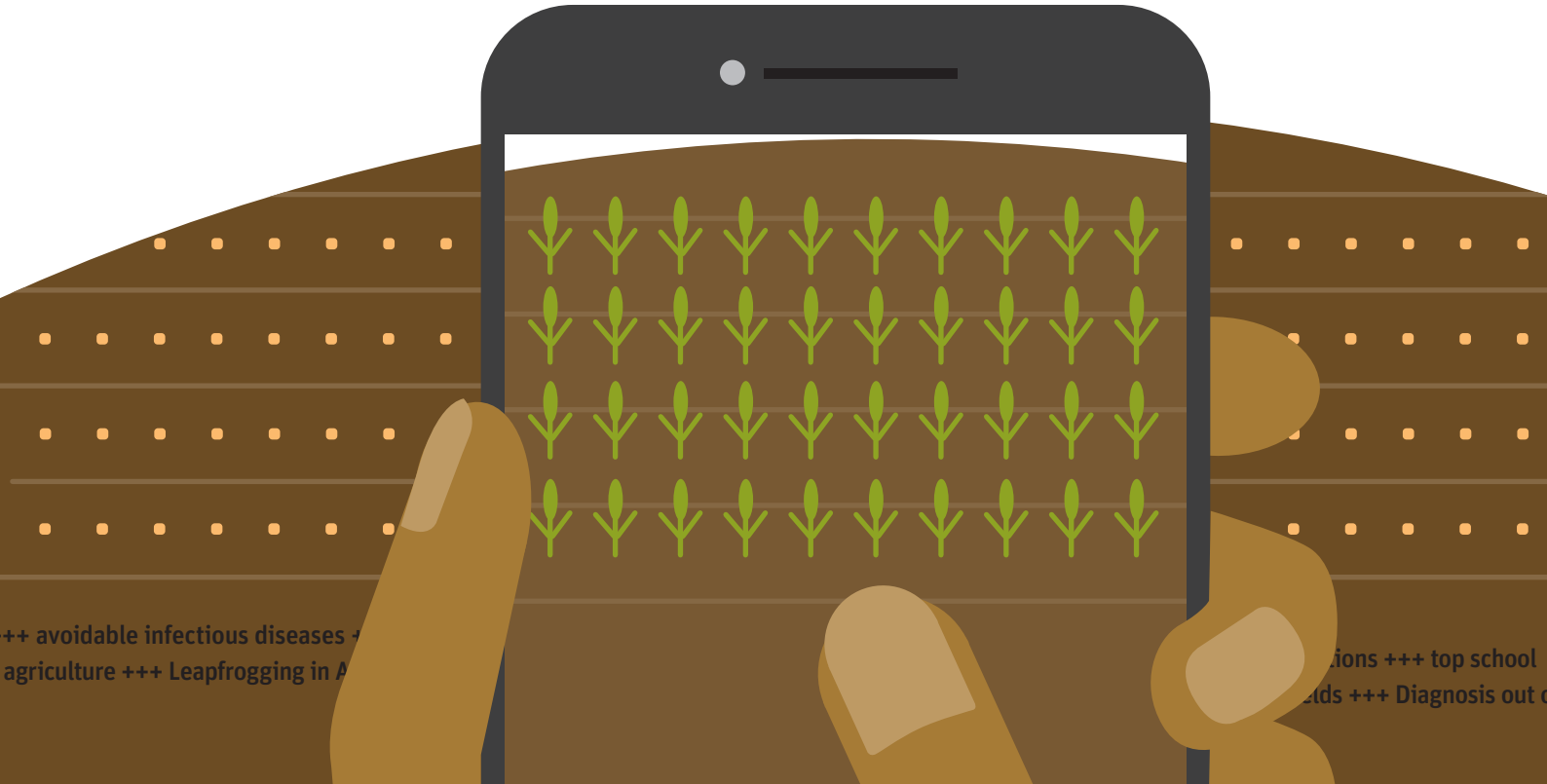
Berlin Institute for Population and Development

Leapfrogging Africa

Sustainable Innovation in Health, Education and Agriculture



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CONTENT

A CONTINENT IN SEARCH OF ITS OWN PATH TO LEAP FORWARD

Since March 2020, the world seems to be upside down: Europe, and most recently the USA and Brazil in particular, are at the centre of a global pandemic. Highly developed countries are groaning under the economic consequences of measures to stop the coronavirus.

Africa – so often in the past referred to as the "hotspot of crises and epidemics" - seemed to be better prepared thanks to experiences with past and present epidemics. Most governments took early measures, closed the borders and imposed tight restrictions as soon as the first Covid-19 cases occurred. Nowhere has there been such a hard lockdown as in South Africa. But after the relaxation of many measures due to economic difficulties, infection numbers steadily increased in the southernmost country of the continent. It is uncertain whether other African states will suffer a similar fate. For now, infection and fatality numbers for Covid-19 are low compared to other world regions and - from a purely demographic point of view - the youth of African populations is a glimmer of hope for a smoother course of the pandemic on the continent. But whether Africa will be spared the great wave of infections or not, nobody can tell. For now, the lack of widespread testing calls for caution regarding the true reach of the virus.

Between vulnerability and hope

However the spread of Covid-19 will unfold in Africa, the consequences of the economic crisis in Europe, Asia and the USA are already hitting the continent hard. The world market prices for raw materials and the demand for cut flowers collapsed as well as remittances from migrants abroad while tourists are staying away. Without social security and working in the informal sector, millions of Africans cannot afford to comply with contact restrictions and lockdown measures in their need to survive. Already existing inequalities are about to deepen while hunger and poverty tend to increase as well.

The crisis highlights the already existing deficiencies in the infrastructure even more clearly: the insufficiently equipped health systems are unable to meet the needs of the people adequately even without a pandemic. Almost everywhere there is a lack of medical staff and equipment such as respirators. Supply chains for essential medicines and contraceptives are interrupted. Millions of children did not go to school even before the lockdown, and now the school closures are tearing another gap in the educational pathways of African youth. The achievement of the sustainable development goals of the United Nations is moving even further into the distance, as is the chance of a demographic dividend.

The situation is serious, perhaps more serious than ever. But the focus on consequences of the coronavirus pandemic also tends to obscure progress in development in recent times. This study shows where Africa is already moving forward in large strides and many small steps, rapidly, innovatively and sustainably, in three areas that are of central importance at the early stages of demographic and socio-economic development: health, education and agriculture. Because only healthy, qualified and well-nourished men and women can develop their own potential and promote the economy of their home countries. This is not only about how African countries ride the big technological waves of the last decade, the development of computers, the internet, social networks or, most recently, block chain technology. Sometimes it is just simple and straight forward solutions that make the difference for the well-being of the people. We have compiled some of them in this study, and they offer possible starting points for a great leap forward – even from the current crisis.

Role models – "made in Africa"

These examples demonstrate the courage to learn from past mistakes of more developed countries and to try out something new. In fact, some of them even indicate where African countries have already taken a leap forward leaving more developed countries behind: In Europe, for example, drones as suppliers of blood reserves or medicines are still dreams of the future; in Ghana or Rwanda they are already a reality. The mobile data network works better in remote areas of Kenya than in some parts of Germany. Small buses in Nairobi – called Matatus – offer

WIFI to their customers. In contrast, those who travel by bus on German country roads often search in vain for an internet connection. Even in the middle of the crisis, African countries lead on innovation: In Senegal, for example, "robot doctors" are currently being developed to care for Covid-19 patients in order to protect hospital staff from infection.

These success stories underline the diversity of the African continent and prove that necessary reforms and ideas must come from Africa for Africa. These are not one-size-fits-all solutions, but rather tailor made to people's needs in order to bring about a noticeable improvement in their living conditions. If these measures are scaled up, great leaps that are urgently needed can be achieved.

African men and women have clear ideas about what they want for their future: a decent job, education, health and sufficient food. In these areas, African governments must take action in order to improve living conditions and promote sustainable development.

The current crisis should remind us in Europe once again that Africa is our neighbouring continent. Isolation remains the wrong path, especially now in times of crisis. Instead, we should do everything we can to ensure that our neighbours weather the storm of the present crisis – it is in our mutual interest. We now have the opportunity to follow a new more equitable and sustainable path and to support African countries in their leap forward.

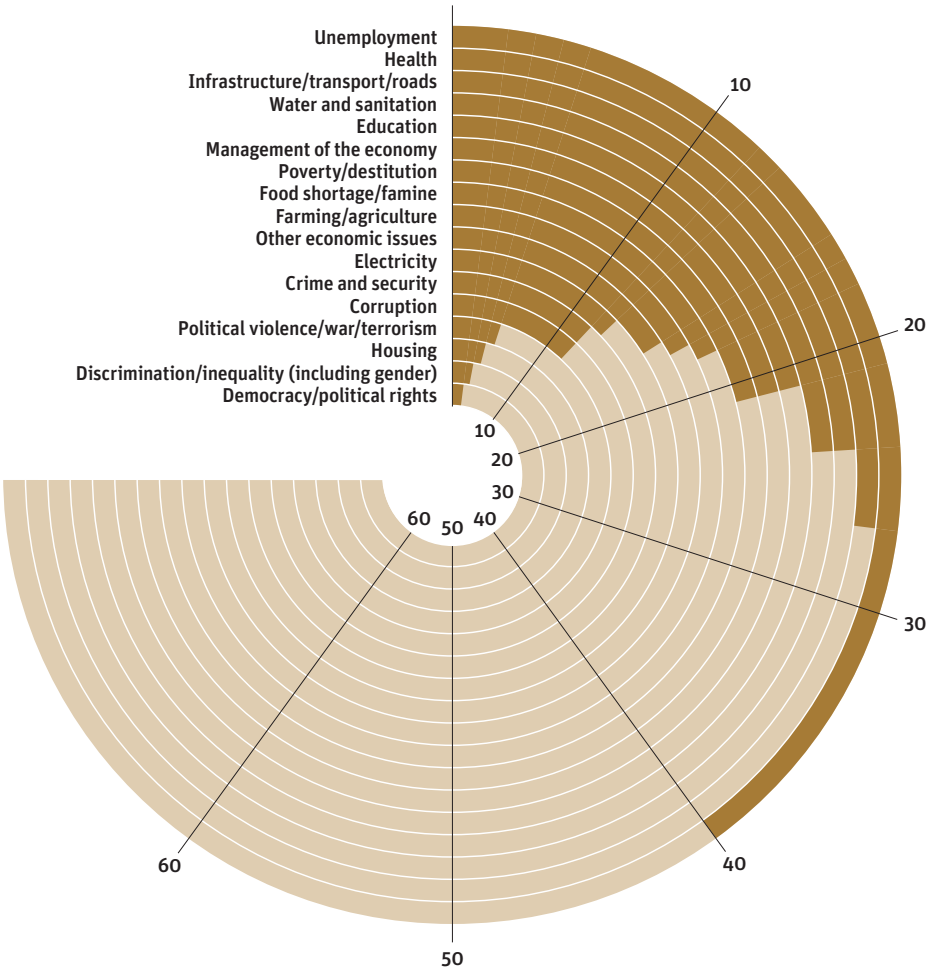
Berlin, August 2020

Catherina Hinz

Director
Berlin Institute for
Population and Development

What people in Africa are concerned about

For residents of African countries, job creation is the top priority, followed by a desire for the government to ensure the health of the population. Better education and progress in agriculture are also important to many respondents. Leapfrogging in these areas is urgently needed to improve people's living conditions and to achieve the world community's sustainable development goals for 2030.



Percentage of answers to the question: "Which three problems in your country would the government need to address most urgently," multiple answers possible, in percent, 2018
(Source: Brookings Institution[1])

SUMMARY

Despite all the progress made in the last decade, Africa still lags behind the rest of the world in the vast majority of development indicators. Many sub-Saharan African countries are barely able to provide their populations with the most necessary services. High population growth, along with the consequences of climate change and conflicts, does not make it any easier to solve the many challenges. Poverty and inequality are still widespread in many places and every new global crisis hits the continent particularly hard. The coronavirus pandemic is a current, but certainly not the last example. Only rapid leaps in development can lead out of this trap.

Catch up quickly, learn from the mistakes of others, move forward under your own steam

The past has shown that international development cooperation can only partially contribute to solving Africa's challenges. Africa needs more of its own ideas, its own minds, its own research, its own companies, in order to make social and economic progress with regionally adapted innovations as quickly as possible. Lagging behind can be an advantage because other countries and regions of the world have also made mistakes on their way to greater prosperity and social progress, with negative effects on the environment, the health of the population or public budgets. Africa should avoid these mistakes and expensive detours as far as possible on its way to a better future.

"Leapfrogging" is the technical term for skipping inefficient, environmentally-harmful and costly intermediate stages of development towards achievements, that improve people's lives.

Focus on three central development sectors

In this study, we look at the potential for development leaps in Africa in three key sectors that provided the basis for socio-economic development around the world: health, education and agriculture. Advances in these sectors increase the human capital, create jobs and economic opportunities and have a positive influence on each other. Healthy and well-fed children can learn better; hygiene and better medical care diminish infant mortality, which reduces the desire for a large number of children; education for women promotes gender equality and causes birth rates to fall further. This creates a population structure under which the economy can grow particularly well: a demographic dividend becomes possible.

Leaps in development are not only about the application of new technical solutions, as they are often associated with leapfrogging, but also about fundamental, simple changes and social ideas, such as the establishment of basic health services in rural areas, free access to family planning resources or functioning schools.

Successful leapfrogging examples can be found for all three sectors. They can be extended and scaled up. They show: Africa is poised to make great leaps.

Health

Status quo: In many places there is still a lack of basic requirements for a healthy population such as clean water, sanitation and hygiene. Infant and maternal mortality is high. Infectious diseases that could actually be avoided are widespread, while non-communicable diseases are increasing rapidly. One indicator of this is the low average life expectancy in worldwide comparison.

Objective: African governments have set themselves the objective of providing access to basic health services for all people, free of charge or at least affordable. To achieve this, the health systems must be strengthened. The cheapest way to achieve a healthy population is prevention, i.e. not allowing diseases to develop in the first place.

Best practice: Africa has already shown the potentials of leapfrogging with the introduction of mobile telephone services, without the detour of setting up a landline network. The widespread use of mobile phones makes noticeable leaps possible also for health. MomConnect, an information and consulting service for pregnant women, improves the chances of survival for women and newborns in **South Africa**. With the Health Extension Program, **Ethiopia** has built up a dense network of basic health stations where specially trained community health workers provide health education, prevention and fundamental medical services even in remote regions. Telemedicine bridges long distances as well as a lack of doctors and nurses in the state of **Cabo Verde**. With the Informed Push model, in which private logistics companies secure the supply chain, **Senegal** ensures a continuous supply of contraceptives and medicines.

Education

Status quo: Africa has the youngest population in the world. In order for them to develop their potentials, young people need an education that qualifies them sufficiently for jobs in the 21st century. But still many children do not go to school at all or drop out after a few years. When they attend school, they often learn little. Many teachers are insufficiently qualified or not qualified at all for their jobs. In addition, many schools remain empty during the coronavirus pandemic. A regulated vocational training, with practical preparation for the labour market, is hardly common in Africa.

Objective: African youth needs universal pre-school, primary and at least lower secondary education, as called for by the United Nations in its Sustainable Development Goals (SDGs). Not only do they need to master the basics, i.e. reading, writing and arithmetic, but they also need to acquire soft skills that are in demand in a modern business environment: skills for communication, conflict resolution, teamwork, intercultural understanding and awareness of sustainability.

Best practice: Liberia has created an electronic database to find out who is employed as a teacher, where and with what qualifications. This enabled the Ministry of Education to identify truant and unsuitable teachers, dismiss a large number of them and hire new, better qualified personnel. With the Tusome programme, **Kenya** has equipped all primary schools with new textbooks and curricula, provides further training for the teachers and monitors their teaching. Within three years, the reading skills of the children have doubled. The international non-governmental organisation Camfed has provided assistance to some one million schoolgirls through secondary school in **Ghana**, **Tanzania**, **Malawi**, **Zambia** and **Zimbabwe**. Those who have managed to overcome the educational disadvantage of girls are hired as mentors and support the next generation. With the Siyavula programme from **South Africa**, young people can take online lessons in mathematics and science and prepare for final exams. In many places in Africa such learning programmes are used, especially where there is a lack of competent teachers. In the beginning of the coronavirus pandemic, the number of *Siyavula* users virtually exploded.

Agriculture

Status quo: Especially in sub-Saharan Africa, agriculture is unable to feed the population. Many countries are dependent on imports or food aid. Livestock farming and crop cultivation on the continent are predominantly in the hands of small family farms. Their yields remain far below what is possible. As a result of climate change, rainy seasons are shifting and extreme weather events are becoming more frequent. The smallholders work hard, but often remain poor.

Objective: Agriculture must become more productive, but in an environmentally sustainable way, and adapt to the effects of climate change. To do this, farmers need know-how and advice, access to credit and markets, secured land rights, modernisation and mechanisation. The establishment of a value chain around agriculture creates jobs in rural areas.

Best practice: In **Nigeria**, the social enterprise Babban Gona helps smallholders to increase yields and income by providing them with low-cost fertilisers and quality seeds, as well as with storage facilities for their products. In **Mali**, the Faso Kaba company, founded by a local entrepreneur, produces and distributes improved seeds nationwide. In **Kenya**, **Tanzania** and **Rwanda**, farmers can insure themselves against weather risks for little money through ACRE Africa. In **Mali**, farmers can deposit small amounts of money into an electronic savings account with MyAgro and use it to buy seed and fertilizer at reduced prices when the season approaches. In **Uganda**, the non-governmental organisation Uganda Rural Development and Training Program ensures that rural people develop their own ideas for their future and at the same time learn how to run a productive and sustainable agriculture with simple means.

Leapfrogging alone is not enough

To make these leaps in development in Africa possible at all, the framework conditions must be right: good governance, reliable institutions and good infrastructure are necessary. It is up to the African governments to create this environment.

The examples cited in this study have the potential to be widely disseminated. They can serve as a blueprint for other organisations and countries. To learn and profit from successful projects and their experiences is nothing else than successful leapfrogging.

1 AFRICA NEEDS GREAT LEAPS

The majority of African farmers have a common problem: they harvest maize and other cereals, legumes such as groundnuts or cash crops such as coffee and cocoa in a hot, often humid climate and the crop contains a lot of moisture in the first place. Together with starch, fat and protein in agricultural products, this provides an ideal breeding ground for moulds, including Aspergillus flavus, which produces a treacherous, carcinogenic poison: it is called aflatoxin and it is invisible, odourless, tasteless. Crops contaminated with aflatoxin reach local markets, even though some of them contain alarming amounts of poison. The products are worthless for export, because the control authorities of the importing countries prevent their import.[1]

There are simple means against this kind of contamination: seeds that are less susceptible to fungal attack, bio-fungicides against moulds and above all proper drying on bamboo mats or in solar dryers.[2] If the moisture content of corn, for example, falls to less than 14 percent and farmers then store the harvest in airtight packaging, Aspergillus flavus has little chance.[3]

But how are the farmers in Ghana or Uganda supposed to know when 14 percent are reached? Usually they rely on traditional knowledge, they shake corn kernels and listen to the sound or test their hardness with their teeth. However, these "measurement results" are extremely unreliable. Commercially available hygrometers, as used by farmers in the US or Europe, are much too expensive.

Scientists at Purdue University in the USA have therefore developed an electronic device for measuring moisture that is sufficiently precise and costs less than one US dollar to produce. The farmers fill a sample of grain into a kind of plastic cup, screw it closed and after 15 minutes they can read the moisture on a digital display. Farmers and grain traders in Kenya and Senegal have already successfully tested this simple but extremely helpful instrument. With a simple but decisive leap, the health risks could be reduced and incomes increased.[4]

This is leapfrogging. As a technical term, it describes the leap to technical and social accomplishments that make life easier for people, while avoiding inefficient, environmentally damaging and costly intermediate stages of development.

Today's Africa is often referred to as the "leapfrogging continent". Nigeria provides a good example of this. In 2000, the 122 million inhabitants there had just 550,000 fixed-line connections.[5] It was not to be expected that anything significant would improve in telecommunications over the years. The technical effort to install lines across the whole wide country would have been too big. At the same time there were only a few solvent users who could have justified the high investment costs.

But when the South African company MSN installed a much cheaper mobile network in 2001, telephoning became a mass phenomenon. In 2019 there were 173 million mobile phone contracts in Nigeria, which now has over 200 million inhabitants.[6] The new communication channels in connection with information technology have made it possible for people who formerly had no access to bank accounts to transfer and withdraw money, take out loans or insurance via mobile phone. Today, people in sub-Saharan Africa, the supposedly most backward region of the world, have mobile bank accounts much more often than people in the rest of the world.[7] They can also use digital education and online advisory services in the health and agricultural sectors. The telecom revolution is an example of how the world's poor can benefit quickly from technological innovations.[8] Leapfrogging means a democratization of achievements.[9]

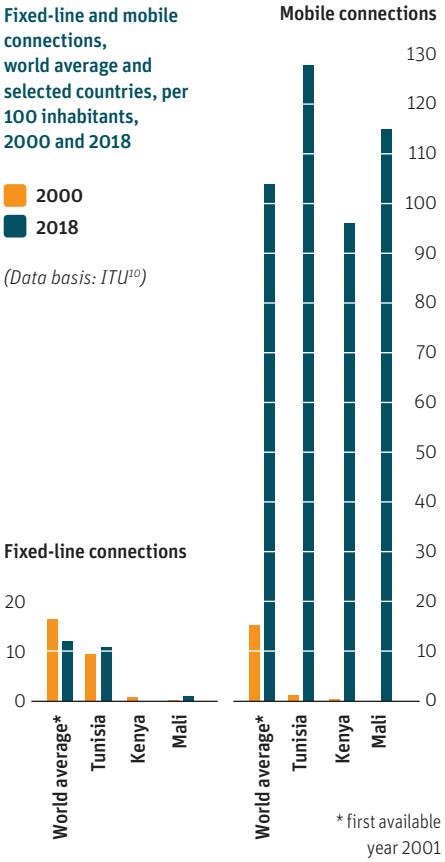
More than technical progress

Modern technology offers a variety of possible applications for Africa: Drones and sensors can help farmers to use fertiliser in a targeted and economical way. Telemedicine can be used to connect patients in remote rural regions. Educational software can teach school children where there is a lack of teachers or where the teachers themselves do not have sufficient training. And – thinking bigger – African countries can skip the fossil phase of electricity supply with coal-fired power plants and expensive overhead power lines and supply themselves directly and decentrally with renewable electricity from sun, wind and water power.

Leapfrogging means much more for Africa than the application of new technical options. Even "simple" changes and social achievements can mean great leaps in the improvement of living conditions. For example, when Ethiopia sets up centres for basic health care in rural areas where there were no medical services before. When local health workers are employed who speak the language of the local people and thus gain more confidence than doctors in white coats in an urban hospital. When a Ministry of Education checks how many teachers actually attend classes and removes "ghost teachers" from the service.

However, development leaps for Africa are also possible through fast and cheap access to means and procedures, products and services, which are usually taken for granted in rich countries, but are poorly available in many places on the African continent. These include vaccines, medicines and family planning methods. Often it is only a question of access to knowledge, which the internet makes possible. Sometimes "mental leapfrogging" also has great effects, for example when education enables people to understand medical interrelationships, for example between unprotected sex and the risk of contagion with HIV/AIDS. Or if they get rid of their fear of vaccinations through education.

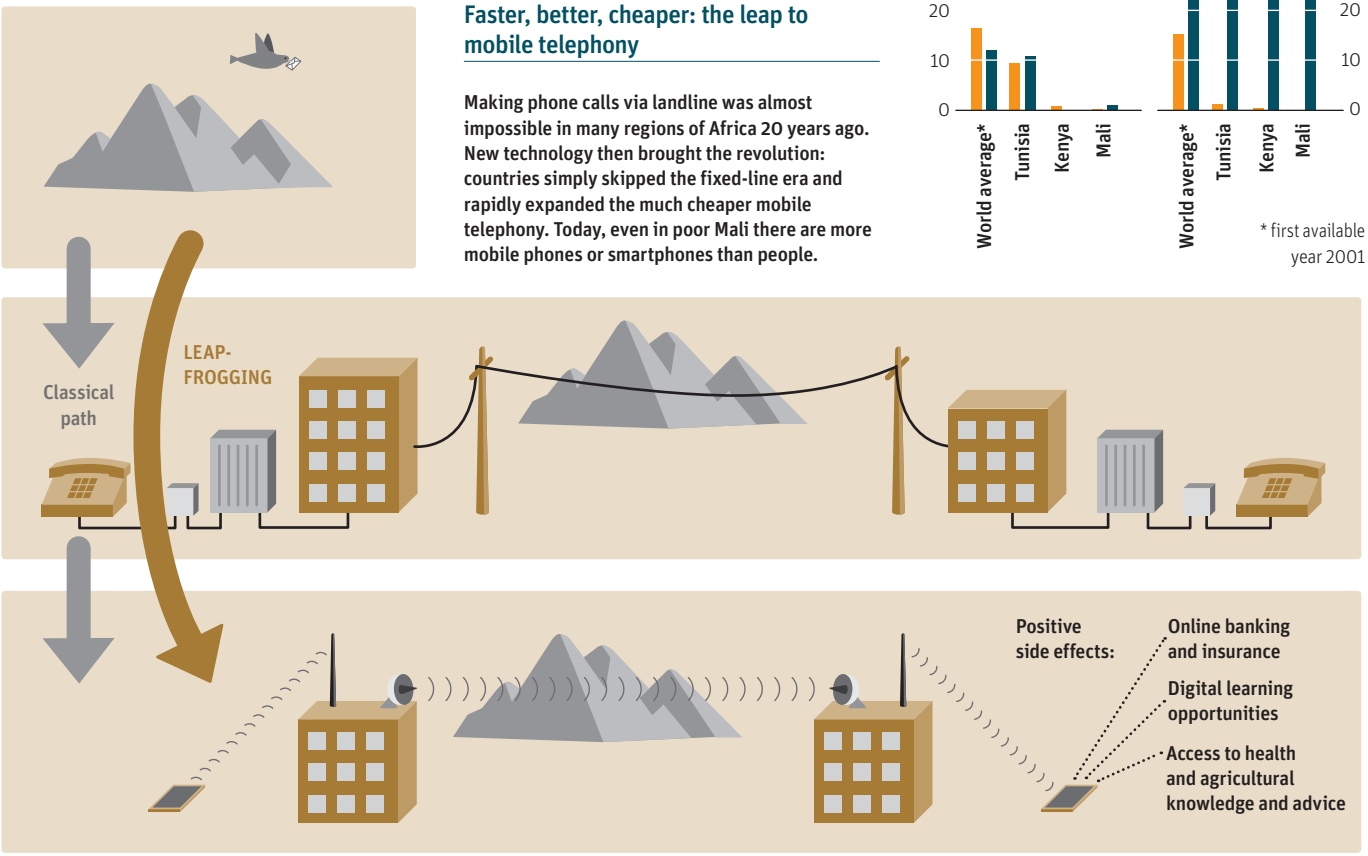
Fixed-line and mobile connections, world average and selected countries, per 100 inhabitants, 2000 and 2018



(Data basis: ITU[10])

Faster, better, cheaper: the leap to mobile telephony

Making phone calls via landline was almost impossible in many regions of Africa 20 years ago. New technology then brought the revolution: countries simply skipped the fixed-line era and rapidly expanded the much cheaper mobile telephony. Today, even in poor Mali there are more mobile phones or smartphones than people.



