder

GOOD PRACTICE

Some 400,000 tons of milk and milk products are consumed by the 15.8 million inhabitants of Senegal annually.¹⁰⁷ More than half of that amount is imported almost exclusively in the form of milk powder – above all, from the over-brimming warehouses of the EU. Those are astonishing figures given that some 3.5 million people in Senegal make their living as herdsman and keep almost as many cows per capita as France, which tops the EU rankings on this indicator.^{108,109} In theory, Senegal could easily cover growing domestic demand for milk and dairy products. But the reality is that less than 10 percent of the milk produced in the country appears on the market; the bulk is used by the herder households themselves.

Unwilling to accept this situation, Bagoré Bathily founded the “Laiterie du Berger” (Herder’s Dairy) in 2006. The employees of his company collect the milk produced by 400 family smallholdings in northern Senegal. After having been pasteurised or processed into yoghurt, the milk is transported 400 kilometres in a refrigerated lorry to the capital city, Dakar, where it is sold in shops and supermarkets.

Bathily, who grew up in Dakar as the son of a Senegalese father and a French mother, studied veterinary medicine in Belgium. And then he returned to Africa: “You can’t live here without seeing that nutrition is a problem. That’s why I wanted to work in animal husbandry.” As the employee of a non-governmental organisation in Mauritania, Senegal’s northern neighbour, he focused on the health of cattle. But he soon realised what the people were lacking: money. The only assets of the herdsman from the Fula tribe, who traditionally have let their cattle graze in the savannah on either side of the Senegal River (which

forms the border between Senegal and Mauritania), are their cows. Each family has on average 80 animals, but only about 10 produce milk – each around just 0.8 litres a day and that only during the rainy season, when there is sufficient fodder. By comparison: German dairy cows produce around 20 litres a day on average.^{110,111}

Once a week, the smallholders set off for the market at the next larger settlement to sell the fermented milk that they cannot use themselves. From those sales, they will earn, perhaps, all of two euros, which they spend immediately on tea, cooking oil or medication. If they need large sums of money, they try to sell a cow. But there is little demand and thus the prices are low. In very dry years, half of the herd can die off. Owing to the increasing number of droughts in Sahel, families have been forced in recent years to roam further south more often in order to graze their animals. During such periods, the children have even fewer opportunities to attend school than when they are at home. This means that the chances of the next generation ever emerging from poverty have already worsened. The women still marry as teenagers and have six or seven children.

Bagoré Bathily was sure that the living conditions of these people could be improved if the milk were collected daily and systematically marketed and that expensive imports would one day become redundant if domestic production were boosted. With the support of two friends, he drew up a business plan and began looking for the capital with which to develop a dairy enterprise. “That was difficult,” he recalls. “Bankers regarded me as too idealistic and recommended that I turn to development organisations.

They, in turn, considered my approach to be capitalist and pointed me to the banks.” Eventually, he found a fund of eight European private individuals who specialised in helping innovative young companies in sub-Saharan Africa get onto their feet by offering starting capital and a mentoring programme. Bathily built a factory in Richard Toll, a town near the border, and acquired three-wheelers, with which employees could collect milk twice a day within a 50 kilometre radius, and lorries for transporting the product to the capital. In 2007, when the company began operating, output totalled 300,000 litres. In the years that followed, the amount increased annually by 20 percent, except for 2012, owing to an extreme drought. For the first time ever, the suppliers now have a regular income, which is currently just over the equivalent of 100 euros a month.

To improve the productivity of his suppliers, the head of the company negotiated favourable supply contracts with the rice and sugar industries in the Senegal River basin for waste products, for rice straw – which until then had been burned – and for molasses from sugar production. In this way, the livestock owners obtained fodder at affordable prices to bridge the dry season. They no longer have to lead a nomadic life but can remain where they are for the entire year and send their children to school. Moreover, Bathily has developed a kind of snowball system to promote the use of breeds with higher milk yields among the herdsman. The firm establishes “mini-farms” each of which comprises four cows that are a cross between the domestic zebu Gobra and a European breed of cattle and produces at least 10 litres a day. Herdsman can work here and gain practical experience of looking after the animals. They come with three of their

own cows and, in exchange, can take one of the mixed-breed animals home with them and start their own mini-farm when, after six months, they are convinced of the advantages of the mixed breed. There are already 12 mini-farms, and a 100 such smallholdings are planned by 2022.