(Own representation)

Latecomers can jump further

The term leapfrogging was coined by US and French economists around the later Nobel Prize winner Joseph Stiglitz in the 1980s.[15] They had investigated under what conditions new players with innovative ideas can quickly assert themselves in the corporate landscape against established companies. This means that the term is relatively young. In reality, however, leapfrogging is an old phenomenon: ground-breaking inventions such as the wheel, the printing press or the steam engine usually took place in one or very few places in the world and succeeded there in the first place. The same applies to social innovations such as "education for all", for pension schemes or the insight of hygiene that invisible microorganisms in drinking water can make people ill. These innovations have advanced the development of the respective societies and increased prosperity. Others, who only learned of the achievements later, were then able to profit all the more quickly from the ideas that had already been developed further in the meantime. These latecomers were always leapfroggers.

In most cases, old, outdated technologies, products or systems were swept out of the market. During this "creative destruction"[16] the handwriting duplicators of books were defeated by the printing press, the horse-drawn carriage by the car or the mechanical typewriter by the PC. Similarly, the family model with many children for old-age security disappeared with the advent of a state-organized pension insurance.

However, leapfrogging is not an automatic process. Leapfrogging, or, to put it in more scientific terms, "socio-economic transformation" always means a struggle between an old and established system that is striving to maintain its status quo and a new system that is developing dynamically due to changing conditions. How well and quickly the new system asserts itself depends on various factors: for example, whether the innovation offers advantages for many people, whether it is possible to make it available to as many users as possible, fast and at low cost, but also whether profiteers of the old system are using their persistence to keep new competitors off their backs.

Interestingly enough, it is precisely the highly developed industrial nations that often have difficulty to exploit radical innovations quickly. For there is a wide network of functioning, conventional technologies and structures in which a lot of capital is invested and with which good money can still be earned. New ideas have difficulty to compete in the first place.

Companies, industrial clusters, even entire societies are then often trapped in a path dependency.[17] One example of this is the classic energy suppliers, whose old business model was based on large coal and nuclear power plants. Because they also had a monopoly position in electricity generation and distribution via the grids, there was little reason to change this. Accordingly, they have long resisted more environmentally friendly, renewable forms of power generation. Stuck in the same path dependency is the automotive industry, which to this day mainly relies on the combustion engine.

Africa – a diverse continent with too little development

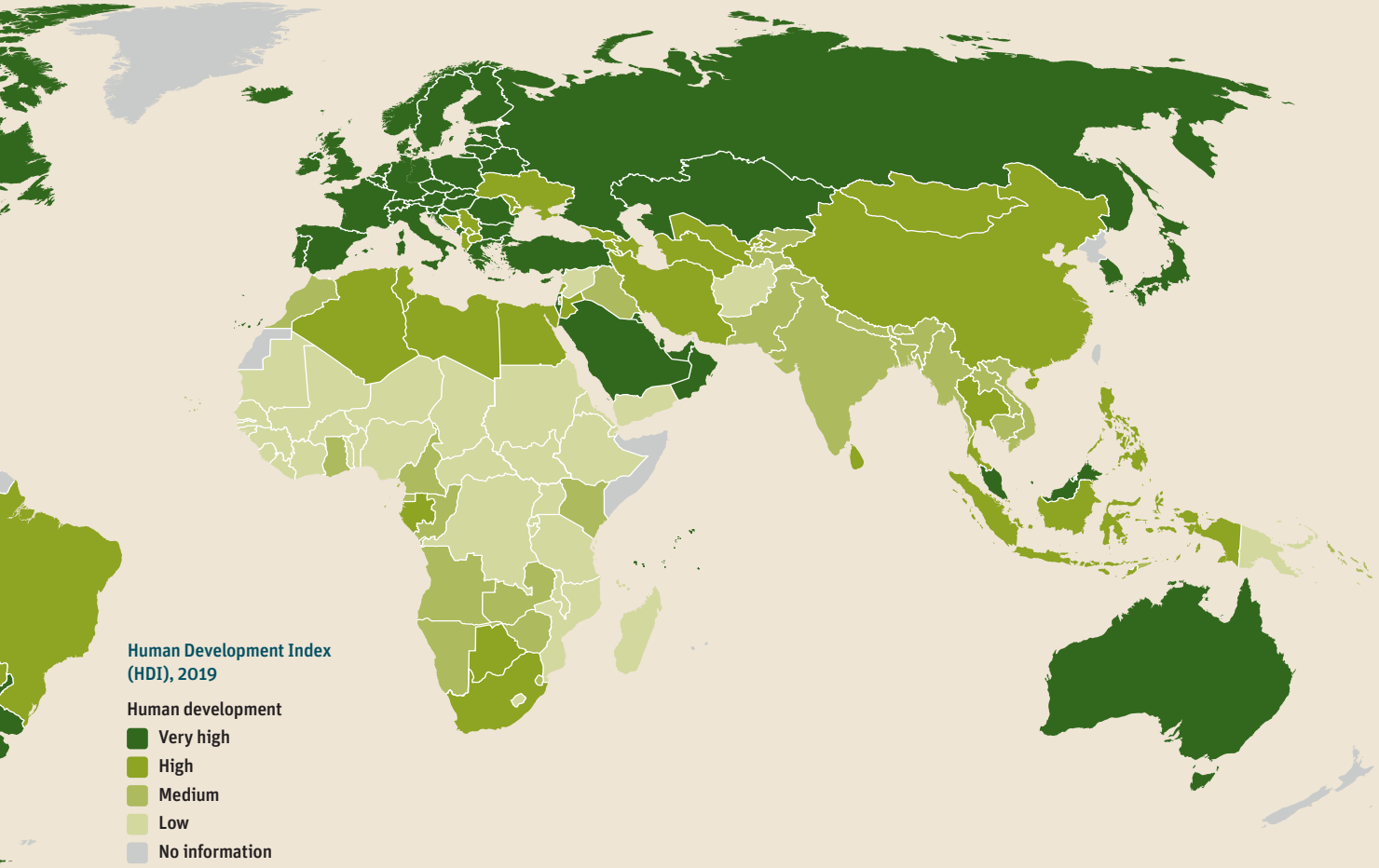
When this study refers to "Africa", it refers to the 54 generally recognised states of the African continent and its islands with their approximately 1.3 billion inhabitants. Many international statistics deal with sub-Saharan Africa as a region in its own right, because this part differs in some aspects from North Africa. When the study is about "sub-Saharan Africa", this is mentioned specifically.

Where progress is urgently needed

The United Nations Human Development Index (HDI) takes into account various indicators that describe the well-being of people. Most African countries are found at the bottom of the ranking in the category "low human development".

The countries between Senegal and Somalia, between Tunisia and South Africa are characterized by a great ethnic, economic and demographic heterogeneity. Some are very densely populated, in others only few people live in large areas. Some are extremely rich of raw materials, but their populations are among the poorest in the world. Africa includes comparatively highly developed nations such as Tunisia, South Africa, Botswana and the island states of Mauritius and Seychelles. However, the majority of countries fall into the category of the world's least developed countries according to the United Nations definition. Of a total of 47 countries worldwide with this status, 33 are in Africa.[11]

Another measure of the level of development of countries is the Human Development Index (HDI) of the United Nations.[12] This index divides all countries into four groups according to life expectancy, education and per capita income and ranges from Norway (1st place) to Niger (189th place). With the Seychelles only 1 country is in the first category "very high human development". 8 African countries are in the second category "high human development", 13 are in the third category "medium human development" and 31 in the fourth "low human development".[13]



(Data basis: UNDP[14])

Advantage for developing countries

These restrictions do not apply in less developed countries because there are no established energy industries or large industrial structures. There are still no well-trodden economic paths, so there are no path dependencies. The same applies to the health sector, at least in those countries where there are still no functioning structures. A first health post in the countryside, with medical assistance personnel that accompanies births or gives vaccinations, can then make the difference between life and death. Such posts can be set up as a first step towards more comprehensive health care – faster and cheaper than large, modern hospitals, which could offer better care, but are currently difficult to finance.

So far, less developed countries have had only limited opportunities to advance their socio-economic advancement through their own research and inventions. This makes it all the more important for them to be able to take over existing and available ideas or concepts from the inventor countries at no great cost, adapt them to local needs and achieve a high level of benefit with little capital input. Africa in particular can become a testing ground for new concepts and even has the opportunity to overtake richer regions of the world in these issues.[18]

This means great potential for the African private sector. Attractive jobs could be created in the agricultural, health and education sectors – in all areas in which new ideas can flourish. The manifold problems that the African countries face are opening up new business opportunities for small and medium-sized private companies. Especially the young technophile African population, which has so far had too few opportunities on the labour market, can realise their potential here and help Africa to find its own development paths.[19]

A further advantage is that fields in which new technical possibilities can spread have hardly been (over)regulated in Africa to date. One example is the US company Zipline from Silicon Valley, which was not granted permission in the United States to test its fixed-wing drones in everyday use.[20] African governments have been more flexible: since 2016, dozens of unmanned aircraft in Rwanda and Ghana have been delivering cooled, life-saving blood reserves to hospitals in remote rural areas.[21, 22]

Why does Africa need great leaps in development?

The African continent lags behind in practically all development indicators, in per capita income, life expectancy, health and education statistics, agricultural yields or the number of patents applied for. There is no shortage of international and African strategies on paper that sketch the way to a promising future. These are bundled together in the African Union's Agenda 2063, the "master plan for Africa's transformation into the global powerhouse of the future". It calls for everything that is lacking in Africa: conflict resolution, economic growth, social progress, gender equality or the empowerment of youth.[23] In reality, however, most countries on the continent are making little progress on the agenda.[24]

What is needed is a rapid economic catch-up process. However, as a latecomer in global development, Africa cannot use the classic industrialisation path of the Asian emerging economies as a blueprint. These countries once built simple industrial plants as extended workbenches to accommodate the many people who were no longer needed in agriculture, and then moved up into higher value chains. In Africa, however, the comparatively high wage costs together with a poor level of education and an inadequate infrastructure are an obstacle to industrialisation. Moreover, due to the possibilities of digitisation and automation, it is not at all certain that the world needs another workbench for simple industrial products after Asia.[25] Above all, however, the classic development path is associated with high resource consumption, massive environmental pollution and considerable climate impacts that undermine all global sustainability goals. For Africa, leapfrogging means that it does not have to follow the path of the pioneers, but should directly use the best available and sustainable methods. Africa has no reasonable alternative to leapfrogging in order to enable the fastest possible improvement of living conditions.[26]

When is leapfrogging useful and successful?

Leapfrogging requires an environment that favours development leaps and does not create obstacles to implementation. Because it is often disruptive, i.e. tears down old structures, there may be resistance to the use of forward-looking methods and technologies. The fewer such barriers there are and the more openly the respective governments are committed to change, the more benefit leapfrogging promises.

Leapfrogging methods are useful and promising if[27] ...

- **they make the construction of expensive infrastructures redundant**, such as the copper cables for fixed-line telephony or large power plants for electricity supply;

- **the need is great enough**, for example when many people without prior access to a bank branch benefit from mobile banking;

- **they can be used in many ways**, for example if smartphones are also used for consulting services, e-learning programs or for collecting medical data;

- **they solve problems efficiently and create new opportunities for socio-economic development**, for example when learning programmes enable or improve schooling where there is a shortage of trained teachers;

- **they enable area-wide coverage by simple means** where previously no care at all was possible, for example with health posts in remote regions where specially trained community health workers provide medical services;

- **they promise a direct benefit for the users**, for example if herders can find available pasture land via an app;

- **they are easy to use and facilitate difficult tasks**, such as drones monitoring the ripening progress of crops and the water content of soils or controlling breeding sites of mosquitoes and other disease vectors;

- **they rapidly become cheaper**, as it was the case with the electronic storage of data;[28]

- **they initially allow small-scale solutions that can then be scaled up quickly**, such as advice for pregnant women and young mothers via smartphones, which is first tested in a poor district and then deployed nationwide;

- **they provide access to necessary products and services** that are available elsewhere but cannot be developed and produced quickly enough at home by reasonable means, such as vaccines or medicines;

- **there are no patents, trade restrictions or costs that hinder their distribution**, for example when pharmaceutical companies develop new anti-viral drugs for the treatment of AIDS patients in the areas where they are most needed, cheaply or free of charge.

Not a panacea

Leapfrogging cannot solve all problems of less developed countries. Computers or laptops in rural areas do not make illiterate people literate, they do not fight malaria and do not lift people out of poverty. The promising possibilities of information and communication technology alone will not eliminate corruption, solve conflicts or replace dysfunctional institutions.[29] Development also has undesirable side effects that can hardly be avoided by leapfrogging. For example, a better supply of high-fat, high-sugar and high-salt food in once poor countries often leads to new "civilization-induced" disease patterns, such as obesity or diabetes.

But leapfrogging can help to achieve development progress if the framework conditions are right. These include good governance, an education system accessible to all, from pre-school to university, free trade, land rights and market access, infrastructure such as roads and other transport links. Smartphones cannot be operated without radio towers, and agricultural products cannot be cooled without electricity. Africa can only develop if all inhabitants have access to clean drinking water and sanitary facilities. Farmers can only become more productive and work sustainably if they have access to irrigation methods, fertilisers, pesticides and modern seeds, and if they have the knowledge and training to use these resources in an environmentally friendly way.

The responsibility for ensuring that African countries benefit as much as possible from leapfrogging and can introduce their own regionally adapted innovations lies less with the countries of the global North, which have so far produced the majority of developmentally useful resources and methods, but more so with African governments. "No one can suggest that great technology is in any way a substitute for good governance," warns Bill Gates, who has earned his billions with software and now wants to support Africa's development as a philanthropist.[30]

One of Africa's greatest challenges has not yet been addressed here: the strong population growth in most countries. It makes it increasingly difficult to solve the existing problems, keeps societies in many places caught in a cycle of poverty and high fertility rates and makes socio-economic change more difficult. Chapter 2 describes the links between population dynamics and development opportunities and how leapfrogging can help to drive development.

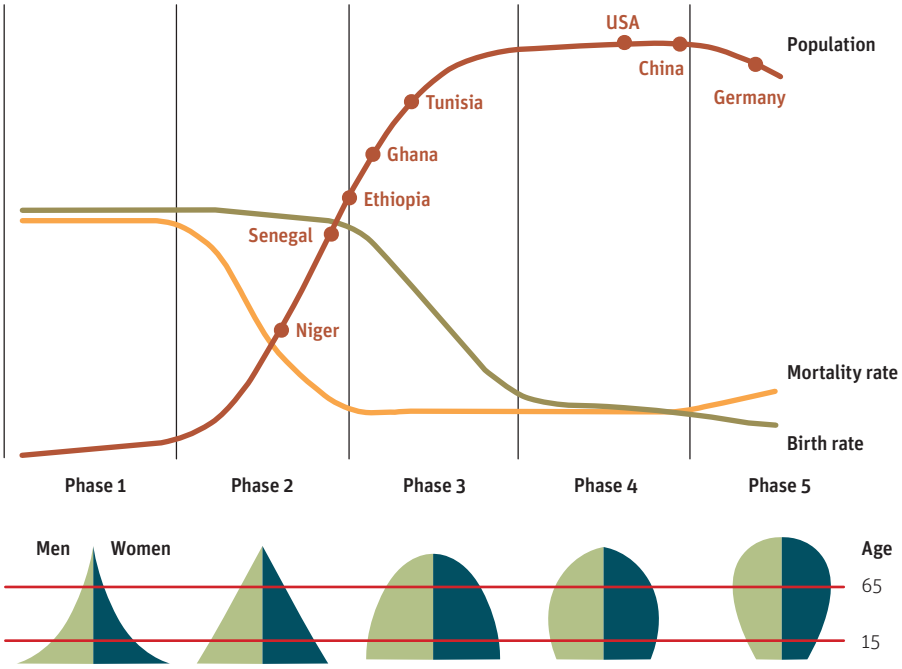
2 HOW DEVELOPMENT SLOWS DOWN POPULATION GROWTH

Africa has the fastest growing population of all continents. With an average of 4.5 children, African women give birth to almost twice as many children as women in other regions of the world.[1] The high fertility rates correlate with a low level of development: those countries that rank far behind in the United Nations Human Development Index (HDI) tend to record the highest numbers of children per woman and the strongest population growth.[2] This is particularly true for the West and Central African countries. In the southern part of the continent, in South Africa, Namibia and Botswana, in the island states of the Seychelles or Mauritius and in the North African Maghreb countries the level of development is higher and population growth is correspondingly lower.[3]

An explanation for this is provided by the model of the demographic transition, the only generally valid economic theory for the development from pre-industrial to modern societies so far. It states that in all agricultural societies many children per woman are born, but also that many people of all ages die and therefore the size of the population hardly changes. If, at some time of development, the mortality rate decreases due to improved living conditions, but the birth rate remains high for the time being, there will be a strong population growth. With a certain time delay of one or two generations, when parents have internalized that more children survive than they expected, when prosperity grows, education

One path for all countries

In the course of socio-economic development, all countries are undergoing a demographic transition. It begins in the pre-industrial era, when both mortality and birth rates are at high levels and the population grows little or not at all (phase 1). In phase 2, the mortality rate initially falls due to improved living conditions, which is why the population starts growing strongly. Only after one or two generations does the birth rate decrease as well (phase 3). At the end of the transition (phase 4) the population stagnates or even begins to shrink (phase 5), unless immigration compensates for the natural decline. Because the various countries are in different phases of the demographic transition, there are maximum differences in population development today – with enormous growth in many African countries and a natural decline combined with strong ageing in countries like Germany or Japan. This is also shown by the respective population pyramids in the course of the demographic transition.



Schematic representation of the development of birth and mortality rates and the total population as well as the change in the age structure in the phases of demographic transition
(Own representation)

spreads, when gender equality is promoted and more individualised planning of life becomes possible, birth rates also fall. Population growth slows down and eventually comes to a complete standstill.[4]

All countries in the world are undergoing this demographic transformation process in the course of their history – albeit at different speeds and with different time lags. While all industrialized and the first emerging countries have largely completed this transition, the process is still ongoing in Africa or has only just begun in some countries. Mortality rates, especially of children and mothers, have already fallen as a result of hygienic and medical achievements and better food supplies, but birth rates remain high in many places. One reason for this is that people's prospects are improving only slowly. Many people are unable to free themselves from the cycle of poverty and high birth rates – also because they see their offspring as the only guarantee for a financial safety net in old age.[5]

No country in the world is known to have modernised socially and economically while fertility rates have remained at a high level. As long as the number of children in Africa does not decline or declines only very slowly and the demographic transition is delayed, development opportunities will remain limited. Declining fertility rates are both a prerequisite and a consequence of development.

Too much – and too little growth

A few figures show the scale of the challenges for Africa. Between 2000 and 2015 alone, the number of people living on the continent rose from 800 million to 1.2 billion, an increase of 50 percent in 15 years. The United Nations estimates that by 2050 it will be around 2.5 billion, almost double the current figure. Half of the global population increase by the middle of the century will thus be in Africa, i.e. in those states that already have great difficulties in adequately providing their populations with hospitals, schools, housing and above all with jobs.[6, 7]

Of the 737 million Africans between 15 and 64 years of age, only 16.8 percent were in regular employment in 2018, 36.6 percent were not looking for work at all. Hardly anyone in Africa is officially "unemployed" (4.3 percent), because in most countries there is neither an employment agency nor unemployment insurance. Therefore, only few people can afford to be without work. In 2018, a large proportion of people of working age (40.5 percent) were employed in the informal sector, i.e. had to struggle through poorly paid, insecure casual jobs without social security or in subsistence farming in order to survive.[9] The precarious conditions apply above all to women and young workers.[10]

This is one of the reasons why almost one third of Africa's working population, in absolute numbers about 150 million people, live in extreme poverty, i.e. on less than the equivalent of 1.90 US dollars a day.[11] The World Data Lab estimates that 70 percent of the world's poor live in Africa – most of them in Nigeria and the Democratic Republic of the Congo.[12]

Although Africa has experienced annual economic growth rates of 2.1 to 3.6 percent between 2015 and 2018, the economies have hardly been able to keep up with the population growth of 2.5 percent per year. In order to offer people sufficient prospects, the economy would have to grow much faster. Average per capita incomes have hardly improved at all over this period, while the prosperity gap with the more developed regions has widened.[14, 15] In some countries, growth is based on the sale of raw materials such as oil or valuable minerals, the proceeds of which usually benefit only a small elite.

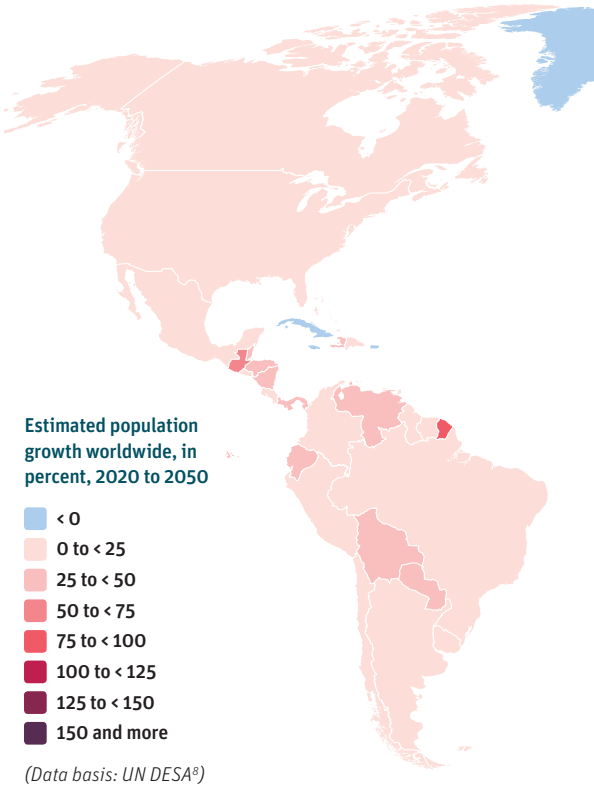
The Ibrahim Index of African Governance confirms this standstill: it measures how well the people in Africa are equipped with social and economic services and opportunities that a state should provide to its citizens. It comes to the conclusion that, despite economic growth, the living situation of the African people over the past ten years has on average not improved at all.[16] All these are findings from the time before the coronavirus pandemic. They have deteriorated significantly since then, even though no concrete data are available as yet.

Considerable tasks await in the future: 60 percent of Africans are under 25 years of age and they need employment immediately or in the foreseeable future. The group of young workers aged 15 to 24 is likely to grow by 65 million in sub-Saharan Africa alone between 2020 and 2030, to 282 million. In North Africa an increase of 10 million to a total of 51 million is expected.[17] Sub-Saharan Africa alone would have to create 18 million new jobs per year. However, only 3 million formal jobs are currently being created per year. Between 2010 and 2020, it is estimated that only 4 percent of those starting their careers have found paid work in industry, 21 percent in the service sector. The rest went away empty-handed.[18]

One consequence of the lack of jobs is that more and more people are looking for work and income opportunities in another African country, where they are not always welcome.[19] Only a small proportion of migration leads to countries outside Africa, for example to Europe. The employment crisis fuels the danger of social tensions and political instability, with all possible consequences up to armed conflicts, flight and displacement.[20]

When many young people become a challenge

World population growth is increasingly concentrated in the less developed countries in Western Asia – and especially in West, East and Central Africa. Women there have about twice as many children as in the rest of the world, and the continent's population is expected to double by 2050.



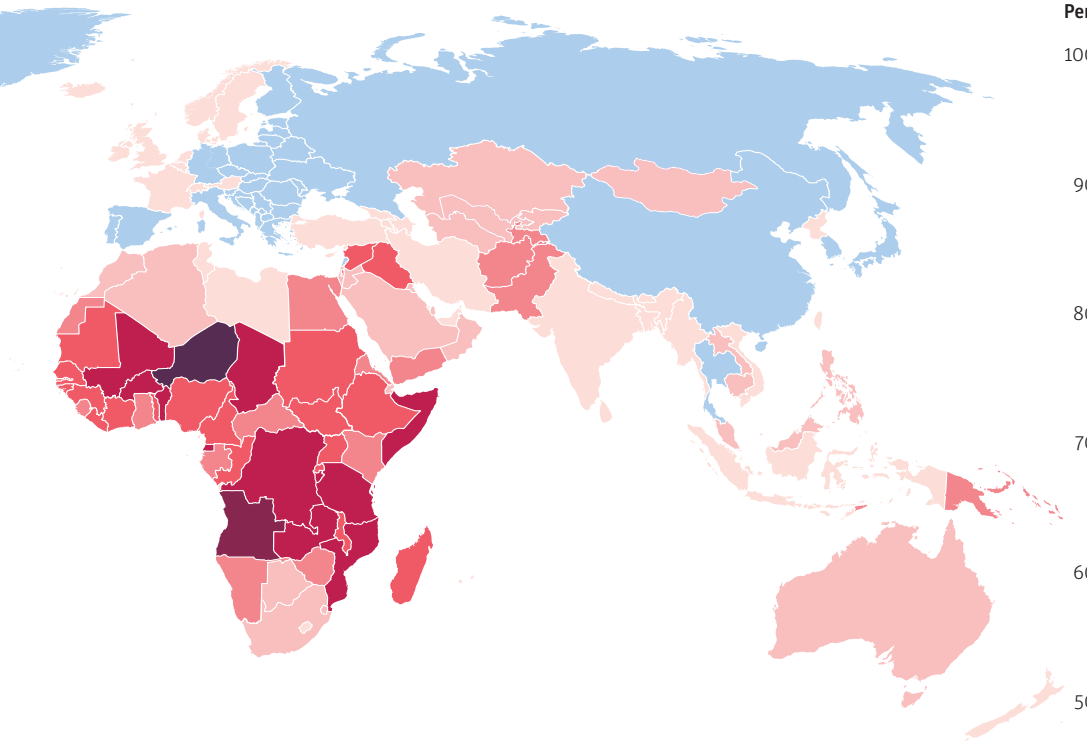
(Data basis: UN DESA[8])

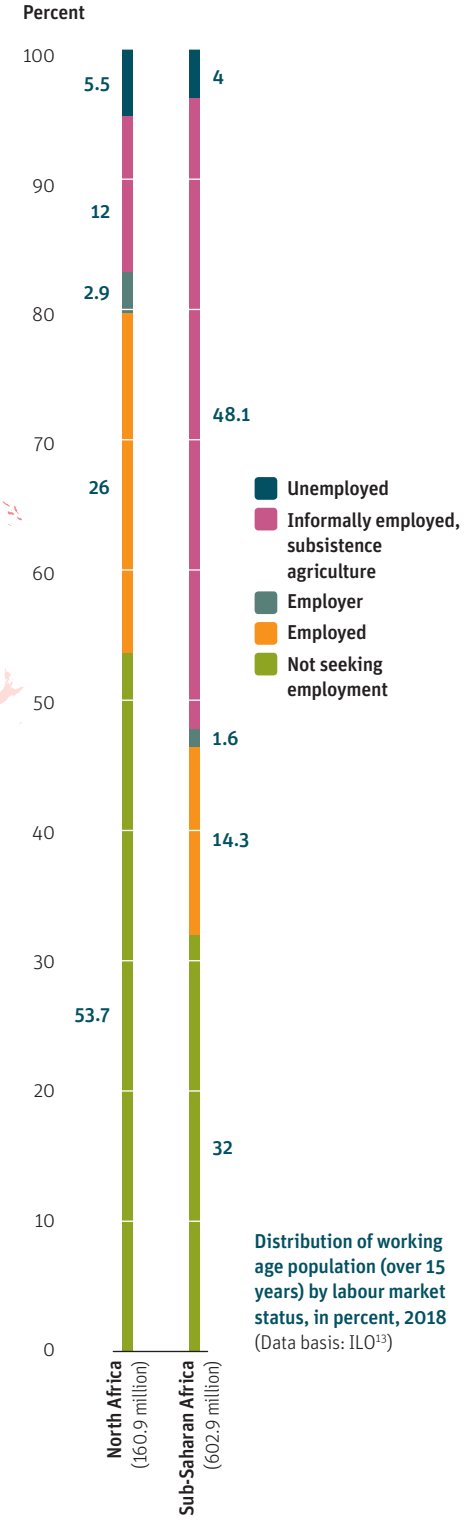
Dividend or disaster?

What new opportunities could open up for Africa if demographic and socio-economic transition were to accelerate, if the number of adequate jobs were to increase and fertility rates were to fall?

Declining fertility rates not only slow down population growth in the long term, they also change the demographic structure of societies in the medium term. The youngest generations are getting smaller, the classical population pyramid transforms into a kind of beehive and the gravity centre of the population shifts to young adults in working age (see graph on page 14, phase 4). While the proportion of children to be cared for is decreasing and the number of older people is still small at this point in time, the economy has a disproportionately large number of young productive labour force at its disposal. A decline in fertility rates automatically increases the average per capita income and gives parents the opportunity to invest more in their children's future.[22] Less offspring also means that women have more opportunities to pursue a career of their own.

This favourable age structure is known as the "demographic bonus". Under good framework conditions, with political stability, sufficient qualifications of the young labour force and a good supply of jobs, the bonus can be transformed into an economic upswing, into a "demographic dividend". Economists attribute the economic rise of the Asian tiger states in the 1980s to a large extent to the optimal use of the demographic bonus.[23]





Distribution of working age population (over 15 years) by labour market status, in percent, 2018
(Data basis: ILO[13])

In this context, it is important to note that a high proportion of young people of working age is not enough on its own to create a demographic dividend. Potential workers only benefit an economy if they can also become productive. In other words: they need a job.

In Africa, only small island states such as Mauritius or the Seychelles have so far been able to benefit from a demographic dividend. Elsewhere, the number of children per woman is still far too high, especially in West and Central Africa, where they are only decreasing very slowly. There the window of opportunity for an economically promising population structure according to UN estimates will not open before 2060

Too few jobs

There is by no means too little work to be done in Africa. The problem is that the large number of people of working age can hardly find any employment to finance a decent life. In North Africa, women in particular stay away from the labour market because society there tends to see them in a traditional role as housewives and mothers. In sub-Saharan Africa, almost half of all those able to work only find a job in the informal sector or in small family farms.

(see graph on page 19).[24] In some countries fertility rates have already fallen, but there is a lack of suitable framework conditions, especially jobs, to derive economic benefit from the bonus. This applies to the North African Maghreb states as well as to South Africa.[25] In these countries, the high proportion of young, increasingly better educated workers means high unemployment and a growing potential for social conflicts. As long as this does not change, the age structure of the demographic bonus does not promise a dividend, but rather a "demographic disaster".[26]

Key development factors: health, education and agriculture

But how can such a disaster be avoided? Instead, how can we speed up the entry into the demographic bonus, skim off a demographic dividend and break the cycle of poverty and high fertility rates?

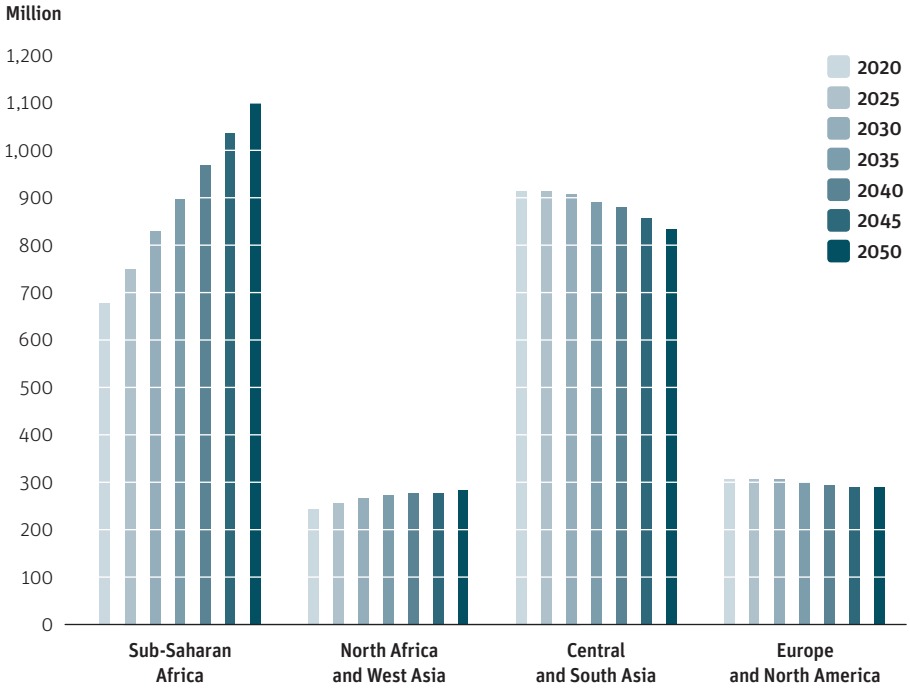
The main factors causing the decline in the number of children per woman are well documented scientifically. They range from good health and education systems, better income opportunities and equal rights for women and men to the provision of information and resources for family planning. It is also known which social and economic conditions are reducing the desire for large families.[28]

In the context of this study, we are concerned with the possibility of development leaps in the three key sectors that have been or are the basis for socio-economic progress in all countries of the world: health, education and agriculture. Development requires a healthy and educated population, in economic terms: a strong human capital.[29] High-yield agriculture, in turn, is the basis for sufficient and good nutrition, without which no country can become productive. Besides, it creates jobs and income.[30]

The three sectors are not only at the centre of development, they also influence each other in a positive sense: when children's health improves and fewer of them die at a young age, the desire of families for a large number of offspring decreases. Smaller families have

Many young people – few prospects

While the number of young people is already declining in the industrialised and also in the Asian emerging countries, it is still growing very strongly in sub-Saharan Africa. Where they will all find employment is still unclear. The growing dissatisfaction of these people increases the probability of social conflicts and political instability.



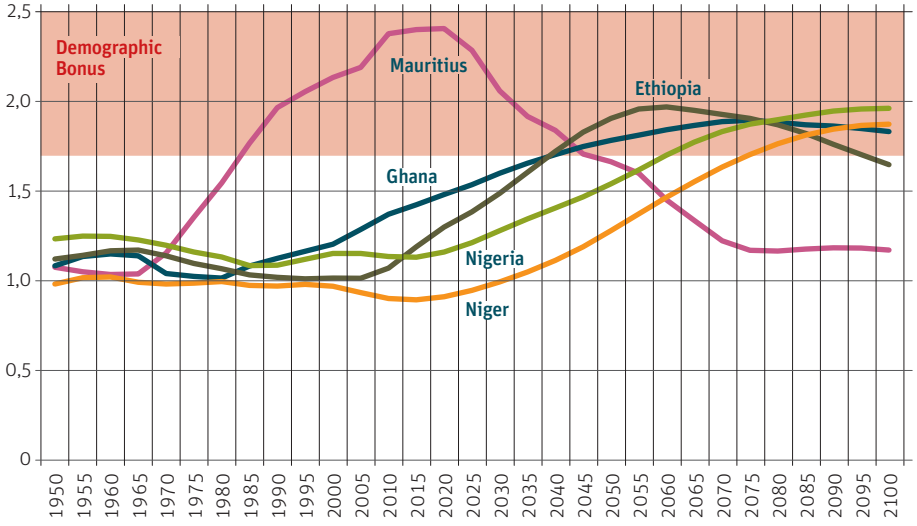
Development of the population under 25 years by selected world regions, in millions
(Data basis: UN DESA[21])

more opportunities to invest in the education of their children. Better-educated women prefer to have significantly fewer children than less educated women and can more easily turn this wish into reality. All over the world, the fertility rates have fallen when girls not only attend primary school, but have been able to benefit from further educational opportunities for as long as possible.[31, 32]

Mothers with higher education know more about medical and hygienic contexts, about how diseases arise and how they can be avoided. In this way, they contribute to a further reduction in child mortality.[33] Education also makes it easier to use modern, efficient and sustainable agricultural techniques and to process agricultural raw materials. The production of marketable food products creates jobs and income. Modern agriculture facilitates the development of societies towards the second and third sector, towards industrial production and services. When the agricultural sector becomes more productive, it needs fewer workers, who can then earn money in economic sectors with higher value added.[34]

When smaller families enable an economic upswing

If the ratio of people of working age to the younger and older people to be cared for rises above 1.7, a demographic bonus is created, i.e. an economically favourable population structure. To achieve this, the high numbers of young people must first decline – as quickly as possible. Between 1963 and 1972, they almost halved in Mauritius, which is why the island state was able to harness an enormous demographic dividend. Other African countries, where the fertility rates are still high and are only slowly decreasing, can only hope for a late and low dividend.



Ratio of the working age population (aged 15-64) to the dependent population (aged 0-14 and over 64), 1950 to 2100
(Data basis: UN DESA[27])

If these synergies between the three key sectors of development were better exploited, the demographic transition could be accelerated and African countries would have an earlier and better chance of harnessing a demographic dividend. The population dynamics on the continent would change massively. According to calculations, the population of Africa as a whole would be 250 million people smaller in 2050 than in the medium scenario of the United Nations if the appropriate investments were made in education systems. With this slowed population growth and better education, life expectancy would rise disproportionately and the income gap between Africa and the rest of the world would narrow.[35] Leaps in development not only in education, but also in the other two sectors of health and agriculture could further improve the continent's prospects.

Chapters 3 to 5 show with practical examples where there are already promising experiences with leapfrogging in the core development areas of health, education and agriculture in Africa and how these can spread as quickly as possible.

3 HEALTH AND WELL-BEING FOR ALL

3.1 Diseases and epidemics hinder development

Dakar, end of August 2014: the news that the first case of Ebola has appeared in Senegal spreads fear and terror. But within a very short time the emergency centre of the Ministry of Health tracks down the 74 people with whom the infected person had contact. After three weeks of surveillance, it is clear that they have not been infected. In this way the imminent epidemic can be averted. Apart from the man from Guinea, who brought the virus into the country – and is released as cured – Senegal has no further infections. In contrast to neighbouring countries, where thousands of people are dying, the West African country has not lost a single victim in the worst Ebola outbreak in history.[1]

There are several reasons for this mild course. Senegal was already alarmed by the epidemics in Guinea, Liberia and Sierra Leone. The authorities in the capital Dakar were able to quickly find, isolate and test the already hospitalised patient. Perhaps the most important reason, however, is the speed with which the Ministry of Health then acted – and the technical means it used to do so. It used text messages to inform the population nationwide about risks and preventive measures. That was easily and quickly accomplished because the technical requirements were already there: as part of a national diabetes programme, since June 2014 patients have been receiving nutritional tips or reminders to monitor their blood sugar during Ramadan by text messages. Now the government used this service, developed in cooperation with the World Health Organization (WHO) and a mobile phone provider, for its Ebola prevention campaign.[2] In addition, to monitor the possible spread of the disease, the Ministry was able to draw on an existing malaria control programme. This has long included a well-developed network of specially trained community health workers.[3] They use a special app on their mobile phones to regularly report the number and location of new malaria cases to the central office. Based on the analysis transmitted back, the helpers can get an idea of the situation in their region and take countermeasures in case of larger outbreaks.[4]

Leapfrogging for healthier living

Text messages for health information and community health workers with mobile phone apps for electronic monitoring of diseases – these are examples that at first glance do not look like leapfrogging. But the reality in Africa shows that they are just that: in some places, health data is still registered manually on paper in local health centres and sent to the district administration once a month. Valuable time may pass before they reach the Ministry of Health and the Ministry can respond.[5] The coronavirus pandemic in 2020 has shown the importance of electronic monitoring to quickly identify the pattern of disease spread.

Leaps are particularly necessary when it comes to the health of Africa's population. There is a lack of money, of doctors and other specialist staff, of care infrastructure and, in parts of the population, of basic knowledge about how many diseases can be prevented.

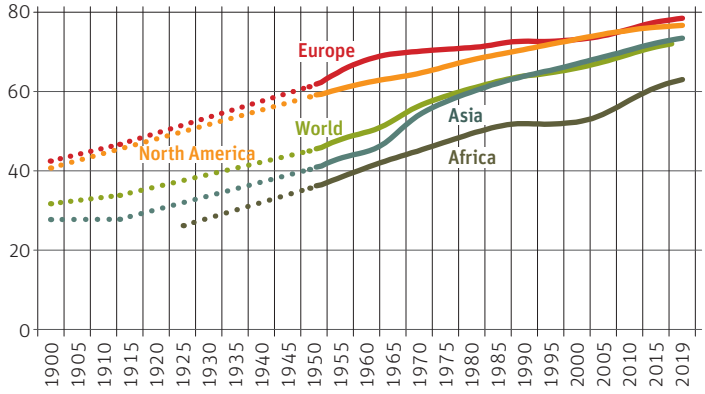
Average life expectancy, a good indicator of a population's state of health and access to medical care, is rising again in Africa, after having declined in the 1990s as a result of the HIV/AIDS epidemic. But it is still far below the values of all other regions of the world.[6] And "healthy life expectancy", i.e. the time spent in full health, has not increased to the same extent as life expectancy overall. In other words, although people are living longer, in many regions of Africa they are comparatively ill, disabled or otherwise physically limited for a long time.[7]

Health is a central prerequisite for people to be able to participate in social life, to educate themselves and work – and thus contribute to socio-economic development. There are estimates that a ten percent increase in life expectancy translates into annual economic growth of 0.4 percent.[8]

Living longer and longer

Where infant mortality falls, average life expectancy rises significantly. In the early industrialised countries, this development already began at the turn of the 20th century. From the 1960s onwards, increased prevention and new treatment options for so-called diseases of civilisation improved the chances of survival even in older age groups and thus gave a further boost to life expectancy. Africa is gradually catching up despite the slump caused by the HIV/AIDS epidemic in the 1990s. It remains to be seen whether the coronavirus pandemic will be reflected in the curves.

Average life expectancy at birth for various world regions, in years, 1900 to 2019
(Data basis: Our World in Data[9])



Advances and new challenges

A report on health in the WHO Africa region states that over the past decade, measures to improve health have shown tangible results: the mortality rate, which is high by global standards, has fallen, particularly among under-five-year-olds and mothers. River blindness and other diseases caused by parasitic worms are no longer a major problem, and leprosy and polio are on the verge of extinction.[10]

Nevertheless, Africa still carries a particularly high burden of disease in the global comparison. This statistical term describes the effect of a certain illness on the population of a region or a country, measured in the number of years of life that people spend ill or lose through premature death due to this illness (Disability Adjusted Life Years, DALYs). The DALY value for all diseases taken together in sub-Saharan Africa has declined since 1990. However, it is still well above the global average loss of healthy life expectancy.[11]

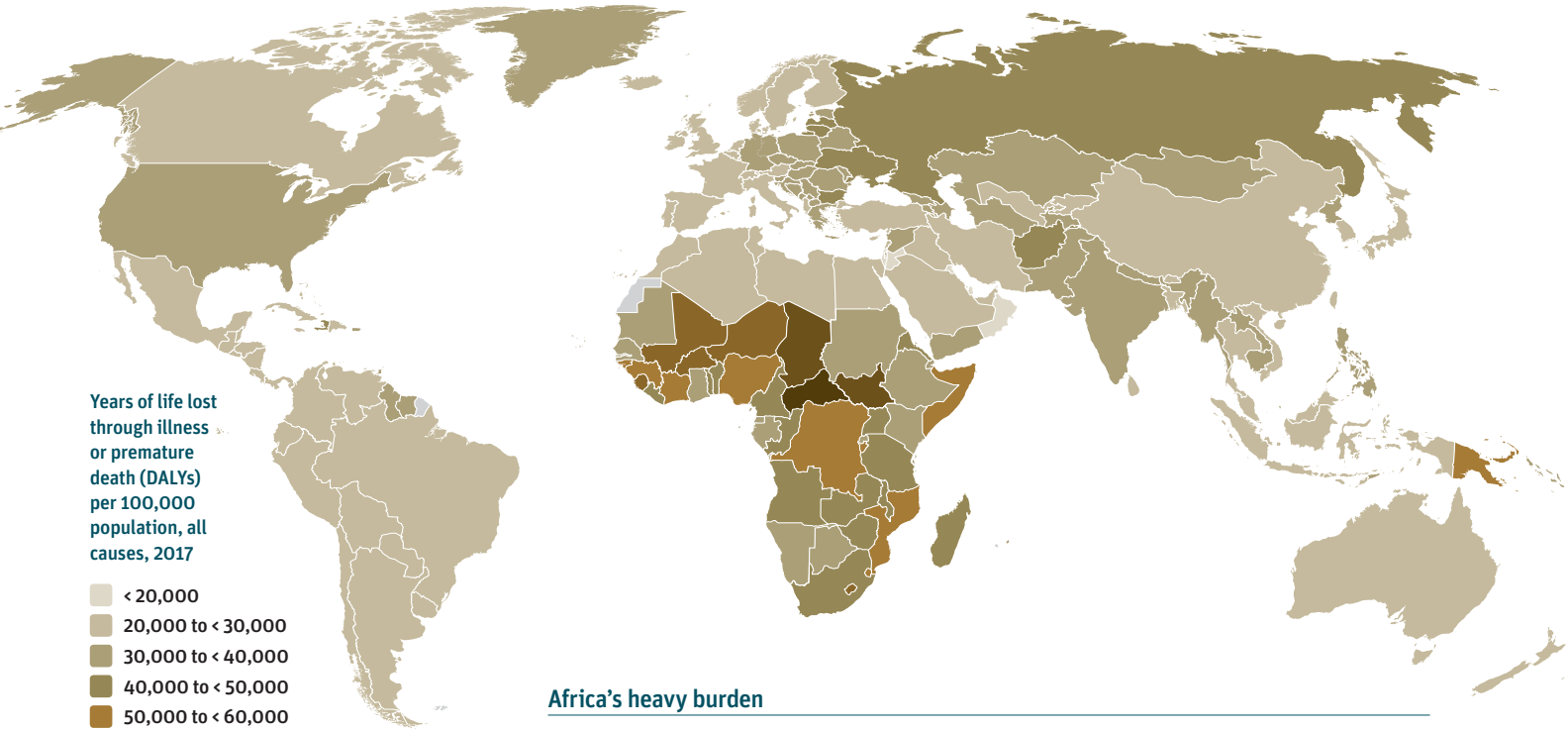
On global average, non-communicable diseases, especially cancer and cardio-vascular diseases, account for the bulk of the disease burden, while the proportion of communicable diseases and health risks related to pregnancy, childbirth and nutrition has been steadily decreasing since 1990. Covid-19 is unlikely to change this situation. In sub-Saharan Africa, the ratio is still the reverse.[15] In the countries of this region of the world the majority of illnesses that people suffer from or die of are infectious diseases, and so far, apart from malaria and tuberculosis, mainly HIV/AIDS. Around two thirds of the 1.8 million new infections with the HI virus occurring worldwide every year happen in the area between the Sahara and the Cape of Good Hope.[16] Studies indicate that the United Nations will not achieve its goal of largely containing the number of new infections in Africa by 2020.[17]

According to the theory of the "epidemio-logical transition" experienced by the early industrialised countries, the burden of disease and mortality due to communicable diseases should also decline in Africa as development progresses, while non-communicable, chronic and often lifestyle-related diseases should gradually increase. In low- and middle-income countries, which include most African states,[18] however, a double burden is increasingly becoming apparent: with growing prosperity, especially in the cities, so-called civilization diseases are increasing rapidly, while the burden of communicable diseases is not decreasing or is even increasing.[19]

What are the reasons for the high burden of disease?

- In many places in Africa there is a lack of access to clean drinking water, simple hygiene precautions and sanitary facilities. More than one third of all people worldwide who have no access to clean water live in sub-Saharan Africa. According to estimates, this means annual economic losses of 30 billion US dollar for this region.[20] This corresponds to almost the entire gross domestic product of Sudan, as of 2018.[21]

- Hunger and lack of essential trace elements in food, known as "hidden hunger", are still widespread. Undernourished and malnourished people become ill more easily and are more susceptible to infections. Women with iron deficiency give birth to underweight babies, malnourished children lag behind in their physical and mental development and are less productive as adults. It is estimated that half of the world's under-five year olds fill their stomach, but are not supplied sufficiently with all the essential nutrients, mainly because cereals are the main source of food; in Africa this applies to over three quarters of under-five-year-olds.[22]



(Data basis: IHME[14])

Africa's heavy burden

The number of years of life "lost" due to illness, disability or premature death (DALYs) calculated from statistics serves as an indicator of the burden of disease in a population.[12] Sub-Saharan Africa has the highest DALY values worldwide. In 2017, the years of life lost to premature death or illness in the Central African Republic were mainly due to communicable diseases, with diarrhoea being the most common. In Western Europe, by contrast, it was mainly non-communicable diseases. In Germany, for example, coronary heart diseases were in first place.[13]

The causes lie in poverty and supply shortfalls due to misguided policies, conflicts or climate change.[23]

■ In the growing African middle class, over-nutrition and excess weight have increased rapidly, in a kind of "negative leapfrogging" from hunger to excessive calorie consumption. This is associated with a rapid and sustained increase in non-communicable diseases. In the DALYs ranking for sub-Saharan Africa, for example, cardiovascular diseases have advanced from seventh to fourth place within 20 years.[24] One of the causes is a lack of knowledge about health connections and risks of a diet rich in salt, fat and sugar.

■ Africa has a lot of catching up to do in terms of gender equality. According to the WHO, poverty and poorer economic status, sexual violence and violence specifically directed against women, including genital mutilation, are the most frequent obstacles to improving women's health.[25] Of all world regions, the African continent has the highest maternal mortality rate.[26] In 2017, two thirds of all worldwide deaths of women in the course of pregnancy or birth were in sub-Saharan Africa.[27] Africa is also above the global average for child marriages of 15- to 19-year-old girls.[28]

Sick health systems

This list shows that many illnesses and premature deaths could be avoided if only everyone had access to clean water and sufficient and balanced nutrition. Many challenges could be met with education and prevention alone. But the fewest health systems in Africa are able to achieve this. Most of them are chronically underfinanced and overstrained in an emergency.[32] There is often a lack of reliable data that could serve as a basis for planning – and, as the example described at the beginning shows, enable rapid action in the event of an epidemic. There are too few personnel and expertise,

materials and medicines. Doctors and nursing staff are migrating, not only because they earn more elsewhere, but also out of frustration that they cannot care for their patients the way they have learned to.[33]

Like all members of the United Nations, the African states have also set themselves the third of the Sustainable Development Goals (SDG 3) to ensure the health and well-being of their populations. This includes to "achieve universal health coverage, including financial risk protection" by 2030, as well as to ensure "access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all."[34]

For many people in Africa, reality is still far from this. Particularly in rural regions, people often do not even have access to primary health care that covers the most basic needs, from prenatal care during pregnancy to care for chronic diseases in old age.[35] When an examination or special treatment is required, rural dwellers often have to travel long distances. Only a few people have health insurance, and most have to pay out of their own pockets for fees and treatment costs. On top of that, a bribe is often required to be admitted at all.[36]

Many Africans are generally suspicious of medical experts, hospitals and vaccination campaigns.[37] This is hardly surprising given the frequent reports of members of the elite who seek treatment abroad, as they obviously do not trust their own health care systems. However, the scepticism is often also based on a lack of knowledge and deep-seated fears, especially of experts who come from outside the country and ask for seemingly incomprehensible changes in behaviour.

3.2 What leaps forward for better health in Africa?

In order to achieve the SDG goal of "health and well-being for all" in the remaining ten years, Africa must therefore make great leaps forward. The health systems of rich countries cannot serve as a model at the current stage: they are reaching their limits, partly because they have to care for an increasing number of elderly people with non-communicable chronic diseases, and partly because they continue to use more sophisticated (and more expensive) treatments and medicines. Africa cannot (for the time being) follow this path in the short time available – and should use the scarce financial resources more effectively than in the development of comparable, nationwide care structures with hospitals and highly qualified specialists. Where already the access to clean water or the availability of effective medicines is a major challenge, even relatively simple innovations that help to improve the health of the population mean leaps.

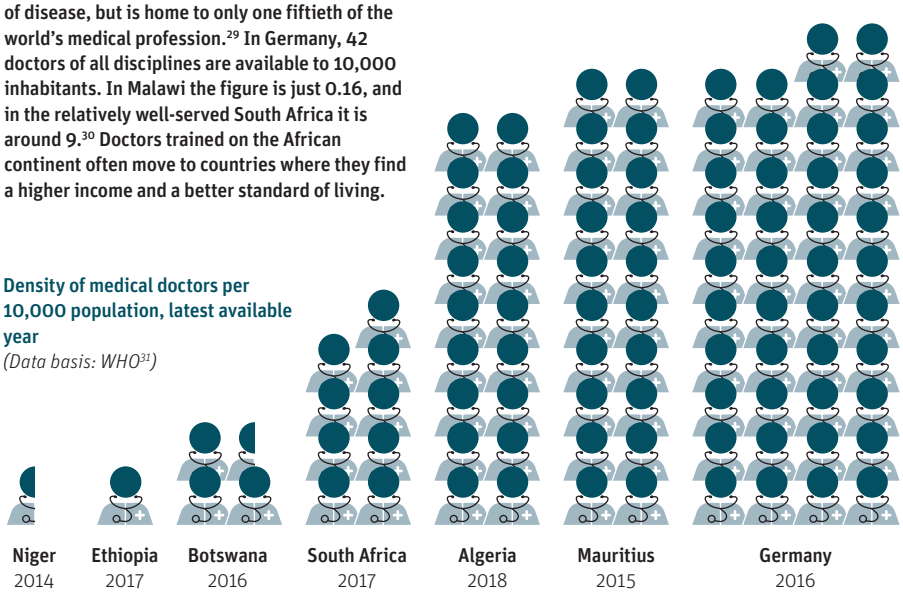
According to studies by the World Economic Forum (WEF), leapfrogging solutions for underdeveloped health systems must meet three conditions: Firstly, they must lead to the goal of "health improvements for all" faster than the usual route in the affluent North. Secondly, they should not cost more, but preferably less. Third, they must be suitable for implementation on a larger scale and under different local conditions. To do this, they must first prove their effectiveness in pilot projects.[38]

Innovation is not only the use of technology and digitisation. It also includes "mental leapfrogging", i.e. the transfer of knowledge and the use of the available know-how. New ideas are also required for the intelligent use of and relief of strain from the available personnel, for partnerships with private industry, social enterprises and non-governmental organisations (NGOs), right through to the development of health insurance systems that can be financed.[39]

Where the next doctor is far away

Africa bears around a quarter of the global burden of disease, but is home to only one fiftieth of the world's medical profession.[29] In Germany, 42 doctors of all disciplines are available to 10,000 inhabitants. In Malawi the figure is just 0.16, and in the relatively well-served South Africa it is around 9.[30] Doctors trained on the African continent often move to countries where they find a higher income and a better standard of living.