Until now, domestic milk production has not proved profitable on its own. For this reason, the Laiterie du Berger also processes powdered milk. With this mixed production, it has been able to increase its annual turnover twenty-fold – to the equivalent of eight million euros – since it began operating. Bathily has now launched a product line that is made 100 percent from Fula milk – a type of Senegalese organic product. While it tastes much better, it costs twice as much as competing products from processed dry milk. But the wealthy, socially aware and health-conscious customers from the Dakar middle class will buy it, he says, and the market is far from being saturated.

The company also has to demand high prices because the Senegalese government does not promote the development of a value chain for domestic milk, as Bathily explains: “Many countries in the world support their farmers through various measures. Senegal, on the other hand, has raised the price of domestic milk production and transport through various kinds of taxation while imported milk powder is unbeatably cheap thanks to lower import duties.” And the state is making the life of domestic milk producers, including the many small dairies in the rural areas, difficult in many other ways. For example, in 2016 the Laiterie du Berger had to halve the number of suppliers, which had risen from 160 initially to 800, because the company could no longer afford a newly

introduced levy on milk collection. Bagoré Bathily is not prepared to accept this situation and persists in negotiating with the responsible authorities: “We must realise the value of domestic products.”

He has good ideas and arguments on his side: his company has 280 employees, many of whom are formally employed for the first time. And the semi-nomadic herdsmen could become producers if a fodder value chain were developed from the abundant waste generated by the rice industry. “Many people here dream of going to Europe and earning a lot of money there. Their models are often successful football players but seldom entrepreneurs.”¹¹²

Ethiopia: Coffee secures rural incomes and protects the forests

GOOD PRACTICE

Smallholders in the Kaffa region of southwest Ethiopia have always known that the coffee they harvest in the forest or from the trees in their gardens has a particularly fine aroma. They take every opportunity they can to sip a bowl of bunna. In the past, they sometimes sold part of the harvest at the local market or to travelling purchasers, who, however, mixed the beans with another type of coffee that was of inferior quality before selling it to a third party. From the proceeds, the smallholders were able at least to pay for their children to go to school and for cooking oil. But when in the early 1990s the world market price for coffee plummeted, the farmers started to clear the forests, which no longer had any value for them, and to cultivate maize and millet in order to make up at least part of their lost income. However, their actions threatened to destroy the last mountain rainforests, which, like all rainforests, are of huge significance for the protection of species and climate. Kaffa numbers among the world's biodiversity hotspots and is the region from which *Coffea arabica* originates and the only place where this coffee variety is to be found in many different wild forms. It is in the local forests that the entire genetic potential of the Arabica variety, which is of considerable economic significance for a large number of tropical and semi-tropical countries, lies waiting to be tapped. Without this gene pool, new breeds – for example of plants resistant to certain pests or diseases – would be virtually impossible.

In 2002, the threatened loss of this resource stirred the German NGO "GEO Rainforest Conservation" into action. It came up with the following project idea: If the farmers could sell the first-class wild

beans to coffee connoisseurs in Europe who were prepared to pay a fair price for the product, then the value of the forest would increase again and the forest itself would be conserved. The important point here is that the wild coffee needs shade and the protection of large trees and cannot be cultivated in plantations.

In separate partnerships with the Freiburg trading company Original Food GmbH and the German Society for International Cooperation (GIZ), the NGO succeeded in implementing the project. Today several cooperatives are engaged independently in the harvesting, preparation, quality control and transport of the wild coffee right up to export. They have received support to be able to obtain organic and fair-trade certification and, in addition, have been trained in the use of agricultural waste as fertiliser and biofuel. Moreover, they have developed domestic supply chains for other certified agricultural products such as honey from the forest, spices and medicinal herbs. Some 13,000 families in Kaffa can now earn their living in this way, that means more than 100,000 people.

Joint efforts by various German and Ethiopian development and research organisations finally led in 2010 to UNESCO recognising two core zones of the forest region as Ethiopia's first biosphere reserves and designating them as protected areas. This means that the prospects for conserving the natural habitat of the wild Arabica coffee over the long term are good.¹¹³

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