Density of medical doctors per 10,000 population, latest available year
(Data basis: WHO[31])



Leapfrogging for health has many forms

Rapid changes in the various sectors of health systems in Africa are often driven by technological innovation. However, they also come about through a new way of looking at things or improvements in operational processes, with information and communication technology acting as a trigger and accelerator.

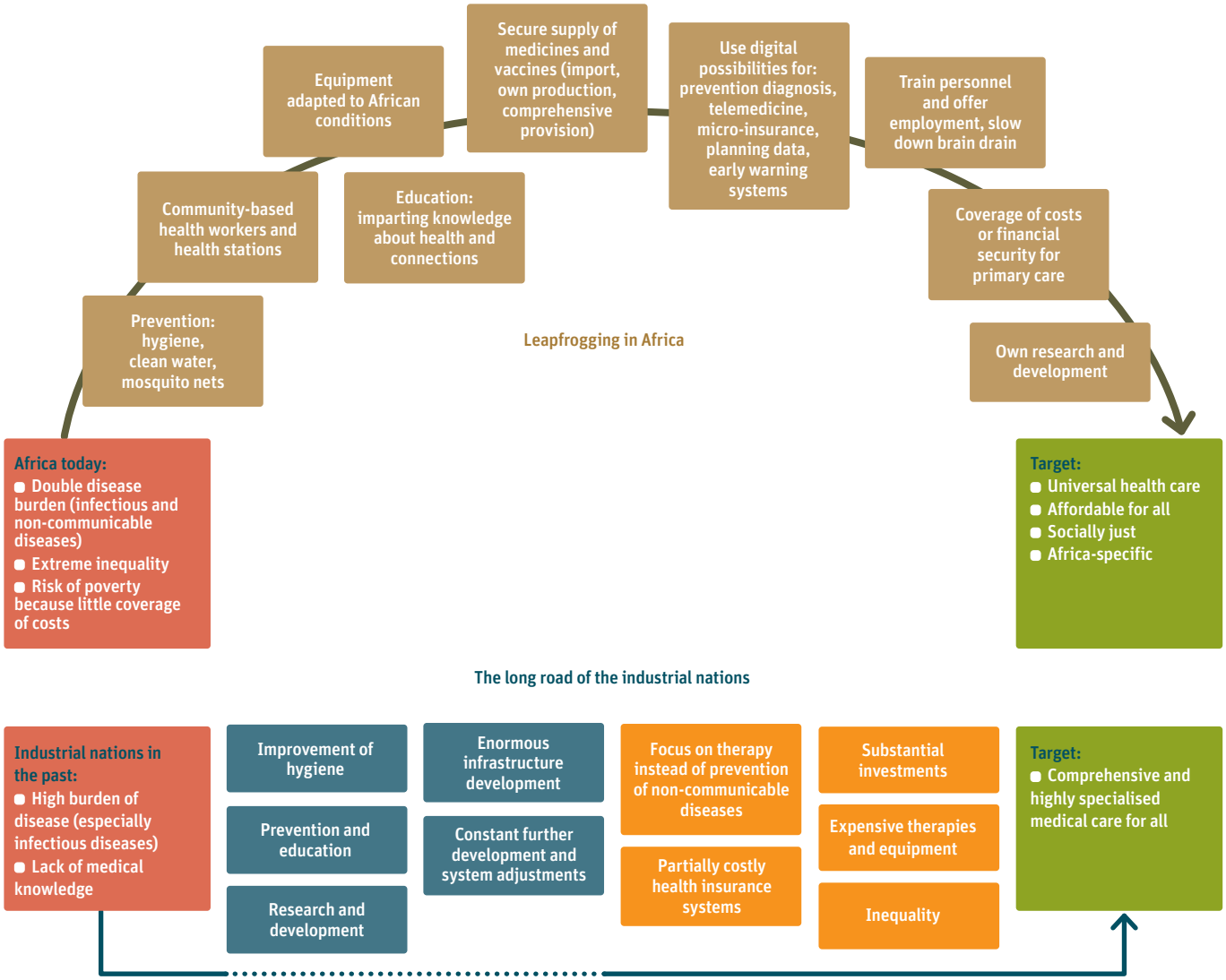
Possibilities for Leap-frogging: / Health system categories:	Using technology	Changing the operating model of health care systems	Influencing the behaviour of the population
Prevention	Advice and information services via mobile phones (mHealth) help to prevent illness and death.	A comprehensive understanding of health instead of merely combating symptoms serves the purpose of prevention, especially in cities.	Awareness campaigns using modern communication channels such as social media spread quickly, reach younger people and counteract misinformation.[40]
	MomConnect for pregnant women, South Africa (p. 27)	Waste disposal as part of an urban health strategy in Accra, Ghana (p. 36)	Information on Ebola via Twitter, Facebook and bloggers during outbreak 2014, Nigeria[41]
Supply	Mobile phones and electronic systems for monitoring the use of medicines enable therapy outside health care facilities, especially in rural and disadvantaged areas.	Telemedicine bridges staff gaps, overcomes long distances and connects patients with the health care system directly or via health care assistants.	Personalized reminder services increase the willingness to take advantage of vaccinations or to behave correctly in the case of chronic diseases such as diabetes.
	Digital tablet box Wisepill and text message reminder service for tuberculosis patients, Uganda[42]	Integrated Telemedicine and e-Health Program, Cabo Verde (p. 28); Telemedicine for community health workers, Ghana (p. 28)	Text message service for diabetics, Senegal (p. 20)
Medicines and medical devices	Cost-effective, robust devices, easy to maintain and insensitive to voltage fluctuations, power failures or heat can improve medical care.	Electronic monitoring of the drug supply chain ensures a reliable supply of effective products and protects against counterfeiting.	Smartphones with built-in or additional measuring devices enable preliminary diagnosis at home when a visit to the doctor is not possible.
	Oxygen meters for monitoring newborns, Tanzania (p. 36)	Informed Push model, Senegal (p. 32); mPedigree system against counterfeiting and theft, Ghana, Nigeria, Kenya (p. 29)	HerHealth self-test for urinary tract infections, Uganda (p. 28)

Examples from Africa in this study and beyond
(Own representation according to WEF[38])

Personnel	Equipping community health workers with smartphones enables rapid contact with experts in diagnosis and treatment.	Systematically developed network of trained community health workers serves as the first point of contact for health problems.	Experienced and trained people from the immediate vicinity of the population create trust.
	Vula app, South Africa (p. 31)	Health Extension Program, Ethiopia (p. 30)	Expert clients for HIV patients, Malawi (p. 31))
Information, communication	Combination of data acquisition, processing and visualization facilitates central monitoring, especially of infections.	Systematic collection of data and information makes it possible to launch campaigns to promote health and to act quickly in emergencies, for example in the event of disease outbreaks.	Information, especially on sensitive or complex topics, is best received if it is written in the regional language and finds the right words.
	Visualize No Malaria initiative, Zambia and other countries[43]	Notification system for infectious diseases in cooperation with community health workers, Senegal (p. 20)	Communication on Ebola, Sierra Leone[44]
Funding	Crowdfunding, the collection of capital via the Internet, is laborious, but it can help individuals to pay for treatment and support start-ups in the development of medical devices, for example.[45]	Mobile savings accounts, electronic vouchers for health services and micro-insurance products also facilitate access to health care for low-income population groups.	Favourable offers for communities or groups overcome the obstacles that stand in the way of insurance against the risk of illness.
	M-Changa, Kenya[46]; Crowdfrica, Ghana[47]	Changamka Health Innovations, Kenya[48]	Community-based insurance models and savings cooperatives, Senegal (p. 38)
Management of health systems, politics	Although electronic patient records require investment, knowledge and data protection, they can optimise medical care and make it possible to identify gaps in care.	Committed politicians and committees or authorities with extensive powers drive forward the implementation of health strategies; supra-regional exchange makes it possible to adopt tried and tested models.	Health-promoting consumer behaviour can be influenced by taxes and other steering measures.
	Particular projects with electronic health records in various African countries[49]	Free basic care for all, Rwanda and Botswana (p. 38); Agence de la Couverture Maladie Universelle, Senegal (p. 38)	Increased levy on sweet drinks to combat the obesity epidemic, South Africa[50]

Taking the leap to better health care with many steps

Africa needs technical and social innovations in order to improve the health of the population quickly and without high costs. Comparatively simple changes such as the systematic establishment of a nationwide network of community health workers represent a leap forward. This is being spurred on by information and communication technology.



Schematic representation of leapfrogging
(Own representation)

3.3 Digitisation in the service of health

The dynamic developments in information and communication technology (ICT) constantly open up new opportunities for improving health care, including in Africa. All over the world and in many places on the continent, projects are focusing on digitisation and start-ups are sprouting up that are producing innovations, from mobile phone apps to platforms for electronic health records.

The high level of penetration of mobile phones and increasingly also smartphones has led to a boom in mobile health services (mHealth). Mobile phones help to collect data and communicate information. They are an inexpensive and easy-to-use means of supporting patients in taking their medication regularly or accompanying and advising pregnant women (see box to the right). Leaders in the development of new mHealth applications are Kenya, Uganda, Tanzania, South Africa, Nigeria and Ghana.[51]

Over a period of two years, the WHO has systematically investigated where the use of mobile phones, tablets and computers in the health care system has proven beneficial. This has led to initial recommendations on how poorer countries in particular can achieve improvements thanks to ICT. Text messages via SMS or WhatsApp, for example, have proven to be useful for reminding parents of vaccination appointments for their children or pregnant women of their preventive check-ups. Advice and professional support for community health workers who work with patients in rural regions has also proved its worth (see p. 30), as well as a digitised storage of medicines

BEST PRACTICE

South Africa: Text messages increase survival chances of mothers and children

"Your baby's movements are now stronger and more frequent." This message is automatically sent to Thembi's mobile phone in the 25th week of pregnancy. Thembi lives in the slum settlement of Khayelitsha on the outskirts of Cape Town and is HIV positive. She registered with MomConnect immediately after the nurse at the community clinic confirmed her pregnancy and made her aware of the free service. Since then, MomConnect has been sending text messages to the expectant mother at least twice a week: reminders of check-ups, tips on how she and her baby can get through the nine months in good health, or advice on how to pick up the free antiviral drugs to prevent the transmission of HIV to the child. When Thembi has a question, she types a text message to MomConnect. The system automatically delivers the answer via SMS. Only in the case of difficult questions do employees intervene personally. Once the birth is safely over, Thembi can also use the service for the first two years of the child's life.

Thembi is one of 2.8 million pregnant women who have registered since the South African Department of Health launched MomConnect in August 2014 as a nationwide "flagship programme". Today the service accompanies about 870,000 active subscribers every month during their pregnancy.[56] The programme was created because it became clear that South Africa would not reach the goal of reducing maternal and child mortality by three quarters and two thirds, respectively, by 2015. Pregnancy risks such as embolisms or blood poisoning were detected too late, and bleeding after birth was fatal. In addition, it was hardly possible to verify whether measures to reduce maternal and child mortality were effective because the Ministry of Health did not have any statistics on this.[57]

MomConnect achieved several improvements at once: first, thanks to professional support, women and children have a better chance of surviving pregnancy and birth. Secondly, regular surveys help to identify weaknesses in the public health system. And thirdly, the Ministry of Health obtains valid, anonymized data in real time on the number and course of the majority of pregnancies in the country. In 2017, initial evaluations showed that MomConnect has proven its worth as a platform for real-time data collection and as an offer to improve care at national level. Unlike in much of sub-Saharan Africa, women in South Africa own a mobile phone almost as often as men.[58] And almost all women can read and write. The experts conclude that MomConnect is suitable as a model for other countries and for use in other programmes, for example to encourage HIV-infected people to take their medication regularly.[59]

Since the beginning of 2019, female users have also been able to communicate with the system via the smartphone application WhatsApp. Now it is also possible to send photos of medication to find out why it was prescribed and how to take it. But messages of thanks or portraits of happy babies are also received. Based on this system, the MomConnect developers of the South African organisation Praekelt.org were able to quickly launch a WhatsApp information service on Covid-19 in spring 2020.[60]

and materials (see p. 29). According to the WHO, further promising applications are video consultation hours between doctors and patients (telemedicine), video conferences for case discussions between doctors, further training for health workers via e-learning, electronic health records and electronically recorded birth and death registers as a basis for statistics.[52]

In principle, systems with artificial intelligence (AI) could be used for health care in low- and middle-income countries. The computer-aided recognition and processing of images and language, self-learning algorithms and the automated analysis of large amounts of data – all of this holds potential, both on an individual level and for the health systems of these countries.[53] However, very few developing and emerging countries fulfil the prerequisites for this: sufficient and valid data collected in the country, specialists for effective application and ethically sound legal regulation for AI applications.[54]

In general: ICT helps, but is not a panacea. In many places on the continent basic prerequisites are needed in the first place to be able to use even simple mobile phone-supported services, such as a power supply to charge the phones and a reasonably reliable mobile or Internet connection in remote regions. Patients must also be confident that their data is safe.[55]

Bridging personnel gaps

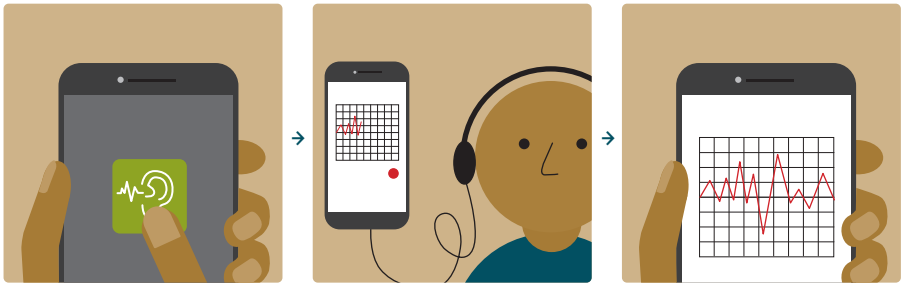
Telemedicine, the personal conversation between a doctor or other experts and patients or lay community health workers over long distances, opens up enormous opportunities for the health systems of sub-Saharan Africa. Especially when specialists have to be consulted who are particularly scarce. So far, however, telemedicine applications have hardly been able to go beyond pilot projects.[61] One exception is the island state of Cabo Verde, which has introduced the technology into standard care nationwide in 2012. Thereby the number of patient evacuations from the smaller of the ten islands scattered across the Atlantic has decreased. Health professionals can train themselves through distance learning.[62] In Ghana, West Africa, community health workers in the Amansie West district have been able to connect to a regional telemedicine centre as part of a pilot project since 2012. There doctors, nurses or midwives offer advice around the clock. In about half of all teleconsultations in 2016, a solution was found immediately, which in many cases made referrals to hard-to-reach specialists superfluous. Ghana's Ministry of Health is now working to make the service available nationwide with the support of the Novartis Foundation.[63]

Diagnosis out of your pocket

Smartphones allow to diagnose some diseases at a distance, for example in rural health centres or even at patients' homes. In some cases, the built-in cameras and sensors can be used for this purpose. To this end, resourceful minds are constantly coming up with new, smaller and smaller test kits to analyse samples. The results can either be transmitted to the relevant specialists in the centres or read off directly via mobile phone, quickly and without the need for expensive laboratory equipment.

How mobile phones help to heal

The *Wulira* mobile app for detecting hearing loss from Uganda provides an example of the opportunities offered by smartphones as tools for remote diagnosis: by means of automated queries, it can be determined within five minutes whether a person is hearing pure tones of different frequencies. The app provides an audiogram and makes a diagnosis according to WHO standards. If an in-depth examination is required, users can send the result to an expert. The result is also stored centrally so that it can be compared with later, renewed tests. The current version of the app is intended for use by health professionals. A version for individuals is planned.[66]



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With the help of credit card-sized "laboratories", it can be determined within minutes whether a saliva sample or a drop of blood taken at the fingertip contains pathogens.[64] However, it can take time until such inventions are ready for the market. For example, during her study period in 2015, Margaret Nanyombi from Uganda developed the HerHealth kit for self-testing for urinary tract infections. She came up with the idea after observing that many young women in her environment talked about such problems but did not consult a doctor: they had no money or they were embarrassed. The nearest doctor's office or clinic was too far away or there were not enough testing facilities. The problem: untreated infections can in the worst case lead to infertility. Nanyombi found a solution: "With an inexpensive self-test, women can quickly and easily determine at home whether a visit to the doctor is necessary." The kit consists of a pen slightly larger than a highlighter and a device the size of two cigarette packets. It allows to measure the acidity of a urine sample conveniently at home. The corresponding app records the measured value and indicates whether it is harmless or not. The device is currently being tested to obtain certification.[65]

Securing the supply of medicines

In Malawi, the Ministry of Health has introduced the cStock platform developed by a US social enterprise as part of a community-based care programme. The platform enables local electronic monitoring of drug stocks in order to avoid the frequent delivery difficulties and supply gaps. Local health workers report the current stock level to the system by SMS. The system determines ordering periods and sends information as soon as the supplies are ready for collection from the regional health centre. Once the medicines have arrived at the health care providers, they confirm receipt by text message. All processes can be monitored on a user-friendly dashboard. This makes it possible to identify and solve problems in the supply chain.[68]

ICT could also help to address another major problem and health risk: one in ten medicines sold in low- and middle-income countries are estimated to be counterfeit or of inferior quality, with 42 percent of the registered cases coming from sub-Saharan Africa.[69] The mPedigree system allows to trace the route of medicines along the entire supply chain from the manufacturer to the consumer, to detect theft and "diversion" of deliveries, and at any time to verify the authenticity of the products. mPedigree is accessible in several different ways, from simple control commands to text messages, smartphone apps and the Internet. Patients can use even simple SMS-enabled mobile phones to check on the spot whether, for example, the antimalarial agent they are being given is genuine. All they have to do is send the code that mPedigree registered manufacturers affix to their product packaging to the system. The system will tell them within seconds whether the medicine in their hands is the original or a useless counterfeit.

Thanks to advanced encryption technology, the system itself is forgery-proof. What is more, multiple, interconnected security mechanisms such as location data and adaptive algorithms can be used to track when and where illegal copies of original packaging appear. Provided that the authorities are connected to the system via a special tool, this provides them with an instrument for taking timely action against counterfeiters or criminal gangs. mPedigree was first tested in Ghana in 2008, where pharmaceutical companies use it on a voluntary basis. Kenya has adopted it, and in Nigeria it is mandatory for manufacturers of key anti-infectives, including antimalarials and antibiotics.[70]

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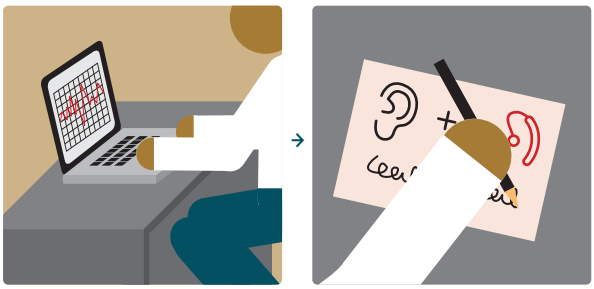


This is how remote diagnosis via smartphone application works
(Own representation according to Wulira[67])

3.4 Knowledge is "social vaccine"

Hawa, one year and eight months old, is feverish. Persistent vomiting and coughing have weakened her so much that her parents took her to the emergency room of the Ola During Children's Hospital in Freetown, the capital of Sierra Leone, in the middle of the night. One drop of blood on a test strip brings certainty: malaria. In Hawa's case complications have already occurred. As it turns out, the parents have given the child herbs. "If you give children herbal medicine," explains the doctor on duty, Nehlama Barrie, to the worried father, "this can lead to liver problems because her small body cannot process them."

Hawa is lucky. She survives the night. And the doctor is glad that no child died on her shift this time.[71] The scene clearly shows the importance of knowledge and education in reducing Africa's burden of disease. The focus is not on dismissing traditional healing methods in general as superstition. Rather, it is a question here of using the available knowledge about how malaria is transmitted, what measures can be taken to reduce the risk of infection, how important it is to act quickly at the first suspicion, and that there are drugs that have proven to be effective under controlled conditions.

The knowledge of how diseases can be treated or even prevented, how health can be promoted and thus life expectancy increased, is there and continues to grow. It is a great leap forward if Africa succeeds in letting especially poor, poorly educated and socially disadvantaged people participate in the accumulated knowledge. Education serves as a "social vaccine".[72]

Advice and help from the neighbourhood

Community health workers who come from the village or region where they work are ideally suited as trustworthy bearers of information. At first glance it does not look like leapfrogging to use them because community health workers have been deployed in developing countries for at least 50 years in different projects and programmes. They are medical and nursing laypersons who have received special training. Their tasks are manifold: they make house calls, give advice on prenatal care, family planning, hygiene or healthy nutrition, provide first aid, take care of chronically ill patients and much more.[73]

BEST PRACTICE

Ethiopia: Trained laypersons in every community

Around 80 percent of the Ethiopian population live in rural areas. Twenty years ago, most rural dwellers had hardly any access to health services. In 2003, the Ministry of Health launched the Health Extension Program. The aim was to offer health services in all parts of the country, as cheaply as possible because Ethiopia is poor. Instead of building a few expensive hospitals, the Ministry set up simple health posts for each of the 15,000 or so smallest administrative units, known as kebele. Two people were recruited from each kebele, mostly women, who usually completed the 10th grade but had no medical or nursing training. In a one-year training course, they acquired basic medical knowledge in order to finally take up work as community health workers in the kebele from which they came – and whose local idiom they spoke, since Ethiopia has more than 80 different languages.[77] The focus of their work is on hygiene, prevention and health education, as well as on the health of pregnant women, mothers and children.

The results after twelve years are impressive: the proportion of women who received expert support during pregnancy and childbirth rose from a quarter to almost two thirds. The number of deaths of mothers and their babies up to the age of twelve months has halved, and the mortality of under-five-year-olds has more than halved. This is due in part to increased awareness of the importance of clean water, good nutrition and vaccinations to prevent infection. The rate of new cases of malaria and HIV infection has been reduced. The number of women using modern contraceptive methods has increased six-fold between 2000 and 2016.[78]

On top of that, the programme has created tens of thousands of formally paid jobs, especially for women. Overall, the programme was able to close a large gap with comparatively low investments and contribute to improving the health of women and children in particular.[79]

The key point is to deploy community health workers ubiquitously to provide preventive care and basic medical services even where there was nothing before. With its Health Extension Program, the Ethiopian government has ensured that basic care is available evenly distributed throughout the country (see box on p. 30). This is social leapfrogging.

Community health workers have been working in Malawi since the 1950s and it is a tradition to involve village communities and neighbours in prevention and awareness raising. This has contributed to a significant reduction in infant mortality and the proportion of fatal malaria diseases. In the meantime, however, around 7,000 community health workers are lacking to meet the demand. Malawi has therefore set itself the target in 2017 of improving community-based health care within five years.[74] In order to support the existing health workers, especially in advising HIV/AIDS patients and monitoring their medication, HIV-positive people have also been trained as voluntary mentors, so-called Expert Clients.[75]

Thanks to modern means of communication, community health workers nowadays can obtain advice in case of doubt and mediate between patients and doctors. In South Africa, the free smartphone app Vula has been available to them since 2014. It was developed by the eye specialist William Mapham. During his work in a rural area of Eswatini (former Swaziland) he had experienced that community health workers often had difficulties, for example in the case of broken bones or burns, asking the right experts for advice and, if necessary, initiating a referral.[76]

3.5 Strengthening the role of girls and women

Community health workers and midwives, who provide expert assistance to pregnant women and newborn babies in underserved regions, make a significant contribution to further reducing the still high maternal and infant mortality rates. This is an important step towards greater gender equality in Africa. Public health systems and NGO programmes have developed many different approaches to inform pregnant women about health risks, to motivate them to take precautions, to give birth in a clinic, at least when complications are foreseeable, and to breastfeed. In many places, mobile phone services that provide information and advice via text messages are "door openers" (see p. 27).

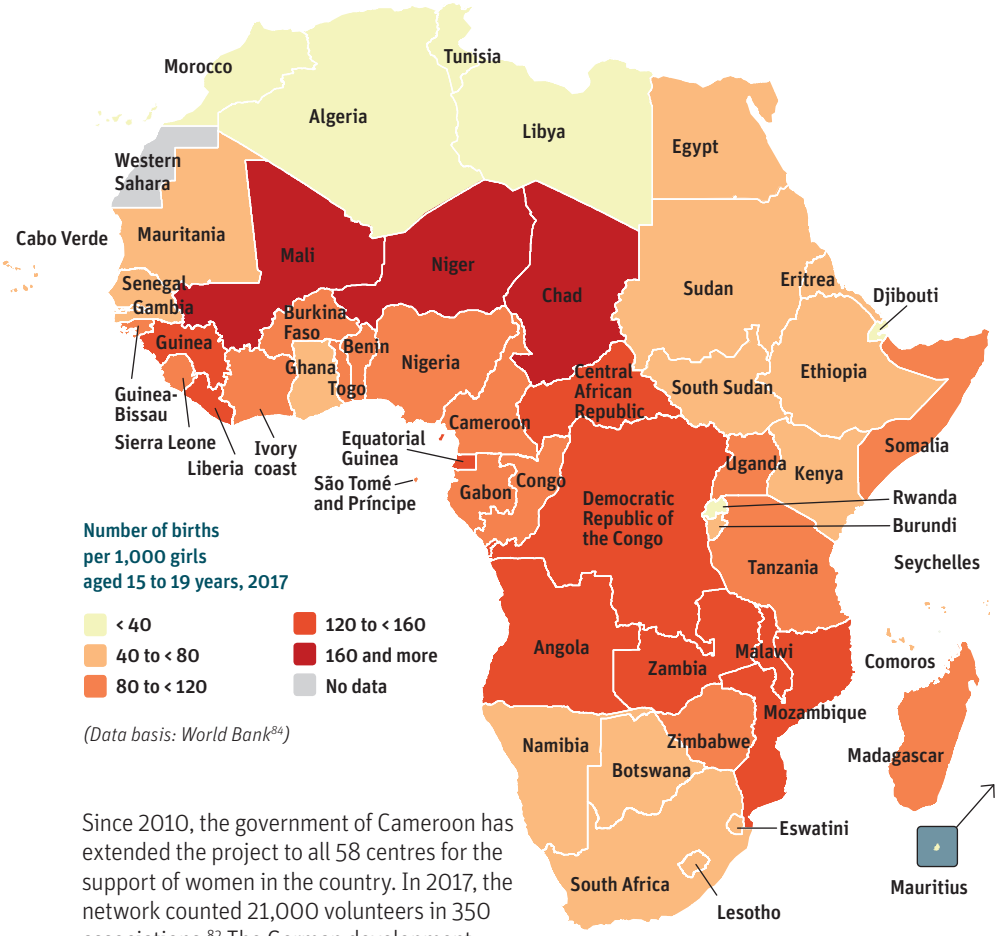
How lack of knowledge affects health and education

Steps towards more gender equality in Africa must, however, take a broader approach. First and foremost, girls and young people need to be educated early and comprehensively about puberty and sexuality, sexually transmitted diseases and HIV/AIDS, pregnancy and birth. In addition to a lack of information, cultural traditions such as child marriage and the taboo surrounding sexuality and sexual violence in many places contribute to the fact that even young girls whose bodies are not yet ready for it become pregnant and bear children at short intervals.

Girls have a significantly higher risk of birth complications than adult women. And in addition to their health, their social development can also suffer. According to a study by Human Rights Watch, tens of thousands of pregnant teenagers in Africa are banned from school and thus deprived of their right to education. Especially in the poorest countries, this is common practice, in some it is official policy. In Angola, Burkina Faso and other countries with high rates of teenage pregnancies, it is difficult for young mothers to return to school after giving birth. At the same time, many schools loudly denounce girls' pregnancies. Out of shame the girls often prefer to leave school voluntarily – or are undergoing unsafe abortions that may endanger their health and fertility.[80] In Sierra Leone, the government had set up special schools for pregnant teenagers where only four subjects were taught three days a week. The Sierra Leonean civil rights organisation Women Against Violence & Exploitation (WAVES) filed a complaint with the court of the West African community of states Ecowas. The court ruled at the end of 2019 that this discriminatory policy should be stopped immediately.[81]

Little aunt, best friend

In Cameroon, tantines (French for "little aunts") continue the tradition that a girl's aunt has always been her closest confidante and advisor in sexual matters: young women who became pregnant as teenagers receive training on sexual and reproductive health. They form local associations to support each other, but also to provide information and advice to young people in their families, in their village or neighbourhood and in schools. The Cameroonian-German health and HIV programme started the Auntie Project in 2001. In 2005 the local associations joined together to form the national network Renata (Réseau National des Tantines). Renata fights with nationwide campaigns for the prevention of unwanted pregnancies, against sexual violence and against the painful practice of "breast ironing", which is still widespread in Cameroon, where adolescent girls' breasts are maltreated with heated tools or tied up – allegedly to prevent sexual assaults.



(Data basis: World Bank[84])

Since 2010, the government of Cameroon has extended the project to all 58 centres for the support of women in the country. In 2017, the network counted 21,000 volunteers in 350 associations.[82] The German development cooperation has published a kind of handbook about how the "little aunts" approach can be extended.[83]

The right to self-determination

Even adults who would like to decide independently about the time and number of their offspring often do not have reliable access to modern contraceptives. It speaks for itself that Africa has the second highest rate of unwanted pregnancies among the developing regions of the world and the most deaths due to unsafe abortions.[85]

In 2011, nine French-speaking West African countries have created the "Ouagadougou Partnership", a coalition of government representatives, donor institutions, religious leaders and civil society activists. The aim was to use coordinated strategies and campaigns to attract 2.2 million more women as users of family planning methods in the region by 2020. By the end of 2019, 87 percent of this target had been met, with a good 1.9 million additional users.[86] Some of these countries can indeed point to a sharp increase in usage rates. In Senegal, for example, the proportion of married women who use family planning methods has almost doubled within seven years, from 14.3 percent in 2012.[87] With the Informed Push model, Senegal has found a successful and replicable method of increasing the supply of contraceptives. Previously, the storages were often empty because the staff in the health facilities had to order three-month injections, hormone implants and condoms, and collect them themselves. Now private logistics companies are determining the need and delivering the required products directly to the health centres. Within just one year, the stock shortages in the test facilities were almost completely eliminated. The system is now up and running nationwide and also closes the supply chains for other medicines.

Some of the Ouagadougou partner countries also joined the Family Planning 2020 (FP2020) initiative launched in London in 2012. The aim of this initiative was to give an additional 120 million women in the 69 poorest countries of the world access to modern contraceptive methods by 2020. To achieve this goal, the share of users in the female population between 15 and 49 years of age would have had to increase by an average of 1.4 percent annually. According to a study in eight sub-Saharan countries, the actual increase was on average higher. As the study states, it is important for further leaps forward that countries that want to meet the unmet need for family planning methods can learn from the experience of local programmes.[89]

Africa counts the most teenage pregnancies

In 1960, on global average 86 out of every 1,000 girls aged 15 to 19 years had a child; by 2017 the figure was only half as high. In Africa, however, it is only gradually being recognised that becoming mothers at a young age limits girls' personal, social and health development. In 2017, on average every tenth girl aged 15 to 19 years in sub-Saharan Africa gave birth to a child, every sixth in Niger. Most of them were already married. In regions where women have good access to contraception and safe abortion practices, teenage pregnancies happen significantly less often.

3.6 Research and development

When the first highly effective anti-HIV drugs came onto the market a good 20 years ago, the number of AIDS deaths quickly began to fall noticeably – but only in countries such as the USA, which could afford the expensive therapy. In sub-Saharan Africa, on the other hand, the number of people who died from HIV every year continued to rise. At the end of 1997, South Africa amended its law to allow it to ignore existing patent agreements "under certain circumstances" and to approve equivalent but cheaper drugs. The drug manufacturers filed a complaint against this. The ensuing legal dispute led to a trade conflict with the USA, triggered international protests by AIDS activists and caused severe damage to the public reputation of the pharmaceutical industry. Only after two years did the parties to the dispute reach an agreement.[90]

In 2018, around 16.4 million of a total of 25.6 million HIV-infected people in sub-Saharan Africa were living an almost normal life thanks to drugs – in some cases for less than 100 US dollars per year.[91] Poor countries also have access to effective drugs at low prices against malaria, tuberculosis, hepatitis C and some types of cancer. Recently, there are even drugs and a vaccine against Ebola.[92] Research and development is also increasingly focusing on the treatment of tropical diseases caused by worms, protozoa, bacteria or viruses such as Dengue or sleeping sickness. They are referred to as "neglected" because they mainly affect

BEST PRACTICE

Tanzania: Science in the middle of the malaria area

When the Tanzanian Honorati Masanja joined the Ifakara Health Institute (IHI) in 1992, the research team consisted of only two compatriots. Swiss and English were the majority. Today, almost all research staff are from Africa and the medical statistician Masanja is already the fourth African director.

Ifakara, the name of the capital of Kilombero, a district about 450 kilometres southwest of the port city of Dar es Salaam, once meant "place to die". The region was considered to be the most severely malaria-infested in Tanzania. Swiss zoologist Rudolf Geigy came here in 1949 in search of a field laboratory to study the living conditions of Anopheles mosquitoes and other insects that transmit tropical diseases. Over time, the simple experimental station has developed into an important health research centre.

IHI researchers are investigating how to improve mosquito nets and are looking for new active ingredients or combinations of known agents to combat the pathogens even if they have become resistant to some conventional malaria drugs. In addition, IHI's scientists are studying the many aspects of health in the region, from environmental influences to health policy. For example, they are developing a programme to halve newborn mortality in Tanzania or setting up standards for a network for the exchange of health-related and demographic data. At IHI's headquarters in the coastal town of Bagamoyo, they are testing drugs and vaccines in clinical trials for benefits and side effects.

In Bagamoyo, the malaria vaccine RTS,S, developed by an American pharmaceutical company, was tested on Africans for the first time in 2006. This is of fundamental importance. Unlike Europeans, the inhabitants of malaria-infested areas are often already partially immune to the pathogen because they have often been bitten by the vector mosquito. After extensive further investigations and clinical studies in Africa, RTS,S is now being used in Ghana, Kenya, Malawi and other African countries to protect children from swamp fever.

IHI cooperates with various partners in universities, governments and private industry. It still maintains close contact with the Swiss Tropical and Public Health Institute in Rudolf Geigy's hometown of Basel. Scientists from there conduct temporary research in Tanzania and vice versa. The Institute also sees itself as a place for capacity building: African researchers are to develop their skills for research in Africa here. Honorati Masanja has adopted the motto of one of his predecessors, the Swiss Marcel Tanner: "In the end, what counts is not how many scientific papers you have published, but how many people you have helped to become good researchers."[97]

the populations of poor countries and are therefore not the focus of the pharmaceutical industry. In 2012, the major corporations have declared their willingness to make their research contribution to this area as well.[93]

The pharmaceutical industry, often notorious as purely profit-seeking, is gradually changing its business practices. This is not a PR claim, but the result of careful analysis by the independent Dutch foundation Access to Medicine. Every year since 2008, the foundation has been compiling a ranking of the 20 companies that together generate around 70 percent of the global profits of this industry. The more their strategy, research and development, pricing and licensing policies are aligned with the aim of "access to medicines for all", the better they score.[94] A report on the results of the last ten years comes to a positive conclusion: 17 of the 20 companies have set themselves the specific goal of reaching markets with low incomes, in some cases by dispensing medicines free of charge.[95] However, drugs and vaccines against "poverty-associated" communicable diseases must increasingly be developed and produced in Africa itself. Since the end of the 1990s, initiatives and new partnerships have been formed to advance research and development on the continent, supported by large international organisations, governmental as well as private development organisations and foundations. The coronavirus pandemic has revealed not only in Africa that tests, medical devices and equipment should increasingly be produced in the country for the domestic market.[96]

Research "made in Africa"

"The challenges that the continent faces are enormous and indigenous research could help provide both effective and focused responses," stated a Thomson Reuters report on research in Africa 2010. It had found that Africa's overall research activity was far too low to have a positive impact on the population.[98] In 2013, the member states of the African Union set themselves the goal in the "Agenda 2063" of laying a strong foundation for the continent's development over the next 50 years by promoting science, technology and innovation. The balance of the third report on progress in this area in 2019 was modest: only a limited number of companies had sufficient capacities in research and development. Universities and state research institutions produced only few useful insights for innovations.[99]

Africa needs more and better research in Africa to develop in small and large leaps. In the fields of biomedicine, health and care, more indigenous research would be important simply because science in the leading regions of the world – in the USA, Europe and more recently also China – is based primarily on the biological conditions and medical needs of their own populations.

"People don't need theory, they need practical benefit"

Interview with Evelyn Gitau, Director at the African Population and Health Research Center in Nairobi, Kenya

Africa has many problems. This should be a good environment for science, because every problem needs a solution?

The tasks are enormous, but the challenges are not on the side of science, but on the side of those who finance science. Our governments are struggling to set priorities. For example, they have to decide whether to build hospitals or start with doing research on how to build more efficient hospitals. The governments then decide to build them quickly because they think in terms of structures, not services.

What does African society gain from science? How do you bring scientific knowledge to where it is needed, to the people?

People don't need theory, they need practical benefit. That's why they should be integrated into what science is studying from the very beginning. You have to identify the problems with them and then figure out how to solve them. For example, we have a great initiative to improve the health of mothers and children. We don't have to wait four or five years for some doctoral theses to be written but can achieve a lot with simple measures that can be implemented immediately.

Do you have a practical example of this?

We know from various studies that breast milk is the best nutrition for babies and toddlers. But the mothers in the slums have to go to work and cannot regularly

breastfeed their children. Employers do not necessarily understand this. So the way women are employed has to change and for that we have to talk to the employers in the slums. The more noise you make, the sooner you can change ways of thinking. We can also set up milk banks, because there are mothers who have more milk than they need for their own baby. But many mothers don't know that you can give milk to someone else's child. Especially in the slums there are many abandoned or premature babies that can be saved with this milk. Therefore, the mothers must be informed.

This sounds like a simple educational and advisory work.

Which has a scientific basis. But there are also more difficult cases of clarification. We have a vaccine against the HP virus that causes cervical cancer. The vaccine is free in Kenya for girls between 9 and 13 years of age, but only 13 percent of them can be vaccinated.

Why is that?

Because the Catholic Church says it lures girls into having sex early.

How to convince the Catholic Church of scientific evidence?

The problem is that the church has its own fake evidence. We have to convince them that evidence can only come from scientists. And science says this vaccine protects against cervical cancer. There are not enough forums yet to discuss these things among different groups in the society. Fortunately, the government is on our side. We need to train scientists to be able to argue with politicians or hostile groups.[100]

Inventions for leaps in development

Beyond medicines and ICT applications, there is no shortage of innovations and inventions from all over the world that are suitable for improving health care in the disadvantaged regions of the continent. This ranges from the simple idea of offering cheap spectacles made of recycled plastic to a heating device the size of a tablet that can be used to keep biological samples at the right temperature even in resource-poor regions of the world.[101]

Cooling without electricity even in hot climate

Most vaccines must be kept cool from the moment they leave the production facility, as they quickly become ineffective in warm temperatures. But on the "last mile" there is often a lack of reliable refrigeration or stable electricity. The "Indigo" portable vaccine storage system preserves vaccines at the required temperature for at least five days without active use of electricity or ice. Carried by a health worker, the vaccines finally reach even the smallest village. Inventors at *Global Good* developed the system, which is currently in early use in several countries before it is commercially available.[105]

The route of a vaccine from production to the end user
(Source: MSF[106])

Innovation can also mean reinventing existing solutions to adapt them to local conditions. This is a speciality of Path. Employees of this social enterprise have developed a robust, cheap infusion pump for remote regions without regular power supply to supply patients intravenously with drugs, fluids or nutritional solutions. Instead of electricity or batteries, it is powered by a bicycle pump.[102]

Three US scientists founded Path in 1977 with the aim of making private industry inventions in the health sector accessible to everyone everywhere. They initially focused on modern methods of family planning. Now the work of Path (short for "Programme for Adapted Healthcare Practices") has the entire system in view. Path supports governments or organisations that want to drive change and is committed to developing and introducing new vaccines, drugs, and diagnostic and therapeutic procedures.[103]

Among many other things, Path is a cooperation partner in a programme that equips rural health stations in Kenya, Tanzania and Senegal with specially developed oxygen measuring devices. This allows to timely detect when newborns reach a critical condition which all too often leads to death from pneumonia if they are not treated.[104]

3.7 Health needs more than just medicine

Accra, the capital of economically booming Ghana, West Africa, has a population of around four million. They produce about 3,000 tons of waste every day, 273 kilograms per capita and year, quite a lot for a developing country.[107] A regulated door-to-door waste collection system has so far only existed in wealthy districts of Accra. The majority of the population lives close to each other in poor settlements that have grown haphazardly and without infrastructure such as waste or sewage disposal. Thus, all kinds of waste pollute the city. They cause waters to overflow, pile up in open dumps or burning heaps. Together with the exuberant traffic and the building boom, which soon covers the last spots of greenery with concrete, a toxic mixture of sources of infection and air pollution results. Fine dust and exhaust fumes alone have caused 2,000 deaths in Accra every year so far.[108]

Ghana is one of the few African countries where the urban population already outweighs the rural population. Overall, almost two thirds of all inhabitants in sub-Saharan Africa still live in rural areas.[109] Due to the persistently high fertility rates, these areas show the highest population growth rates, but the employment opportunities do not meet the demand. Therefore, more and more people are migrating to the cities. Many of them end up in slums, informal settlements with high population density, air pollution and poor hygienic conditions. These are risk factors for malaria, HIV/AIDS and tuberculosis, for lung diseases and diarrhoea, among others, as well as a rapid spread of new infections such as Covid-19. At the same time, the environment offers little opportunity for healthy eating and little or no room for safe physical activity. Lack of exercise, poor nutrition, unfavourable habits such as smoking and excessive alcohol consumption are risk factors not only for overweight, diabetes, arteriosclerosis or strokes, but also for an increased susceptibility to infection. In addition, infectious diseases or the respective drugs make people more susceptible to certain non-communicable diseases and vice versa. For example, type 2 diabetes increases the risk of tuberculosis. Falling ill with malaria carries an increased risk of kidney failure. All in all the coexistence of very different risk factors and diseases more often lead to multiple diseases.[110]

Clean water and air to breathe

In Accra something should change now. When Ghana's President Nana Addo Akufo-Addo took office at the beginning of 2017, he declared that Accra should become the most beautiful city in Africa, and for the first time created a Ghanaian Ministry of Sanitation and Water Resources. Accra's mayor Mohammed Adjei Sowah, elected shortly afterwards, took up the fight against waste, for clean water, better air and thus better health. In a test region, the administration specifically approached schools as well as imams and other leading figures in order to raise the awareness of the inhabitants for the problem of waste and air pollution and to encourage them to act responsibly. Differently coloured dustbins are to help households to separate recyclable and other residual materials. Informal waste collectors are now integrated into the professional municipal waste collection system. A reporting system for illegally dumped waste has been created and polluters have to pay. Flowers and trees are planted. Gradually, these changes will apply throughout the city.[111]

The initiative of the city of Accra embodies the WHO's urban health approach in an exemplary manner. According to this, health for people in the growing metropolises of developing countries can only be achieved with a strategy that starts at the causes instead of fighting symptoms, and holds all those involved accountable, from the affected residents to the mayor.[112]

Nigerian Tolullah Oni, epidemiologist at the University of Cambridge in the UK, established an interdisciplinary Research Initiative for Cities Health and Equity (RICHE) in 2015. The aim is to gather different approaches and experiences in order to develop comprehensive strategies for better health in rapidly growing cities.[113] Oni describes this cross-sectoral prevention approach with a comparison, "If there is a fire at the same place over and over again, the fire department has to think about how to prevent it."[114]

Strengthening health systems

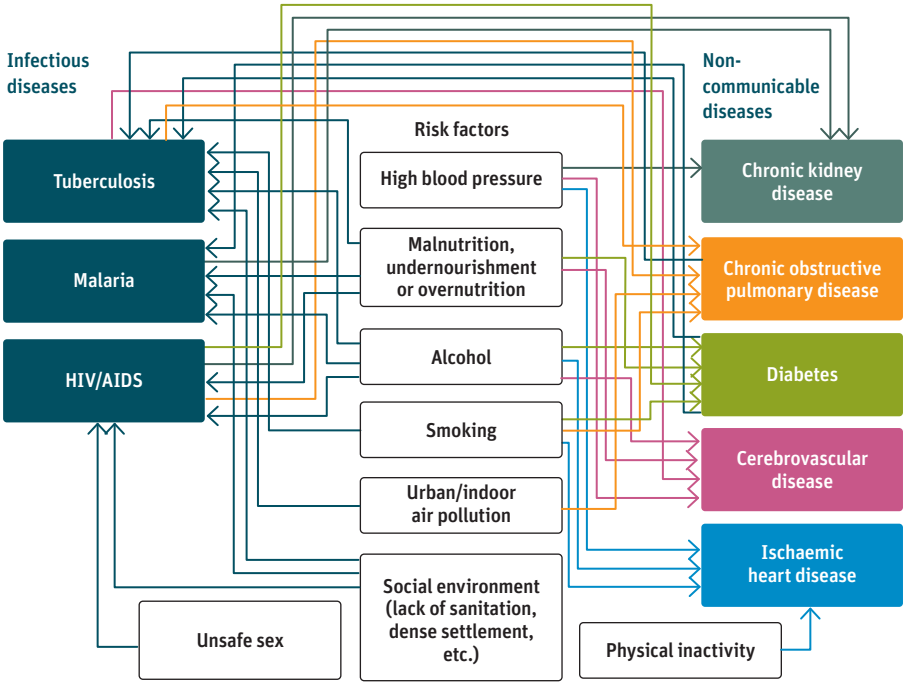
In the Abuja Declaration of 2001, the member states of the African Union (AU) committed themselves to devoting at least 15 percent of their annual budgets to improving the health sector. By 2014, only 4 countries had adhered to this commitment, 18 of them spent between 10 and 15 percent, the majority between 5 and 10.[116] In 2001, the AU had at the same time urged the donor countries to finally increase public funds for development to 0.7 percent of gross national income, as adopted by the UN General Assembly in 1970. Only a few countries have reached this goal, the average being at 0.4 percent.[117]

The link between the two goals through the AU already indicates that to date, the health sectors of the poor and poorest countries in sub-Saharan Africa depend on external funding. In 2016, the donor share of national health care expenditure was up to 60 percent. However, external grants are often tied to a specific use, even if the priorities in the recipient country may be different.[118]

It would be a huge leap forward if it were possible to analyse the needs of the inhabitants in the countries themselves first and then set priorities. This requires governments to recognise that economic development and public health are mutually dependent on each other – and that "technical" solutions such as vaccination campaigns or the provision of anti-HIV drugs alone are not enough. They must develop a more comprehensive understanding of the fundamentals of health.[119] They need to cooperate with the donors in order to use external funds more efficiently, to copy successful projects, develop intelligent ideas and endorse innovations.[120]

Diverse interactions

Poverty and high settlement density, lack of access to clean water, sanitation and sewage disposal, air pollution, under- and over-nutrition are in complex interrelations with existing, new or emerging diseases. These are infectious diseases such as HIV/AIDS or diarrhoea, but increasingly also non-communicable diseases such as heart attack, stroke, asthma, cancer or depression. In the sprawling cities, injuries and deaths due to violence and accidents are the third factor.



Mutual influence of different health risk factors, infectious and non-communicable diseases
(Source: Oni & Unwin 2015[115])

Insure everyone against the risk of illness

Every year eleven million people in Africa fall into extreme poverty because they have to pay for treatment and medication out of their own pockets.[121] At many conferences, African heads of state also adopt ever new declarations of intent to introduce "universal health coverage, including financial risk protection" (UHC, see p. 23).[122] According to the WHO, Africa has a lot of catching up to do both in providing basic health services for all and in relieving private households of the burden of health spending.[123]

Some African countries offer basic health services free of charge or at least at affordable prices – but this does not mean that those are locally accessible or of good quality.[124] In Africa there is no state-organised insurance against the financial risks of illness, as most European countries know it. State insurance schemes, where they exist, seldom cover more than basic care, while private health insurance schemes can only be afforded by the wealthy. In some places, start-ups or established companies offer inexpensive micro-insurances, for limited benefits and periods of your choice; registration and premium payments are made by mobile phone.

Senegal launched a programme to implement the UHC goal in 2013 and established a UHC agency in 2015. In order to reach the population in the informal sector, which has so far had little coverage, the government is relying on "community-based insurance models". This usually involves the formation of local groups or "pools" of similar risks and financial opportunities, some of which participate in the design of the model.[125] For example, women smallholders in the Kaffrine region of central Senegal have joined together to form the Naikhene group. The UHC agency has arranged an insurance company for them that covers up to 80 percent of the basic services for members and their families. The insurance cover costs each woman the equivalent of six US dollars a year.[126]

In 2018 Kenya launched a pilot project for free primary care in 4 of the 47 semi-autonomous local authorities, the counties. Densely populated counties with a high maternal mortality rate and high disease and accident rates were selected. Over time, the model is to be extended to the entire country.[127] For a long time Kenya has had a state health insurance, which is obligatory for some occupational groups and includes large parts of the population, but for many only covers partial packages of services.[128] The country is also experimenting with micro-insurance for low-income earners in the informal sector, without any resounding success so far.[129]

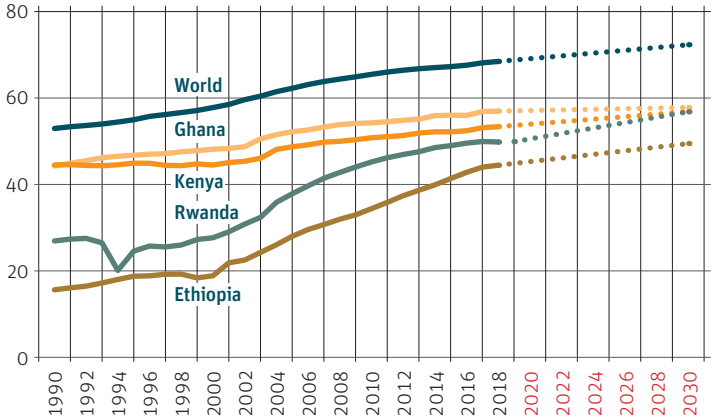
Rwanda's health system is considered one of the best in Africa. The state has used the good economic development since the end of the civil war to invest in the health of its population. At times, it invested over 20 percent of the national budget in the health system, well above the Abuja target. Since 2004, it offers a "community-based health insurance" specifically for Rwandans who do not work in the formal sector. Nearly everyone in the target group uses it to benefit from basic health care.[130] With a free public health care system, Botswana, too, has achieved the goal of nationwide health coverage without financial risks. The sparsely populated country in the south of the continent invests the enormous income from the country's significant diamond deposits – in contrast to other resource-rich African states such as Nigeria – to a large extent in infrastructure, health and education for its population.[131]

The money is not the decisive factor. Christopher Dye, formerly Director of Strategy at WHO, sees the recipe for success above all in the fact that "in both countries, politics, the public and the private sector have succeeded in uniting behind a common goal, namely to enforce the insight that everyone can get into a situation of need and that the community will stand up for it". In Botswana, he says, this is relatively easy because the country is home to comparatively few different ethnic groups and these get along with each other. In Rwanda, the will for reconciliation after the genocide is the driving force.[132] According to a 2014 analysis, Rwanda's dictatorial and centralist, but stable government since 1994 pursues a policy based on the principle of equality and focuses on social cohesion and people-centred development.[133]

Where investments make a big impact

The Universal Health Service Coverage Index shows on a scale of 0 to 100 whether basic health services are covered for everyone in a country. The index includes 9 services such as vaccinations or anti-HIV drugs and 32 indicators that provide information on access to the health system and the quality of care for various infectious and non-communicable diseases.[134] Poorer countries such as Ethiopia and Rwanda also made gains in the evaluation, as they invested their funds primarily in local basic health care.[135]

Evaluation of the provision of and cover for primary health care services according to the Universal Health Service Coverage Index (0 to 100 points), 1990 to 2030 (forecast after 2018)
(Data basis: IHME[136])



3.8 What is to be done?

Necessary leaps in development in the field of health

Health deficits are an obstacle to development. In view of the challenges that Africa's health systems were already facing before the coronavirus pandemic reached them, even simple things mean leapfrogging.

Develop strategies

African countries have committed themselves to providing their populations with access to primary health services without causing people to fall into poverty. To achieve this, they must first lay the foundations by:

- **Using the available financial resources efficiently.** Africa cannot go the long way of the industrialised countries towards highly technical, costly health systems.

- **Meeting fundamental requirements for health.** Governments must ensure that all people have sufficient food, access to clean water and sanitation.

- **Focusing on prevention.** The cheapest and most effective health strategy is to prevent disease. The first priority is education.[137] In order to counter the increase in non-communicable diseases, governments can use information campaigns or sports programmes, but also control measures such as food labelling on ready-made products or taxes on tobacco, trans fats and sugar. South Africa, which has the third highest proportion of obese adults in Africa after Libya and Egypt, has introduced a levy on sweet drinks.[138]

- **Understanding health comprehensively.** While high-quality health care accessible to all is important, it is not enough to improve the health of the population and increase life expectancy. Governments must include in their strategies other factors that have a negative impact on general health status: poverty, air pollution and stress are just a few of them. The Ghanaian capital Accra is trying to put this approach into practice together with its citizens (see p. 36).

- **Preparing for crises.** Governments must use data and information networks to take rapid action in the event of disease outbreaks or other threats to life and limb. Science warns that epidemics or even pandemics can occur repeatedly and probably with increasing frequency. Senegal benefited in the wake of the Ebola crisis in West Africa in 2014 from the fact that it already had an early warning system for malaria outbreaks and was able to inform all population groups quickly via an SMS service (see p. 20).

Provide basic care

The first step on the road to universal health care is to establish community-based primary care. Its employees can build trust, accompany people, advise them and connect them to the health system without it costing them a lot.[139] To achieve this, governments must:

- **Train and educate community health workers.** As there is a lack of doctors, nurses and midwives everywhere, trained lay people provide basic care in many places. Governments must work to recruit, train and pay such community health workers. In order to motivate them and offer them opportunities for advancement, health workers should be able to receive further training and qualifications.

- **Systematically expand the primary care network.** Community health workers must also be available within easy reach in remote rural areas and in the slums of large cities. To create trust, they should know the language and traditions of the respective population group. Ethiopia's Health Extension Program has implemented this in an exemplary manner (see p. 30).

- **Connect the community health workers to the health system.** They must not be left alone. They must be equipped with mobile phones or computers so that they can contact experts at any time to obtain expert advice and refer patients to the nearest clinic if necessary. Ghana has had good experience with a telemedicine pilot project (see p. 28).

- **Secure the supply of medicines.** In cooperation with manufacturers and distribution organisations, governments must ensure that safe drugs are available nationwide at affordable prices. In particular, patients who depend on the regular intake of certain products should be able to rely on a well-organised supply chain. Senegal's Informed Push model has proven its effectiveness and is transferable (see p. 32).

- **Make industry take responsibility.** It is important to take advantage of the fact that the multinational pharmaceutical companies want to (re)gain confidence and offer developing countries urgently needed drugs and vaccines at good conditions. But this also means that governments must improve the framework conditions for registration and distribution.

- **Take action against counterfeit medicines.** The flourishing trade in counterfeits and non-standard medicines must be stopped, because they can be fatal. Technical tracking options such as the mPedigree system from Ghana (see p. 29) offer authorities the opportunity for leapfrogging in the surveillance of such illegal activities.

Use digital opportunities

Africa's health systems must make greater use of the potential of information and communication technology for better health care by:

- **Expanding mobile phone services and telemedicine.** Text messaging services such as MomConnect (see p. 27) have been proven to contribute to prevention and health improvement. Diagnostic systems with smartphones such as HerHealth (see p. 28) and telemedicine applications can bridge the huge personnel gaps in African health systems and save people long distances, long waiting times and high costs. Governments and investors must recognise the leapfrogging potential of such services and spread them widely. The prerequisite is a nationwide mobile phone and Internet connection.

- **Using data, but excluding misuse.** Registers and statistics form the basis for identifying needs and developing comprehensive health care. Because health and identification data are particularly sensitive, their handling must be strictly regulated.

- **Hedging risks.** Data are also the basis for risk models, on the basis of which health insurances can be calculated. Governments need to partner with insurance companies and donors to offer micro-insurance – simple, digital, affordable, and time-limitable.

Create more gender equality

Governments must strengthen the role of women and girls by:

- **Reducing health risks.** They must ensure, for example, that girls are no longer exposed to the adverse effects of genital mutilation, child marriages and early pregnancies. And they must support any approach to reduce maternal and child mortality.

- **Promoting sexual and reproductive health and rights.** Couples must be free to choose whether, when and how many children they want to have. To achieve this, modern methods of family planning must firstly be available and secondly accessible. The aim should be to reduce the number of unwanted pregnancies, especially in teenage years.

- **Educating and raising awareness.** Girls and boys must have unhindered access to information about puberty, sexuality, pregnancy and birth as well as sexually transmitted diseases and HIV/AIDS. Pregnant teenagers must not be excluded from school attendance.

Training, research and development

For better health, Africa needs more doctors, nurses, scientists, inventors and entrepreneurs. To this end, the countries should:

- **Provide for a high-quality education.** Governments must invest in health education and ensure equal opportunities for access to it. Universities and technical colleges should not only pay attention to the academic qualifications of their teaching staff, but also to the way they impart (practical) knowledge and critical thinking.[140]

- **Prevent the brain drain.** Besides a lack of infrastructure, corruption and nepotism are among the factors that drive talent abroad. Better living conditions and career opportunities there attract them.[141] Well-educated young Africans need the prospect of finding relatively well-paid jobs that promote social development in research, in functioning health care systems or in companies in Africa. Then they are more likely to stay in the country or return.

- **Promote practice-oriented research in Africa for Africa.** Africa needs more homegrown biomedical research, adapted treatment methods, medical equipment, drugs and vaccines as well as clinical trials for them (see p. 33).

- **Support the creation of innovative enterprises.** Governments need to create an environment that allows innovative minds to start businesses and makes it easier for existing domestic and foreign companies to produce drugs, vaccines, equipment and other medical supplies tailored to local needs.

4 LEARNING FOR THE 21ST CENTURY

4.1 Education makes the difference

A ten-year-old boy, let's call him Charles, sits behind his wooden desk in the fourth-grade classroom of a school in Kampala, the capital of Uganda. It is about nutrition and agriculture and the teacher tells the children to list some foods. Charles immediately thinks of his favourite fruit, he calls up and says "guava". "Wrong," the teacher replies, the correct answer is "cassava, pocho or matooke".

Of course, the teacher is wrong, because the sweet and sour guavas are very much part of the food. But in the worn-out textbook of the students, the three starchy and filling staple foods of Uganda are listed under the corresponding keyword. Learning in most schools of the country means frontal teaching, i.e. learning by heart and repeating, not critical thinking or asking questions.[1]

"How are these children going to learn to understand the world," asks the Ugandan education expert Connie Nshemereirwe from the Global Young Academy, an organisation that promotes young, outstanding scientists worldwide, so that they can make themselves useful for the benefit of mankind. "How can these children learn to find answers to the complex questions that will face our societies? How should such schools produce the leaders that Africa needs for its development in the 21st century?"[2]

Unused potentials

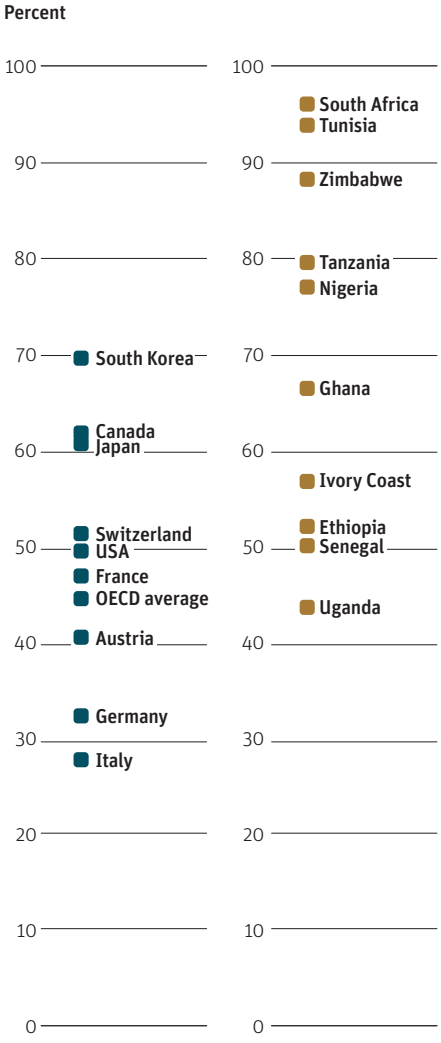
Africa has the youngest population in the world. The median age is 19.7 years, which means that one half of the African population is younger and the other half older. In Niger in West Africa, the country with the world's fastest population growth, the median age is just 15.2 years. For comparison: the median age in Germany is 45.7 years.[3]

The African Union calls its young population the continent's "greatest resource", whose "active and full participation" will make it possible to overcome all current problems.[4] In fact, the almost 700 million under the age of 20 are Africa's future.[5] They can make the difference in development. But for this they need one thing above all: a good education.

Knowledge and education are the most important capital of mankind. Education leads to higher prosperity and better health.[8] Education of mothers increases the likelihood of infants' survival.[9] Education increases life satisfaction, makes the emergence of democracies more likely and makes people more resilient to natural and man-made environmental hazards.[10]

Enormous educational backlog

Africa has an educational level like Europe or North America about 100 years ago. Asian countries were also far behind at that time. Since then they massively invested in education and today score very well in education results compared to the OECD countries. In some of these highly developed countries, young people today more often have a tertiary education than their peers in many African countries have a primary school qualification.



Share of 25- to 34-year olds with tertiary education (2018) and of children and young people with primary school qualifications (household surveys, last available year in each case), in percent
(Data basis: OECD[6], UIS[7])

"We must train Africans in Africa for Africa, who will take care of the needs of Africans," says Peter Wasamba from the University of Nairobi. He is a board member of the Partnership for Africa's Next Generation of Academics, a network of African universities whose aim is to produce a generation of competent scientists: "Africans account for one-sixth of the world's population, by 2100 it could be one-third. That means the majority of future human capital will come from Africa. We must mobilise that."[11]

Progress in development, but the backlog is widening

A look at the statistics shows that Africa is far from this claim. Hardly any African country has managed to guarantee all its children to complete primary school by 2015, as envisaged by the United Nations Millennium Development Goals (MDGs). Of all children worldwide who did not attend primary school at the designated age in 2018, 59 percent lived in sub-Saharan Africa. In 2000, this figure was only 43 percent.[12] The deterioration by 13 percentage points is explained, among other things, by the high population growth. Africa is miles away from reaching the Sustainable Development Goals (SDGs), which call for high-quality secondary education for all young people by 2030.[13]

The gross enrolment rate in sub-Saharan Africa in 2018 was on average over 98 percent, which is a clear improvement on 1990, when it was only 73 percent.[14] But the high figure is attributable to the fact that children often start school at a higher age than actually intended – in Malawi, for example, this applies to 80 percent of all first-graders.[15] The number of children in the first grade is then higher than the number of children of the official school enrolment age and the gross enrolment rates are in some cases well over 100 percent.

Above all, many children in sub-Saharan Africa drop out of school after a few years, so that by 2015 only 76 percent of 5- to 15-year-olds were attending school – the age group which, according to the United Nations, belongs there 100 percent.[17] In many African countries, despite improved school enrolment rates, the discrimination of girls against boys persists. Studies show that although educational gender equity has improved in the early 2000s, the catching-up process has now come to a standstill.[18]

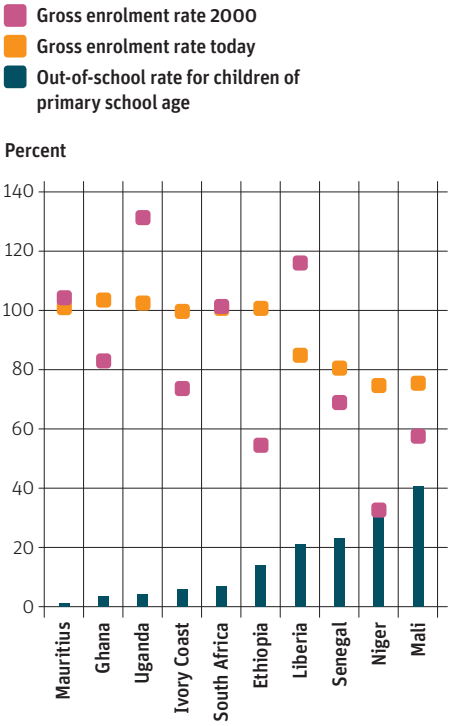
It is true that education outcomes, for example in the regional comparative study Sacmeq, in which East and South African countries participate, have improved considerably between 2007 and 2013. But in this and other recent surveys, African students performed far worse than their peers in other low- and middle-income regions of the world. Since 2010, education systems have been suffering in many places because international development funds for education have not increased since the 2008 financial crisis. During the coronavirus crisis they will not do much better.[19]

The most recent analysis of Afrobarometer, a research network that has collected data from 34 African countries and conducted representative surveys, also comes to a mixed conclusion: it confirms slow but steady progress among the younger generation, especially in secondary education. At the same time, however, one fifth of the adult population has no schooling at all, in some countries the figure is as high as two thirds. In addition, almost half of those surveyed say that they are dissatisfied with their governments' commitment to education. This is particularly true in North and West Africa. And even the most recent progress is endangered by the Covid-19 crisis: many children and young people are currently unable to go to school and the economic impact of the pandemic is threatening already stretched education budgets.[20]

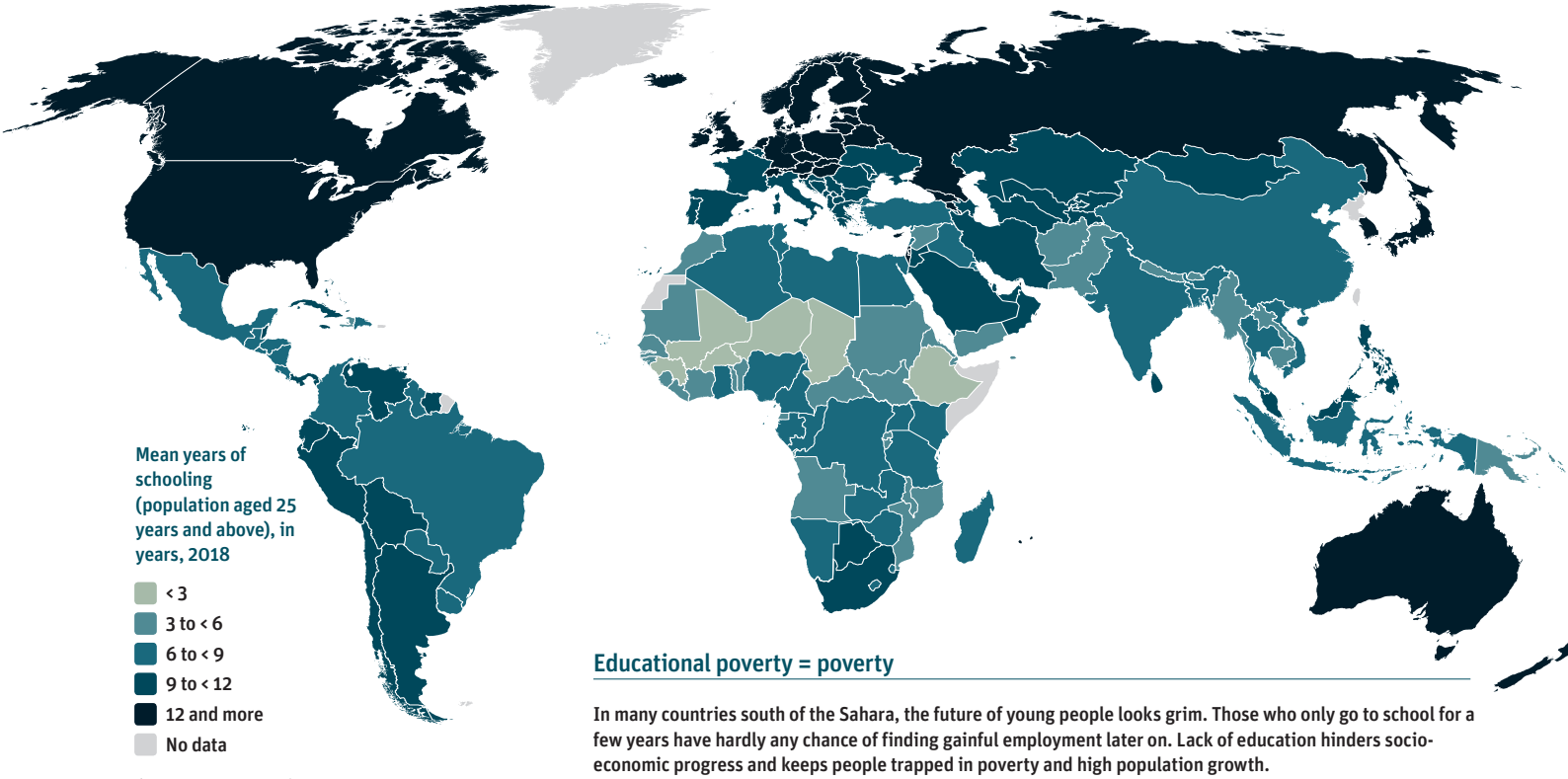
Africa today has a level of education like Japan, Europe or the English-speaking North America about a hundred years ago.[21] The countries of the Sahel have a particular need to catch up.[22]

Good news – bad news

Enrolment rates have improved practically everywhere in Africa. In some places, they are even above 100 percent, because children often do not attend first grade until they are older than the designated age. The situation is particularly critical in West Africa, where many children do not go to school at all, drop out at an early age and do not even achieve a primary school leaving certificate, as the Millennium Development Goals had once called for by 2015.



Gross enrolment rates in 2000 and today (latest year available) and out-of-school rate for children of primary school age (latest year available)
(Data basis: UIS[16])



(Data basis: UNDP[23])

Educational poverty = poverty

In many countries south of the Sahara, the future of young people looks grim. Those who only go to school for a few years have hardly any chance of finding gainful employment later on. Lack of education hinders socio-economic progress and keeps people trapped in poverty and high population growth.

Where school does not necessarily mean learning

In a study, the World Bank speaks of a "serious learning crisis" in Africa and points to another major educational problem of the continent: going to school there does not mean that the children acquire the necessary basic skills in the form of reading, writing and arithmetic, which they need for their later educational career. Three-quarters of second-graders in seven sub-Saharan African countries surveyed could not count over 80, according to the study. 40 percent were not able to add up single-digit numbers. Between 50 and 80 percent could not answer a question about a short sentence they were supposed to read. A large proportion could not read a single word. These deficits were particularly evident in those countries where three core problems came together: strong population growth, low economic growth and frequent conflicts.[24]

Another study, also conducted in seven countries south of the Sahara, showed that the deficits were not due to stupid children but to incompetent teachers: only seven percent of the teachers in primary schools had any basic pedagogical knowledge at all about how to teach children to read and write. And 44 percent of the teachers were not even present during unannounced inspections of the school classes.[25]

Teachers who either do not come to school at all or do not show up in class, so-called ghost teachers, cost the countries of sub-Saharan Africa an estimated 20 billion US dollars a year. A special case of this phenomenon is known from South Africa. In March 2019, Portia Sizani, the wife of the acting South African ambassador in Berlin and a former employee of the Ministry of Education of the Eastern Cape Province, was sentenced for hiring a number of ghost teachers and ensuring that their salaries amounting to 1.2 million rand, the equivalent of around 65,000 euros, were transferred to her own account. The case is currently on appeal.[26]

BEST PRACTICE

Liberia: Getting rid of ghosts

Liberia, located on the west coast of Africa, is one of the poorest countries in the world. In 2003 a 14-year civil war with estimated 150,000 to 300,000 deaths had ended and in 2014 the country had experienced the worst Ebola epidemic ever.[27, 28] In the UN Human Development Index (HDI), Liberia ranks 181 out of 189.[29] According to this the educational opportunities for the next generation of young people are poor.

George Werner knew this when President Ellen Johnson Sirleaf appointed him Secretary of Education in 2015. Two years earlier, all 25,000 high school graduates who applied to the University of Liberia at Monrovia had failed to pass the entrance test.[30] According to Unicef estimates, 36 percent of all primary school teachers had no education or training for their jobs.[31]

One problem was that the government did not even know which of the 19,000 teachers in public schools with which qualifications taught what and where in the country. All they knew was that they were paying a salary to everyone. And that there was a lot of ghost teachers who were illegally drawing a salary or retired long ago. George Werner therefore ordered the development of an electronic database for the three most populous districts of the country, in which all teachers and school principals were recorded with photo, fingerprint, ID and their certificates. And he had the entire staff take a test in mathematics and the national language, English. The resistance of the Liberian Teachers' Association (a kind of union) to the test could only be overcome when the minister agreed to offer in-service training to failed teachers who were deemed "fit for further training". About half of the teachers failed the test. Some could not even spell the name of their school or the word "Liberia".[32]

By the time the database was created and all successfully tested teachers had received a biometric ID, the government was able to identify 2,046 ghost teachers. It immediately cut most of them from salary payments, thereby saving 2.3 million US dollars a year and enabling it to hire 1,371 better trained teachers in return. In addition, the database made staff planning possible for the first time in the educational system. Among other things, it became clear that the country lacked over 10,000 teachers and that almost a thousand of the teachers tested were "untrainable". They too are to be removed from the teaching profession.[33]

4.2 What must education achieve?

In order to make up for the existing development gap in education, Africa must make great leaps forward at all levels. This applies from pre-school to university and professional qualification, for educational content as well as for pedagogy. It must be possible to give all children access to educational opportunities, regardless of gender, race or their parents' financial means.

Leapfrogging in education means taking advantage of every opportunity to quickly improve learning outcomes. In other words, first of all to lay the foundations for empowering young people – and only secondly to make use of the latest technical possibilities, i.e. computers, tablets or online learning programs. What is needed is an initial leap towards sufficient textbooks, well-trained and motivated teachers, pedagogically successful teaching methods and the involvement of parents in the learning process. Harvesting these low-hanging fruits would promote the education of young people simply and without great cost, as written in a working paper of the International Monetary Fund.[34]

Classically, the basic fundament of education is reading, writing and arithmetic. However, these skills are no longer sufficient in today's world. Because people must be able to put what they learn into a context and apply it in a different context than the one in which they learned it. Today, education is less about conveying knowledge content (which search engines can provide much faster) than about acquiring the skills to use knowledge in everyday life.[35]

Education must help us "to steer safely through an increasingly insecure, volatile and ambiguous world," as Andreas Schleicher, head of the OECD's Education Department, which coordinates the Pisa studies, puts it in a nutshell. Contemporary education is aimed "at economic and social change that is faster than ever before, at jobs that do not even exist yet, at the use of technology that has not yet been invented and at the solution of social problems whose emergence we do not yet foresee".[36]

The OECD education experts list a number of competences that people – especially the younger generations – need in the 21st century. In addition to the already mentioned basics, there are topics such as entrepreneurship and business administration, robotics and digital methods. Education must also impart soft skills like critical thinking, so that we can check whether information corresponds to reality at all; communication skills, conflict resolution skills and the ability to cooperate, so that we can work in teams; intercultural understanding for a working environment that is becoming increasingly diverse; cognitive flexibility and the willingness to make mistakes, because mistakes are a natural part of learning; and finally global competence, because nowadays problems can no longer be viewed and solved from the perspective of a single country.[37]

In order to cope with the future tasks of mankind, learning content and methods must also be continuously adapted, because the tasks of society are changing: economic growth can no longer be an end in itself, but is only desirable if it serves social progress and the well-being of people in harmony with the environment.

4.3 Where are quick improvements necessary? And how are they made possible?

Education begins at home, it becomes generally accessible in pre-school, then in primary and secondary school. Later, vocational training or higher education provide further qualification for young people. It is important that a broadly based education pyramid is created in the respective countries, i.e. that as many children as possible receive primary and at least secondary education.* From this large reservoir, many can then reach a higher secondary or vocational qualification and the most talented can study at a college or university. An education pyramid offers the best and cheapest way to make the most of a population's skills.

4.3.1 Education begins before school

Findings from neurobiology, psychology, linguistics and sociology prove that learning experiences in early childhood are decisive for the further development of young people. The maturation of the brain is largely completed by the age of five years, i.e. before children enter regular school. In this phase of development, children are naturally eager to learn and to know. Their young brain is like a sponge that absorbs all new information and forms it step by step into a world view. To be underchallenged during this time can hardly be compensated in later phases of life by intensive training. Children need early-learning experiences, ideally in a stimulating supervision, in pre-school or kindergarten.[38] The World Bank considers such investments to be "one of smartest things a country can do to eliminate extreme poverty, boost prosperity, and create the human capital needed for economies to diversify and grow".[39]

In the high-income countries, 83 percent of all children already enjoy at least one year of high-quality pre-school education, as required by the Sustainable Development Goals for 2030. This applies to half of all children worldwide, but in Africa not even to one third. Only 7 of the 49 sub-Saharan African countries offer free pre-schooling. Children in conflict regions are particularly affected, because they often suffer from malnutrition, poor medical care and trauma. This combination can lead to "toxic stress" which hinders brain maturation, writes Unicef. While less developed countries in Asia are making great strides and countries like Nepal and Bangladesh have pre-school enrolment rates of almost 90 percent, Ethiopia is one of the few bright spots in Africa in the area of early childhood education (see box p. 46).[40]

One problem in developing pre-school education is that administrations initially provide services where children can be easily reached. Children in informal settlements or in rural regions are left empty-handed for the time being, as there is a lack of staff, appropriate buildings, learning materials and stimulating toys. At the same time, the need is greatest in these poorer areas – also because the fertility rates are highest there. Even where expansion is successful, it is often at the expense of quality: In Tanzania, for example, it has been possible to enrol almost half of all children in a pre-school by 2016, but in the classes a teacher has to teach 135 girls and boys on average.[41] Even in the comparatively rich South Africa, where on

* According to international standards, secondary education is divided into lower secondary (ISECD2) and upper secondary (ISCED3). Generally, this corresponds to a degree according to the 10th grade or 13th grade respectively. However, there may be differences depending on the national education system.

paper there are clear rules for pre-schooling[42] and where President Cyril Ramaphosa has announced a compulsory two-year pre-school until 2024,[43] care for all those who cannot afford expensive private facilities is conceivably poor. "Pre-school in the poor environments means that an older lady without any qualifications does babysitting for some children," says South African education expert Sarah Howie: "These children go to primary school without preparation and start with a backlog that is difficult to catch up."[44]

4.3.2 Primary school: learning to read and reading to learn

Primary school in Africa begins at the age of six to seven years and lasts five to eight years, depending on the country. This is the phase in which children first understand how words, sentences and contexts arise from abstract characters. They "learn to read" so that they can later "read to learn".[51] Fatally, however, many African children still lack this skill in the fourth grade. According to a representative study, in Senegal, Kenya, Tanzania, Nigeria, Togo, Uganda and Mozambique, an average of 38 percent of pupils could not read a single letter, 53 percent could not read a complete sentence and 89 percent could not read a whole paragraph.[52]

BEST PRACTICE

Ethiopia: Early investment in the education pyramid

Ethiopia has proven that great leaps in early childhood development are possible. In the year 2000, just 1.6 percent of all children had the chance of attending pre-school. In 2017, the figure was 46 percent, and the trend is still rising. There is a clear programme behind this success. The government had initially targeted a two-year pre-school for children between the ages of four and six. Then it changed its plan when it became clear that this project could not be realised in the short time available and given the financial options. Instead, it decided to offer one year of pre-schooling and to reach even the most remote parts of the country.[45]

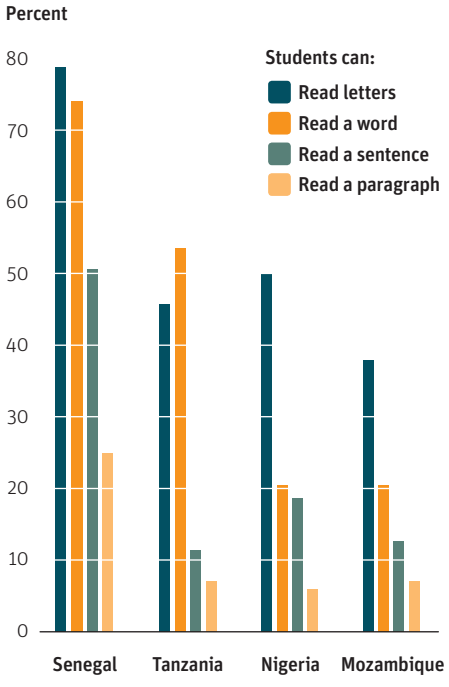
The programme was supported by the School Readiness Initiative (SRI), a non-governmental organisation that helps children with their first reading experiences in Amharic and English, assists them in their emotional development and advises parents, for example on how mothers can start a small business. SRI started in 2007 with a pilot project in the capital Addis Ababa. Supported by foreign foundations, 80 children were able to attend two pre-schools. In 2010 the Ethiopian government became part of the project and carried the costs for teachers and infrastructure. By 2016, 11,500 children between three and six years of age were attending 52 free pre-schools in the capital. 2,000 teachers were specially trained for these tasks. The government now uses the SRI manuals in all pre-schools in the country. Studies show that children who attend these facilities show significantly higher performance in their linguistic and cognitive development, and are socially and emotionally more competent than children in a comparison group without SRI experience.[46] The successes are particularly impressive because the pre-schools are sparsely equipped for lack of money and often 40 to 50 children attend a class. On a visit at a school, two swings and a slide in a dusty backyard were the only play equipments. At least, colourful pictures of animals and photos of each child with their career aspirations hung on the cracked classroom wall. As everywhere else in the world, firefighters, doctors, teachers or policemen were the preferred options.[47]

Ethiopia, the continent's second most populous country with over 110 million inhabitants, has laid the foundation for further educational success with its pre-school initiative. In the recent past, the country has also made the greatest progress in primary education in Africa. Within a decade, the number of children attending school has risen from 10 to 25 million. According to Unesco estimates, eight out of ten children should complete eight years of primary school in 2030, compared with only three out of ten in 2000. This puts Ethiopia, along with India, in first place among the world's educational catch-up countries.[48]

Between 2010 and 2015, the country spent between 26 and 30 percent of its national budget each year on education. This is more than in other countries in the region, such as Kenya or Tanzania, and also more than the UN's Education for All strategy asks for.[49] Contrary to the usual trend on the continent, it has been possible to double the school enrolment rate within eleven years and at the same time to achieve a more favourable students-teachers ratio. Another achievement: today, girls go to school just as often as boys.[50]

When school attendance is not enough

If you do not learn to read, there is hardly any other learning content available. Children should have acquired these skills by the fourth grade at the latest. In many African countries this is unfortunately not the case. Despite attending school, a high proportion of the children are not able to understand the content of simple texts.



Fourth-graders by reading ability, in percent, 2017
(Data basis: Bold et al.[53])

It's all about the teachers

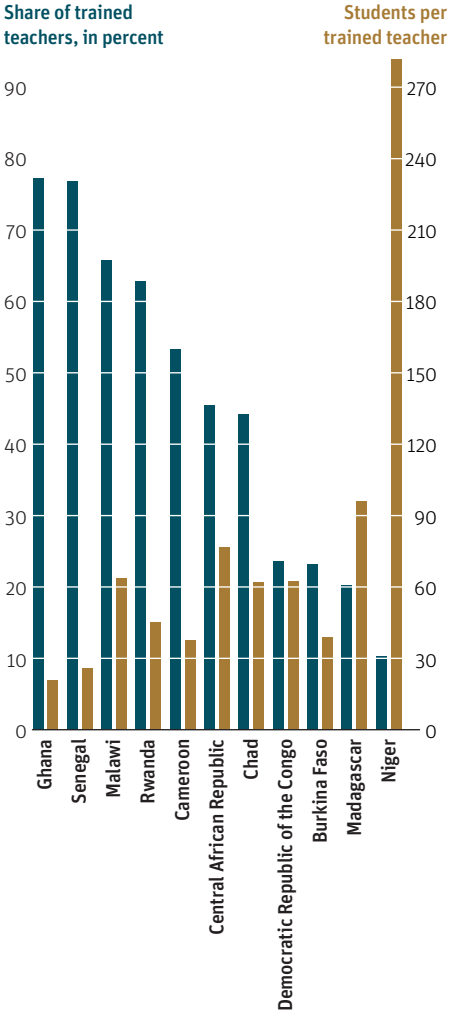
Studies from all over the world show that whether children learn something or not is essentially due to the teaching method, pedagogical concepts, and the commitment and qualifications of the teachers.[54] But teachers are the weak point in the African system. Most of them have little or no education. Moreover, there are far too few teachers in view of the growing number of students. At the same time, they cost African governments a lot of money. At over 70 percent, their salaries make up by far the largest part of the education budget. Measured in terms of the per capita economic power of their countries, the salaries in sub-Saharan Africa are four times higher than in the OECD countries.[55]

Interestingly enough, a World Bank report says that the teacher shortage offers a unique opportunity for a great leap in the quality of education, if only because the demand is increasing enormously due to population growth. To keep the teacher-student ratio in Africa from rising above 1:40, the continent will need two million additional teachers by 2030 and five million by 2050.[57] To reach the SDGs and provide primary and secondary education for all young people by 2030, sub-Saharan-Africa would need around 9.5 million additional teachers compared to 2016. In addition, another 7.6 million teachers would have to be trained to replace outgoing teachers.[58]

The new teachers to be recruited would, however, have to receive much better training – firstly, to acquire the necessary basic skills for teaching and secondly, to be able to apply modern teaching methods. A large number of studies on how to improve teaching show that teachers cannot apply a one-fits-for-all teaching programme, but should rather focus on each pupil's individual strengths and weaknesses and teach them according to their respective level of knowledge, and that the teaching staff needs intensive, continuous and regionally adapted training.[59, 60]

Many young people – too few trained teachers

In many places in Africa there is a shortage of teachers who have acquired adequate qualifications. In some countries there are up to 100 or more young people for every trained secondary school teacher. In others, such as Senegal or Ghana, the ratio is better.



Proportion of secondary school teachers trained (in percent) and number of pupils per trained teacher, last available year
(Data basis: UIS[56])

If it were possible to train African teachers in this way, to define clear criteria in the selection of teachers and to recruit only qualified personnel, the quality of the teaching staff could be improved at a stroke. This would be leapfrogging through new recruitments. In addition, some studies argue that motivated and committed teachers should be paid according to the educational results of the students in order to achieve an incentive effect through payment.[61]

Only a few African countries have so far managed to fundamentally upgrade their education systems. One of the exceptions is Ethiopia, which had the lowest school enrolment rate in the world in the 1990s. At that time, the government set ambitious goals with the Education Sector Development Program (ESDP).[62] After initial success, in 2008 and 2013 the government launched the General Education Quality Improvement Program (GEQIP) to better equip all schools nationwide and in all language areas.[63] Even though the education system in Ethiopia is still far from perfect, the drop-out rate of first-graders has fallen to 13 percent, below the government target of 17 percent. 133 million textbooks and other teaching materials were printed.[64]

BEST PRACTICE

Kenya: Tusome – let's read

There is no lack of projects to give children in Africa better educational opportunities. Countless national and international non-governmental organisations, sponsorship or scholarship programmes support individual schools or villages in building proper classrooms, paying teachers and providing teaching materials from books to tablets. Many of these initiatives have been successful. That is why there have been many approaches to multiply and upscale them in order to turn model schools into a functioning model for an entire country. But these attempts practically always fail.[65] There are many reasons for this: sometimes good projects are based on committed teaching staff that cannot be found elsewhere. In other cases, educational success depends on external funding or technical resources that cannot be found everywhere.

The Tusome programme in Kenya takes a different, simple and very pragmatic approach to moving from an inefficient education to an organised teaching system. It aims to improve the reading skills of first- to third-graders in English and Swahili. In Kenya, although almost all children go to primary school, many leave as illiterate.[66, 67]

Tusome is Swahili for "Let's read". Kenya's 81 million US dollar Ministry of Education programme, supported by the United States Agency for International Development (USAID) and the UK Government's Department for Foreign Aid (DFID), has developed an overall strategy for effective education and a mechanism to ensure that all schools and teachers adopt this strategy.

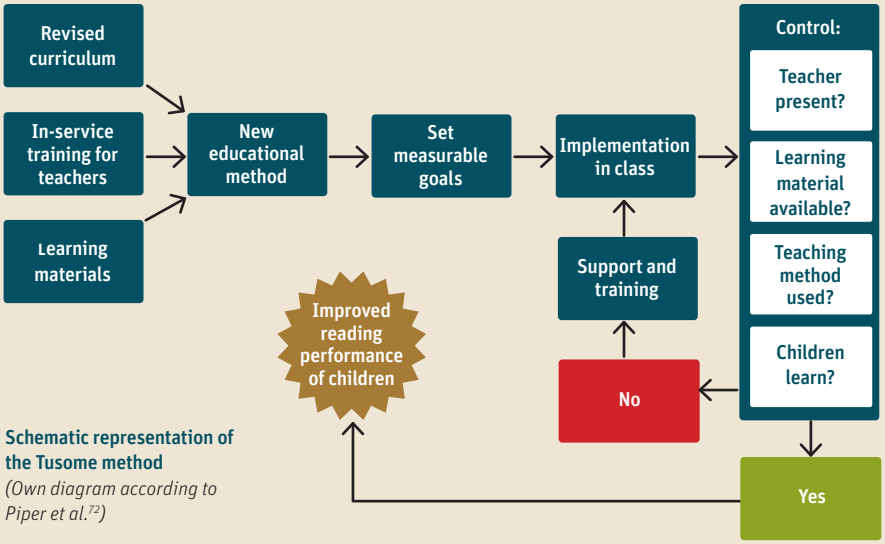
Tusome works with three key approaches: First, the government has set measurable goals, defined desired learning outcomes and communicated them clearly to school administrators, schools, teaching staff and students. Second, it provided timely support to students and teachers if they are unable to achieve the goals set. And third, it monitored the achievement of the goals at all levels: Did the schools really receive the prescribed teaching materials? Did the teachers adhere to the teaching guidelines? Did the students learn what they were supposed to learn?

The programme started in 2015, when reading results were well below the government's targets. Nationwide, more than 24,000 primary schools with a total of 3.4 million children participated in the programme.[68] Kenyan scientists then independently evaluated Tusome and attested the initiative impressive successes: after only three years, the children were able to read significantly better than their predecessors in both English and Swahili. In grade 2, around two thirds of the children achieved the reading performance expected at their age, around twice as many as before Tusome began.[69]

The researchers cite the approximately 1,200 specially appointed Curriculum Support Officers (CSOs) as an important success factor. As advisors to schools and teachers, they regularly visited the educational institutions, monitored success and have supported the teachers in implementing the pedagogical concepts. The CSOs in turn received training three times a year, as well as tablets to record project progress and feed it into a database. This provided the government with real-time data on the progress of the programme. The tablets provided CSOs with immediate information on how to improve the performance of specific students. The work of the CSOs was also documented: each time an officer attended school, the tablet registered their exact location via GPS to ensure that the officers were actually on site, that they visited even remote schools and that they did not fake checks. There had never been such a control of the educational efforts in Kenya before. So the teaching staff could be sure that the government was watching them to see if they were following the project's guidelines, but also that they were getting support when necessary.

The evaluation of Tusome also revealed shortcomings and the scientists still saw considerable potential for improvement. The study emphasised that sanctions were not helpful if teachers or CSOs did not achieve the desired successes, but rather advice on how to achieve them. Neither in the neighbouring countries nor in any pilot projects has there been such success in such a short time, the report concludes.[70] And all this at a cost of only about four US dollars per child and year.[71]

Support and control



Schematic representation of the Tusome method
(Own diagram according to Piper et al.[72])

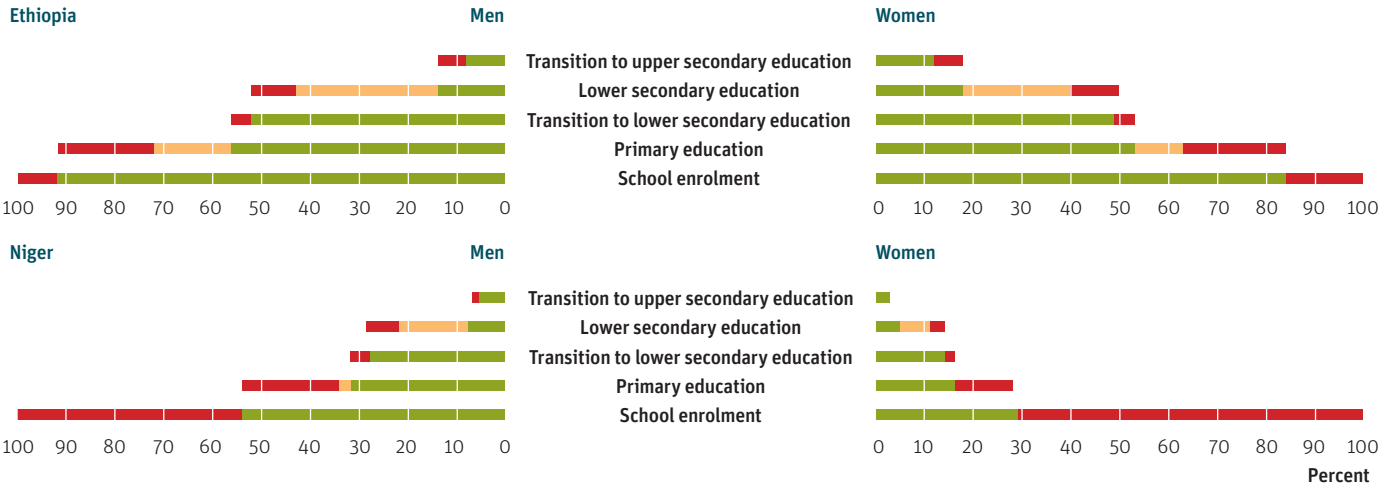
4.3.3 Secondary school

Secondary education today has a completely different meaning worldwide than just a few decades ago. Long a privilege of a limited number of students, it has now become the standard in more developed countries to prepare young people for higher education and the job market. According to the SDGs, this is to apply to the whole world by 2030.

This is a particular challenge for Africa. Firstly, only 25 percent of all young people in sub-Saharan Africa complete secondary school, while all the others get lost on the way to higher education. In many countries, less girls than boys reach secondary education.[73] Secondly, there is a lack of schools and trained teachers. And thirdly, the young population is growing rapidly.[74] Countries must therefore look for efficient means and cost-effective ways to at least come close to the goal.

Project-based learning – leap into real life

Teaching in a school does not necessarily enable young people to understand the meaning of learning. The memorisation of a physical formula or the interpretation of a text have little to do with practical life and arouse little curiosity about the meaning of these topics. Especially in secondary school, where the foundations of learning are already in place, young people should move from theory to practice. They must immerse themselves in the real world and find solutions to problems through trial and error.[76]



Too many obstacles on the way up

Being enrolled in a primary school is an important step in an educational career. In Ethiopia this is now possible for around 90 percent of all children. However, many of them fall by the wayside later on, and only about 10 percent make it to secondary school. In Niger, the country with the worst educational opportunities in the world, not even 20 percent of girls and only about 30 percent of boys complete primary school.

Percentage of young people in upper secondary education (Ethiopia: 17- to 18-year-olds (2016), Niger: 15- to 17-year-olds (2012)) who have completed, dropped out or never reached different levels of education
(Data basis: Unicef[75])

- Successful
- Not (yet) successful
- Not successful

Project-based learning, also known as learning by doing, opens up this world to African students. The South African High School Learner Support Project of the Zenex Foundation, for example, aims to inspire students from townships to take an interest in mathematics, science and English and to get them interested in a higher education career. The project starts with an idea, preferably from the pupils, for example to design a school website or to answer the question of how to ensure the water supply in the region during a period of drought. A certain number of students then form an "academic club" that meets regularly to discuss the project. Students of higher grades or former students are available as mentors, and the academic clubs can also invite experts from industry or the university for advice. By the end of the project, almost 90 percent of the participants had successfully completed secondary school.[77, 78]

The American non-profit organisation Lesson Planet offers a few hundred thousand online courses and practical learning projects. One of these is Connecting Africa, which gives students the task of connecting Tunis and Cape Town with a highway. The aim is to improve political and economic exchange within Africa – at low cost and without excessive environmental pollution. At least 13 and a maximum of 25 countries must be connected to the road, building materials must be locally available, civil war areas and regions where Ebola or Dengue are threatening must be avoided. Not an easy task, therefore, which even experienced planners can fail at. For pupils this is a most exciting project: they can slip into the role of politicians or planners and learn about the importance of large infrastructure projects for individual countries and an entire continent.[79]

Teachers can also learn together with their students on a project basis. In Botswana, a project has been set up to integrate pressing environmental issues into the curriculum. For example, how the wastewater from a school in Francistown can be treated to make it suitable for irrigation of the gardens. Teachers and pupils then obtained information from the local waterworks about the water quality required for this purpose. They drew up a plan for a sewage treatment plant, laid pipes and built a 10,000-litre tank. In the end, teachers gained experience in project-based learning and the students

learned a lot about the scarce resource water.[80] A similar project could deal with the ever-present rubbish in the African environment and what the consequences of this pollution are. All these are ideas that deal with the analysis and the solution of socio-ecological problems that prevail throughout Africa. All these learning units can be standardized and spread as in Lesson Planet.

Secondary education – particularly important for girls

59 percent of all girls in sub-Saharan Africa now complete primary school, but only 22 percent complete secondary school. The figures for boys are 61 and 29 percent respectively. This means that the education system becomes less gender equitable with increasing age. No wonder that in sub-Saharan Africa women are less likely than men to be enrolled in higher education and to graduate from university.[81] Not only is this unfair, it also blocks women's prospects of earning an independent income and, in addition, means a delayed demographic transition. For women with higher education in Africa have significantly fewer children than their female counterparts who have attended school for some years only or not at all. Every year of secondary education reduces the likelihood that girls will be married before the age of 18, on average by five percentage points.[82] Secondary education can virtually eliminate child marriages.[83] Conversely, child marriages and early pregnancies are a major reason why girls drop out of school.[84]

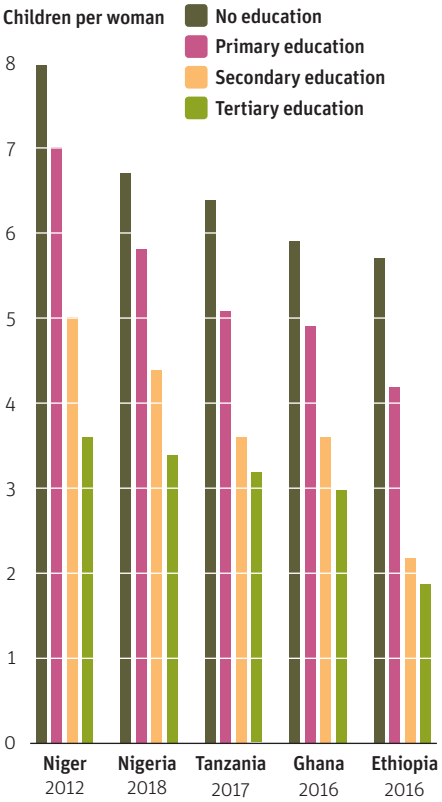
The Center for Girls Education in Nigeria has set itself the goal of helping girls in the Sahel countries to attend school for as long as possible and strengthen their self-confidence. "Girls get married here at the age of 12 or 14, they often can't even write their own name," says the team leader Habiba Mohammed. "At 15 they have their first child, although they are still children themselves and their bodies are not yet ready for it. Many die during pregnancy." The initiative gives advice to parents who do not consider it necessary for their daughters to go to school for a long time or at all about the value of and the basic right to education. The initiative ensures that early school leavers return to school or take up vocational training.[86]

Because there are too few female contact persons for women in the health sector, the initiative's Girls for Health programme prepares girls for training as midwives, nurses, doctors or pharmacists while they are still at secondary school. It uses all the arguments found in the Koran to convince imams in the Muslim north of Nigeria, where educational deficits are greatest, of the benefits of girls' education. The expertise for this comes, among others, from the women's rights activist Mardhiyya Abbas Mashi, a graduated Arabist and Islamic scholar. In addition, the Center for Girls Education has created Safe Space Clubs for around 20,000 girls, i.e. protected rooms in which mentors can talk to girls undisturbed about sensitive issues such as menstruation, family planning or parenthood.[87]

In Ghana, West Africa, the Making Ghanaian Girls Great initiative is aimed at girls who are at risk of dropping out of school and who lack well-trained, motivating teachers. The project has worked with such teachers in a television studio of the capital Accra and recorded lessons in mathematics and English, which are used throughout the country. The actual teachers present these lessons with solar-powered projectors, supervise the students and learn how to teach well by the way. Girls who have already turned their backs on school can make up for the lessons in evening classes.[88]

Education as a the most efficient contraceptive

Everywhere in less developed countries, the average number of children per woman decreases with the women's level of education. School attendance is a major protection against forced marriages and premature pregnancy. Women with higher education have better career opportunities, want fewer children and can more easily enforce this wish against their partners.



Average number of children per woman according to educational attainment, in each case last available year
(Data basis: DHS[85])

BEST PRACTICE

Support for schoolgirls and for women who promote them

In 2014, Camfed, short for Campaign for Female Education, set itself the goal of helping one million girls through secondary school. In 2018, the international, donor-funded organisation was involved in 6,200 schools in Ghana, Tanzania, Malawi, Zambia and Zimbabwe and had achieved 96 percent of its goal. Camfed covers school fees, the cost of school meals and uniforms where necessary and finances bicycles when the journey to school is long.

The impetus for Camfed was the fact that girls, especially in rural Africa, have poorer educational opportunities than boys. To combat this disadvantage, the organisation sought out young women who were able to build a professional existence, hired them as mentors and trained them for new tasks. 65,000 of them, supported by 138,000 alumnae from the programme, look after and advise over 300,000 schoolgirls, for example when they are to drop out of school, their parents have died or forced marriage is imminent. They explain how to handle money reasonably and which health issues are important for young girls. Above all, they serve as role models. In return, the mentors receive interest-free loans to start a small business as well as lessons in accounting, business administration and leadership skills. According to Camfed, the alumnae network is the largest of its kind in Africa and is intended to produce a new generation of self-confident women. Some of them have already made it into parliaments and the executive floors of companies.[89]

Alice Saisha is a living example of the Camfed motto: "Receive and give back". Growing up in rural Zambia with a widowed mother and eight siblings, as a child she lacked the money to continue to go to school. Instead, Alice was to be married at 14. A Camfed scholarship enabled her to avoid this, and a mentor stood by her side. Today Alice earns her own income and as an alumna she takes care of four orphaned girls. She makes sure that they get three meals a day, have a roof over their heads and can go to school.[90]

4.3.4 Vocational training

Hardly any African country offers its young people sufficient employment opportunities. A sign of the problem are the many "NEETs" (people who are Not in Education, Employment or Training). In South Africa, for example, 52 percent of the 20- to 24-year-old women and 45 percent of men in that age group are NEETs.[91] At the same time, there is a shortage of skilled labour almost everywhere in Africa: Two-thirds of young people are insufficiently educated and almost half of those who have a job feel that they are poorly qualified, according to surveys. The African Development Bank states that the continent has the world's largest mismatch between educational attainment and labour market needs.[92]

What the African labour market lacks is a middle class of young people with a vocational qualification.[93] As a role model, the apprenticeship, known from Germany, Austria and Switzerland, which imparts learning both at school and at the workbench, often applies. This type of training has developed over decades in line with the specific requirements of the German-speaking labour market. For Africa, it is only suitable to a limited extent, as young people there are hardly prepared to invest in a three-year apprenticeship and earn little in the meantime. Craft professions are regarded as second-class jobs in Africa.[94] There is also a lack of vocational schools, companies with qualified trainers, defined job descriptions and criteria for what trainees should actually learn.

What is needed is a slimmed-down version of the apprenticeship system that provides young people with a craft training and companies with the skilled workers they are looking for. Such models are emerging in a wide variety of African countries.[95] One example is Young Africa, an initiative that has been offering six- to twelve-month training courses for around 40 professions in Zimbabwe, Zambia, Mozambique and Namibia for over 20 years, from farm manager to solar technician to car mechanic.[96] The Uganda Rural Development and Training Programme trains young people in a similarly short time in metalworking, solar technology, in the processing and marketing of agricultural products, and imparts the knowledge needed to set up a business.[97]

Go for Gold trains young people for the construction industry in South Africa, where many companies have problems finding technical experts. The programme begins in the last two grades of secondary school, provides tutoring in mathematics, natural sciences and computer science in disadvantaged neighbourhoods and then places suitable candidates with partner companies for a one-year paid internship. During this time the young people learn about the career opportunities in the industry and then study for a Bachelor's degree in civil engineering or project management at a technical college. Afterwards most of the Go for Gold students take their first job, usually where they did their internship.[98, 99]

BEST PRACTICE

Kenya: Training – and off to work

The international initiative offers four- to twelve-week training programmes for 25 professions. Young men and women can take an entrance examination and qualify as web developers, pharmacy assistants, sales representatives or microcredit brokers for a fee. Generation has been active worldwide since 2015, including in Spain, India, Mexico, Pakistan and the USA, and can thus benefit from experience under very different conditions. Kenya is so far the only project country in Africa. Here Generation trains around 4,000 young people per year.[102] Founded by the consulting firm McKinsey and supported by numerous international companies and foundations, Generation not only trains young people, but also immediately links the newly qualified with potential employers. Thanks to this employment agency, 84 percent of Kenyan graduates find a job after an average of three months. 82 percent of employers state on record that they would hire people trained by Generation.[103, 104, 105]

Eunice stands for a typical Generation career. She grew up in difficult circumstances, orphaned at the age of nine, and lived in Kawangware, a poor district in the west of the Kenyan capital. In her barrack there was no electricity or drinking water supply. Nevertheless, she had made it to a secondary school, but had to drop out when she became pregnant for the first time. Soon she had a second child, but had neither a job nor an education, let alone a husband to support her. For a while, she struggled to make a living as a street vendor. Then she heard about Generation, completed a programme in sales and marketing, and quickly found employment with a large food company. Today she is a sales manager and lives with her daughter and son in their own apartment in Nairobi. "If you grew up in a slum, you don't want your children to have the same experience," says Eunice.[106]

In Ghana, the government has been planning for years to formalise vocational training, but with moderate success. 90 percent of the young people find a job only in the informal sector after school, where they "learn" from "trainers" who have no training themselves. "When we started, there was no curriculum, no model or method for training. If I was taking an apprentice, he just observed what I was doing. There was no standard to follow," says Emmanuel Morrison, president of the Electronic Technicians Association in Ghana.[100] The National Vocational Training Institute (NVTI) wants to remedy this situation, supported by the German Society for International Cooperation (GIZ). In a pilot project, it is training master craftsmen, who in turn train young people to become electricians, mobile phone technicians, welders or carpenters according to clear requirements, for three months to two years, depending on requirements. Important are security issues and financial management, topics that usually play no role in informal training. "Usually, they don't look at safety when they are trained informally," explains Bernard Forson of NVTI. "And they also don't know how to do estimates. They have to work all day long, pay their expenses and at the end, lose money."[101]

4.3.5 After School

In sub-Saharan Africa, on average only 5 percent of men and 4 percent of women complete two to four years of tertiary education. In the Europe/North America region, this applies to 44 percent of men and 53 percent of women. The low figures can be explained by the school system which does not provide enough young people with a secondary school graduation, but also by the limited possibilities of finding a job as a university graduate.[109] This in turn is due to the fact that students often are not learning enough at universities and often decide to study the humanities and social sciences, although the labour market tends to demand mathematicians, technicians and engineers.[110] Many young people hope to be employed in public administration which does not offer enough jobs. As a result, many academics are dismissed without any chance of entering the labour market, while at the same time there is a shortage of skilled workers.[111] In a survey conducted by the international consulting firm PricewaterhouseCoopers, 87 percent of the managing directors of African companies reported a shortage of qualified applicants; 54 percent said that this deprives them of opportunities for growth.[112, 113] Better training in the three development-related areas of health, education and agriculture considered in this study would also be important because they promise numerous jobs and can thus lead to fundamental improvements in living conditions (see chapters 3 and 5).[114]

BEST PRACTICE

Uganda: Learning entrepreneurship with Educate!

Uganda is one of the countries where young people have enormous difficulties in finding adequate employment. One reason for this is the insufficient level of education. Another reason is that after schooling, young people usually end up in informal and insecure jobs. In order to become successfully self-employed, they usually lack entrepreneurial and business management knowledge.

The non-governmental organisation Educate! tries to fill this gap. It has set itself the task of equipping young people with a practical basic knowledge of accounting, business planning, management, leadership and teamwork. Since 2009 Educate! offers an 18-month training course in the last two years of secondary school. After an entrance examination, the young people take lessons in addition to their school programme and then usually start a small business, for example to produce soap, to recycle materials such as paper and glass or to earn money with agricultural products. They are looked after in groups, so-called business clubs, by teachers specially trained for this purpose, but above all by mentors aged up to 25 years. These mentors already have experience with their own companies and are also trained for their tasks. As remuneration, the mentors receive scholarships or loans for their own companies. From the beginning Educate! intended to expand the programme and become more efficient. Following a standardised procedure, it reaches more than 120,000 Ugandan students per year and has also been active in Rwanda since 2016. To participate in the programme, schools pay a small fee to Educate! The total cost per student is about 100 dollars. It is planned to reduce it to 63 dollars over time through economies of scale.

Educate! continuously documents the students' progress via mobile services and has a good track record: the Educate! participants were 44 percent more likely to start a small business during their school years than young people in a reference group without this kind of instruction. They earned twice as much money after finishing school. They had to struggle much less often with unattractive jobs such as the production of charcoal and bricks or as domestic help. Instead, they were more likely to find a formal job or go to university after secondary school. The public appearance of the young people, their ability to take on leadership tasks and participate in community tasks had improved significantly. In general, girls in the programme developed significantly more skills than boys.[107, 108]

4.4 Leapfrogging with technology

New information and communication technology (ICT) tools allow information and knowledge to be disseminated better than ever before. But does Edtech, i.e. digital learning, also work where there is a lack of committed teachers and good schools? With the right software, can children ultimately teach themselves even without teachers?

International evaluations of numerous attempts to improve learning success with ICT have produced mixed results: many show little or no benefit at all from computers and software in classrooms.Some of them prove that Edtech can give an additional boost to schools that already teach at a high level. Others point out that ICT can make learning easier, especially in less developed countries, where there is a shortage of competent teachers and a lack of good pedagogy. In addition, computer-supported learning programs have improved considerably in recent times. Their impact cannot yet be taken into account in many project evaluations.[115]

Useful – but only under certain conditions

ICT learning methods are particularly successful when teachers support the children in working with the computer, when this work takes place in addition to the actual lessons and does not displace other learning content.[116] There are further reasons for using ICT at least as a support: children learn more easily at the computer because they are not afraid of giving wrong answers. A tablet has more patience than any teacher, it can repeat a question a thousand times or vary math problems until the students have grasped its meaning.

Computers provide access to a wealth of information, educational videos and lectures that no teacher can provide. An artificial intelligence (AI) supported learning software can adapt learning content and speed to individual students, continuously analyse their success or failure and evolve independently. Thus, children in one class can learn different things at the same time, which is hardly possible in a "normal" classroom. The use of computers also opens the way to digital literacy and prepares for the later use of ICT in the professional world.[117] The African Development Bank is convinced that better ICT skills will open up leapfrogging opportunities for Africa in various areas.[118]

Learning without a teacher?

Educational software is increasingly being used in Africa: onebillion, a non-profit organisation based in London and Nairobi, has developed a reading and math program to help overworked teachers take care of their students. In Malawi, for example, this is urgently needed. In 1994, the government abolished fees for primary schools and the number of children enrolled in school rose from 1.9 to 3.2 million within one year. But there were hardly any additional teachers or school buildings, so on average 100 children had to share a classroom.[119, 120]

Years later, with the self-explanatory software from onebillion, it was possible to divide some of the overcrowded Malawian primary school classes into groups. There, the virtual instructor Alefa teaches groups of 25 children each in Chichewa on tablets that were specially developed for this purpose. They are robust, affordable and rechargeable via solar module.

BEST PRACTICE

South Africa: Access to online learning programmes

The South African project Siyavula was created because a few students wanted to share their knowledge with children in disadvantaged, rural areas. In 2002, physics student Mark Horner was demonstrating experiments with friends at a science fair when a few young kids arrived with pens and notepads and asked if they could write everything down. They had no schoolbooks, but what they had seen and heard was exactly what they needed to know for their next exam. Horner was impressed by the poor barefoot kids, and over the next five years, with up to 50 volunteers, developed a freely available online textbook on math and science for upper secondary schools. Students use it for learning and teachers use it to improve their teaching.

When South African teachers went on strike nationwide for a month in 2010, the Ministry of Education called on Siyavula to at least allow students to prepare for their final exams. In 2013, the government took over the printed version of the textbook for grades 4 to 6 for all public schools, saving some 84 million US dollars. In 2014, the plan was to supply the entire country with 42 different open educational resource textbooks. This approach failed because the government had just launched a poorly planned education reform, which resulted in no new textbooks being printed at all for three years. Siyavula also jumped into this void and negotiated an agreement with the country's two largest mobile phone providers to allow students to download educational programs to mobile phones free of charge.[129]

Those who use Siyavula usually start with simple arithmetic tasks. For example, how to combine the digits 5, 1, 9, and 4 into two two-digit numbers, which in their sum result in the smallest possible number. The right answer is 64. If the learner enters an incorrect answer twice, a detailed explanation of the solution in single steps follows. The simple task thus turns into a small, logically structured puzzle that stimulates the mathematical imagination. With the next question, the students can then work their way forward until they arrive at complex tasks, exponential functions or differential and integral equations.

The advantage of Siyavula over traditional teaching methods is that the software does not query a catalogue of tasks, but that the algorithm increases the level of difficulty of the questions in such a way that every student can answer them correctly with 70 percent probability. This is the rate at which students neither get bored nor break off the lesson in frustration. Under these conditions, learning has the greatest possible effect.[130]

Because Siyavula "knows" its students, the software can tell at any time what their level of knowledge is, where there are gaps and what the young people still have to do to reach a certain learning goal. Siyavula tells the teachers where they can intervene, which students need support or which tasks they have fundamental problems with.

In Tanzania the teacher is called Mahira and speaks Kiswahili. In a large-scale experiment with 8,000 donated tablets children who have never been to school were taught the most important basics of reading, writing and arithmetic within 15 months without outside help – in the fields, while herding cattle, or in their huts in remote villages.[121] In 2019, onebillion won a prize of five million US dollars in the Global Learning XPrize for the best software for teaching in the absence of teachers.[122]

During the coronavirus pandemic, ICT learning methods are often the only way to provide school children with instruction. In Kenya, for example, tech companies were already on the starting blocks: Eneza Education had long digitised the entire Kenyan curriculum from fourth grade to secondary education and converted it into small SMS-compatible units. Within one month after school closures, the number of learning units accessed rose from 360,000 to 4.3 million. The Eneza program Ask a Teacher receives over 20,000 questions per day, ten times as many as before the pandemic, and was able to answer 60 percent of them within five minutes. At Kenya's Zeraki learning platform, downloads of instructional videos, which were actually intended to help students catch up when they were lagging behind, have increased a hundredfold within a month. In South Africa, Siyavula's educational software for science (see box on p. 55) has recorded a four hundred percent increase in user numbers since the outbreak of the crisis.[123]

Learning from others

India has gained some experience with learning programmes that could also be used in Africa. Mindspark, a software for reading and mathematics, draws on an archive of 45,000 questions and increases their level of difficulty according to the performance of the users. Mindspark "learns" from mistakes in the students' thinking and trains them with special tasks in order to avoid the mistakes from now on.[124]

BEST PRACTICE

Feed the Monster: Learning to read in crisis areas

What to do when bombs are falling, when the schools have burned down and the teachers have fled? This was the question facing Unicef when, during the Syrian civil war in 2019, over two million children were denied school attendance. The same applied to 800,000 boys and girls who had been accommodated in refugee camps in neighbouring countries.[131] In this situation, the Norwegian government sponsored a contest to develop an app that would teach children of primary school age to read Arabic in a playful way and at the same time strengthen their psychological well-being. The result was Feed the Monster, an open source software for mobile phones that is now available in countless languages and dialects, from Somali to isiXhosa.[132]

The game tells the story of friendly monsters with big ears and a villain named Harboot. He conquered the monster land and drove its inhabitants into exile. With a curse he also turned them into eggs. The children must now feed the eggs on the screen with the correct letters, syllables and words so that friendly monsters hatch out of them again.

An evaluation of Feed the Monster showed that after only 22 hours of learning, the children were making basic reading progress, that they were able to use the software with little or no help from adults, and that they emerged emotionally strengthened from the exercise – among other things because the program invites children to use it together with friends or family. One evaluation concludes that Feed the Monster is a good tool for promoting reading skills in primary school children under extreme conditions.[133]

Even simpler is an idea that the Indian educationalist Sugata Mirta had in 1999: the Hole in the Wall Project. As an experiment, he had embedded a computer with Internet access and a touchpad into an opening in the wall in a slum in New Delhi. A little later, children who had no basic knowledge of computers at the time noticed the device, found out that the touchpad reacts to touch and learned to operate the computer in no time at all. "After eight hours, 70 children were ready to browse," Sugata Mirta recalls. The Internet was only available in English at the time, but that was no obstacle. When Mirta visited another hole-in-the-wall experiment in a remote area of northeast India, the children, who had no knowledge of English or computing, had already learned 200 words in English. As soon as the kids saw Mirta, they told him, "We need a faster processor and a better mouse." Mirta concludes that children are keen enough on experimenting to learn autonomously with the help of computers, especially if they work together in groups.[125]

The pilot project has long since given rise to Hole in the Wall Education Ltd., which has installed such computer terminals in various countries in Asia and Africa. With prize money of one million US dollars, Mirta then founded the initiative School in the Cloud Self Organised Learning Environment, in which teams of children and young people all over the world work on "big questions" with the help of the Internet alone. For example: "Why do we humans exist?", "How does my smartphone know where I am?" or "What would happen if all the insects disappeared from the earth?"[126, 127]

The bottom line for all computer-based learning programs is that good software is always better than a bad teacher and that a balanced combination of Edtech and human-to-human pedagogy gives the best results.[128]

4.5 Guarantee access for all

Of course there are also good and excellent schools with good and excellent teachers in sub-Saharan Africa. However, they are usually only open to a well-heeled upper class who can afford the sometimes very high fees. This is why sub-Saharan Africa, as the region with the world's greatest income inequality, also has the greatest educational inequality. The danger is that this will translate into even greater income inequality in the next generation.[134] Nowhere in the world is the loss of human potential through inequality greater than in sub-Saharan Africa, the United Nations writes. One way to overcome inequality is through better education for disadvantaged population groups – education is a key factor for social mobility.[135]

Interestingly, in sub-Saharan Africa, measured by the World Bank's Gini index, inequality is lowest where poverty levels and population growth are highest. Great inequality tends to prevail where the demographic transition is more advanced and the gross domestic product per capita is comparatively high. This is particularly true in southern Africa, in Botswana, Namibia and South Africa, where there is a small layer of super-rich but a large number of marginalised people. In these countries, inequality has increased even further in recent times.[136]

The phenomenon of educational inequality or injustice can be studied in South Africa as an example: although the continent's one and only industrialised country offers schooling for almost all children, it regularly ranks low or even last in international comparative education studies, no matter whether those are about reading, mathematics or scientific knowledge.[137] This is particularly tragic, because with the end of the racial segregation policy in 1994, the country wanted to offer all children and young people the chance of an appropriate education. "Education is the most powerful weapon to change the world," Nelson Mandela, the first president after apartheid, once said.[138]

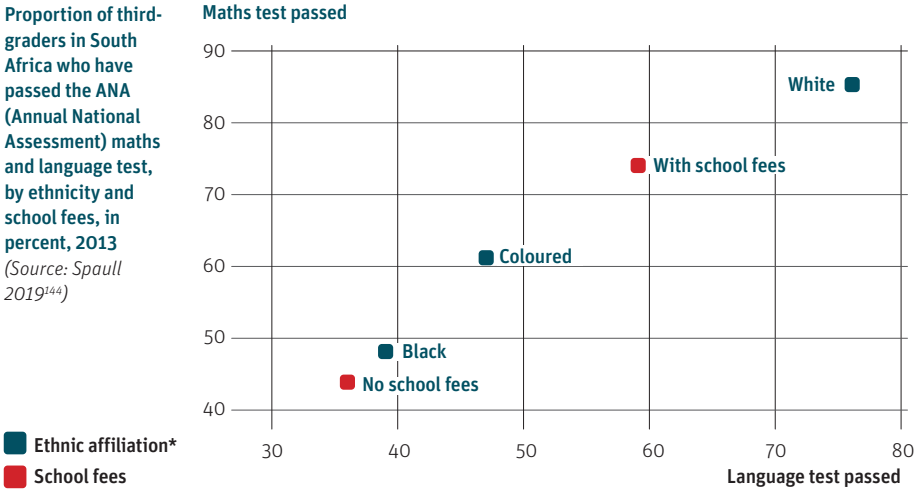
More than 25 years later, educational opportunities depend less on skin colour, but all the more on the financial means of the parents. Fee-based private schools provide by far the best results, free state schools with few exceptions bad results.[139] This system is also self-sustaining: students from poor schools who have barely managed to graduate often opt for becoming teachers themselves. Their school certificates are only sufficient for bad universities, where they are necessarily trained as bad teachers. Later, they teach at similarly bad schools as those they themselves once attended.[140]

Jonathan Jansen, the former rector of the University of Free State and one of the most experienced education experts in South Africa, estimates that his country has about 20 percent good and 80 percent dysfunctional schools.[141] One consequence of this is that almost four-fifths of South Africa's fourth-graders are functional illiterates, i.e. people who can recognize letters and read and write some words, but do not understand the meaning of longer texts.[142] Another consequence is that the best 3 percent of South African secondary schools have produced more mathematics graduates in 2018 than the 97 percent of all other schools combined.[143]

New form of apartheid

South Africa is the country with the highest social inequality in the world – and probably also the highest educational inequality. Children from white families and those from the black upper class go to the best, usually fee-paying schools. They perform well in mathematics and their first language. The vast majority of the black population is forced to attend the free schools – and learns very little there.

Proportion of third-graders in South Africa who have passed the ANA (Annual National Assessment) maths and language test, by ethnicity and school fees, in percent, 2013
(Source: Spaull 2019[144])



* In South Africa the ethnic categories of apartheid (black, white, coloured, Asian and others) are still used. Every South African can indicate for himself which ethnic group he or she belongs to.

But how could more equality and justice in educational matters be achieved? Here, the South African government has the first responsibility. It has, at least on paper, high expectations and issued minimum requirements for schools. Among other things, it wants to improve the school infrastructure, employ more teachers, deliver high-quality learning materials, and raise completion rates.[145] "But in reality, our government has little interest in more equality," says Jonathan Jansen and explains this with the end of apartheid: at that time, the white minority had to give up some of their privileges, but only the new black upper class got access to good private schools. This group, which today represents the political elite, would in turn lose many of their privileges if these schools were to be opened up to the majority of the population. So nothing would change.[146]

Top schools in poor districts

As long as the South African government is incapable of fundamental reforms, Jonathan Jansen will focus on those schools that manage to deliver good results under the most difficult conditions, i.e. in black townships and in rural areas. "With capable leadership, discipline and dedicated teachers, these schools can teach that learning is the most important thing in life," says Jansen. "A good school focuses on doing the simple things properly."

Indeed, there are such islands of excellence in the sea of dysfunctionality. One of them is the Center of Science and Technology (Cosat) in Khayelitsha, a township of 400,000 inhabitants near Cape Town, which is considered the fifth largest slum in the world.[147] "No Excuses – Just Success" is written in big letters in the entrance foyer of the public secondary school. Director Phadelia Cooper quickly makes it clear that she does not tolerate excuses: "Our students come from difficult backgrounds. There are no books at home. There is violence and crime all around them," she says. "But we believe in the kids. Only then can they believe in themselves. We focus on each individual student from the very first minute."

Cosat is located in iLitha Park, a slightly better part of Khayelitsha. But almost all of the teenagers, who arrive in the morning in their shiny blue school uniforms, come from the densely packed tin huts or simple brick houses that make up the major part of Khayelitsha. They all passed an entrance test for Cosat after primary school.

The lessons at Cosat go beyond the normal timetable, there are extra courses for the weaker students. Teachers and students come for Saturday classes as well. "We place particular emphasis on maths, science and computer science," says Cooper, "these are the subjects our country needs most."[148] But they are also subjects that many students avoid because they require a special effort and are often considered demanding. For mathematician Cooper, who grew up in a township herself, this is just another challenge: "We have to set goals as a school. And if the children don't achieve the goals, the teachers have to help them."

The mathematics teacher William Shonhiwa shows how to do this: he explains the solution of a differential equation using an example and involves the students in every step of the calculation. Afterwards, the twelfth-graders sink into the tasks with a quiet murmur. Shonhiwa goes from table to table and intervenes only when necessary. Next door, in the computer lab, the students of the 10th grade sit in front of modern computers, devices that would have been stolen long ago in other schools, typing commands in the programming language Delphi into the keyboard.

In 2019, 90 percent of Cosat students graduated from high school, they matriculated, as it is called in South Africa, a figure Cooper is not happy with, because she has already seen years when it was 100 percent. A total of 63 percent of the graduates received a university entrance qualification in 2019.[149] They then typically study engineering, computer science, biology or medicine. The others usually attend a technical college or are trained directly by IT companies.

In 2009, Cosat students beat Westerford High School from Rondebosch in Cape Town at the foot of Table Mountain, which was considered the best school in the Western Cape Province at that time, in the nationwide debating competition. In 2011, Cosat for the first time ranked among the top 10 schools in the province, where the expensive private schools from the posh areas are normally found.[150] Cosat, however, does not cost the parents a cent, at most a small donation, if they can afford it. Foundations and companies support the school so that children from very poor families can also afford the school uniform or pay for school meals.[151] The top universities offer scholarships for particularly good graduates.[152]

But what is the secret of an exceptional school in a poor district that offers its graduates the best prospects? For Phadelia Cooper the recipe is quite simple: "Rigor and sensitivity. Passion and clear rules for everyone involved. As much teaching time as possible. And we need to involve the parents. They should motivate and control, that their children do their homework. But they're also supposed to check that we as teachers are doing our job properly."[153]

Jonathan Clark from the Schools Development Unit at the University of Cape Town and former director of Cosat, does not want to accept that this school is unique. "Cosat is not fantastic. It is simply a good school. With good management and teachers who are willing to put in overtime to educate the youth many schools can reach this level. Not all, but significantly more than today."[154]

Can private schools do more than the government?

Within ten years, the number of private schools in Africa has almost doubled. In 2017, 15 percent of students were already attending private secondary schools. Behind this is a growing middle and upper class that is no longer satisfied with the poor public services and can afford school fees.[155] In South Africa, for example, the entrepreneur Chris van der Merwe founded the first Curro school for 300 young people in 1998. By 2020 there will already be 80 schools for 90,000 students. Curro is a profit-oriented, stock market listed company that operates according to "Christian values", builds educational facilities according to a predetermined design and manages them centrally. The schools can thus operate cost-effectively through economies of scale. Curro directors decide independently on the employment of teachers. School fees are lower than those of traditional private schools in the country, but still well above what an average family can afford.[156, 157]

Such private schools improve the educational offer, but they can hardly improve the educational justice. On the contrary, wealthy families "buy" their children out of the public system, which then has to struggle all the more with children from socially underprivileged families. Nevertheless, many governments subsidise the private institutions because it is still cheaper than if they had to run the schools themselves.[158]

This is one of the reasons why the government in Liberia is pushing for the semi-privatisation of schools. In 2016, it handed over 93 public schools to private operators and international non-governmental organisations on an experimental basis. On the one hand, the educational facilities remain public and free of charge, and the government continues to pay teachers the standard national salary. On the other hand, the operators raise additional donations, so that they can invest up to twenty times more money per child than mere state schools. In this way they hire better and more motivated teachers. Not all schools have benefited from the semi-privatisation, but on average, learning successes improved by about 60 percent after the first year.[159] But even these successes must be viewed critically, for some schools had removed the worst performing pupils from class before the performance test and thus manipulated the results. The government now wants to expand the programme with the best school operators.[160]

4.6 What is to be done?

Necessary leaps in development in the field of education

The chances of the young African population to receive an education appropriate to the 21st century are, with exceptions, poor. Individual initiatives which, with a great deal of commitment and special support, strengthen certain educational institutions, are singular successes, but they must be standardised and carried out on a broad basis and, above all, they must be financially viable. **On the one hand, leapfrogging in the education sector means to use and disseminate every good idea that promises improvement** in order to make progress in small steps. **On the other hand, it means fundamental reforms** for the big leap.

The basics of these reforms are well known and can be found in many development programmes, such as the Sustainable Development Goals of the United Nations. Because they are far from being fulfilled, they still belong in every catalogue of demands to improve educational opportunities. For such reforms strong support by the respective governments is indispensable. Governments need the political will, the necessary financial resources and **a long-term plan for the efficient implementation** of measures for a generally accessible education. And they must be prepared to have the results of their efforts evaluated according to international standards.[161]

Do the simple things right

Even school desks, textbooks, proper school buildings and the presence of teachers mean great leaps in the education sector for many African countries.[162] African governments must also provide the following services:

- **Invest in pre-school education.** In this phase the joy of learning can be awakened and children get cognitively prepared for the next steps: literacy and numeracy. Reading is the most important basis for further learning processes. The pre-school programmes in Ethiopia show how this can be achieved (see p. 46).

- **Enrol all children, regardless of origin, place of residence and gender**, and teach them for at least five years, preferably in their mother tongue, in order to build up the broadest possible educational pyramid.

- **Eliminate the discrimination of girls in the education system** that still exists in many countries. Establish female teachers as role models.

- **Work towards the medium-term goal of compulsory secondary education of ten years' duration.** In doing so, young people must acquire the relevant capacities for later vocational training or studies. In addition to the basic skills these skills include the capacity for teamwork, conflict resolution, intercultural understanding and knowledge of entrepreneurship, digitisation and global challenges. Project-based learning helps to convey the practical meaning of learning to young people and to prepare them for professional life (see p. 50).

- **Give priority to neglected regions.** Where there are no or only dysfunctional schools, the greatest educational improvements can be achieved by basic investments in school buildings and the appointment of motivated teachers.

Better qualify teachers

There are too few and too few good teachers in Africa. At the same time, teachers are by far the most expensive item in the education budget. Improving their skills must therefore be a top priority:

- **Organise teacher training according to clear minimum standards in terms of content and pedagogy.**

- **Train teachers in line with the strong growth in demand and, in the case of new hires, select only trained and committed staff.** Teachers must be able to set an example of discipline and show empathy. Incompetent, unmotivated and truant candidates have no place in schools. For the first time, Liberia has used a database to gain an overview of the number and qualifications of its teaching staff and was thus able to get rid of unsuitable staff (see p. 44).

- **Make in-service training programmes compulsory for teachers,** especially for those who do not have adequate qualifications.

- **Design pay and promotion opportunities based on previously defined educational achievements.**

- **Create curricula with clear and achievable goals** and provide the necessary materials. Regularly monitor teachers' work and learning progress – and provide support when needed. Kenya has done both with the Tusome programme and massively improved the reading ability of primary school children (see p. 48).

- **Continuously document the performance of teachers, students and school infrastructure** so that the right conclusions can be drawn from successes and failures and used for further planning.

- **Select the best teachers with the highest motivation force for colleagues and students for the position of headmaster.**

Use modern technology

Computers and educational software cannot replace capable teachers. But they can help to improve teaching, or they can open the door to learning in the first place.

- **Use self-explanatory learning programmes for autonomous learning** where there is a lack of trained teachers. In Malawi and Tanzania, software from the organisation onebillion teaches primary school children reading and arithmetic (see p. 55).

- **Equip teachers with adaptive learning software** that records the learning progress of students, adapts to their learning speed and enables individual support. South Africa has had good experience with the Siyavula program (see p. 55).

- **Use learning programmes in teacher training.**

Prepare for working life

Even in primary and more so in secondary school, teaching should be application-oriented and supported by practical projects in order to make the benefits of education clear to children at an early age, to awaken their interest in a later career and at the same time prepare them for the demands of the working world. Therefore, governments should:

- **Identify training gaps and draw up a list of occupations that provide good job opportunities on the labour market, together with the private sector.**[163]

- **Promote vocational training.** Since it is hardly possible to build up an apprenticeship training system based on the German model from scratch, more basic interim solutions are needed, such as those offered by Generation in Kenya (see p. 53). The training programmes must provide young people with the necessary practical knowledge for a career after school and bring them into contact with the relevant enterprises.

- **Provide young founders and start-ups with mentors, the necessary market information and loans.** At Educate! in Uganda (see p. 54) young people learn from their peers what it means to start and run a small business.

- **Inform candidates for university studies about the fact that not all subjects offered promise professional success. Already at school, governments should promote disciplines that can speed up socio-economic development – especially natural sciences, ICT, agriculture, teaching and health care professions.**

Learn from others

Some African countries show astonishing successes in reforming their education systems or in individual education projects. They can be role models for the entire continent. African countries should:

- **Look for functioning concepts** in other countries and adopt them customized to regional conditions.

- **Implement, evaluate and, if successful, scale up new ideas** in a permanent process.

- **Take part in regional and international comparative education studies** to identify country-specific deficits and derive improvements.

5 FILLING STOMACHS AND CREATING JOBS

5.1 Food for more and more people

"Some people gave up farming and went to Boko Haram," says Jamilu Magaji, a farmer in the North Central region of Nigeria: "Then came Babban Gona. These people have helped us to produce more and improve our living conditions."

Babban Gona is a company with the business objective of contributing to the solution of social problems. It was founded in 2012 by the Nigerian Kola Masha. The trained engineer and business manager has worked for many years in leading positions for international companies and as the Senior Advisor to the Nigerian Minister of Agriculture. According to Masha's analysis, the small farmers in this West African country have a problem: "They are trapped in a cycle of poverty." The reason is less to do with occasional attacks by the Islamist fighters of Boko Haram. The farmers are hardly discouraged by this, because they are tied to their land, Masha observed. But because they are poor, they cannot buy improved seed from professional breeders that yield far higher than the grains they keep from each harvest to sow in the next season. Because they are poor, no bank gives them loans to buy fertiliser, rent a tractor or lease additional land. Often there is also a lack of agricultural services and advice. Ultimately, the farmers can hardly produce more of Nigeria's basic foodstuff maize than they and their families consume.

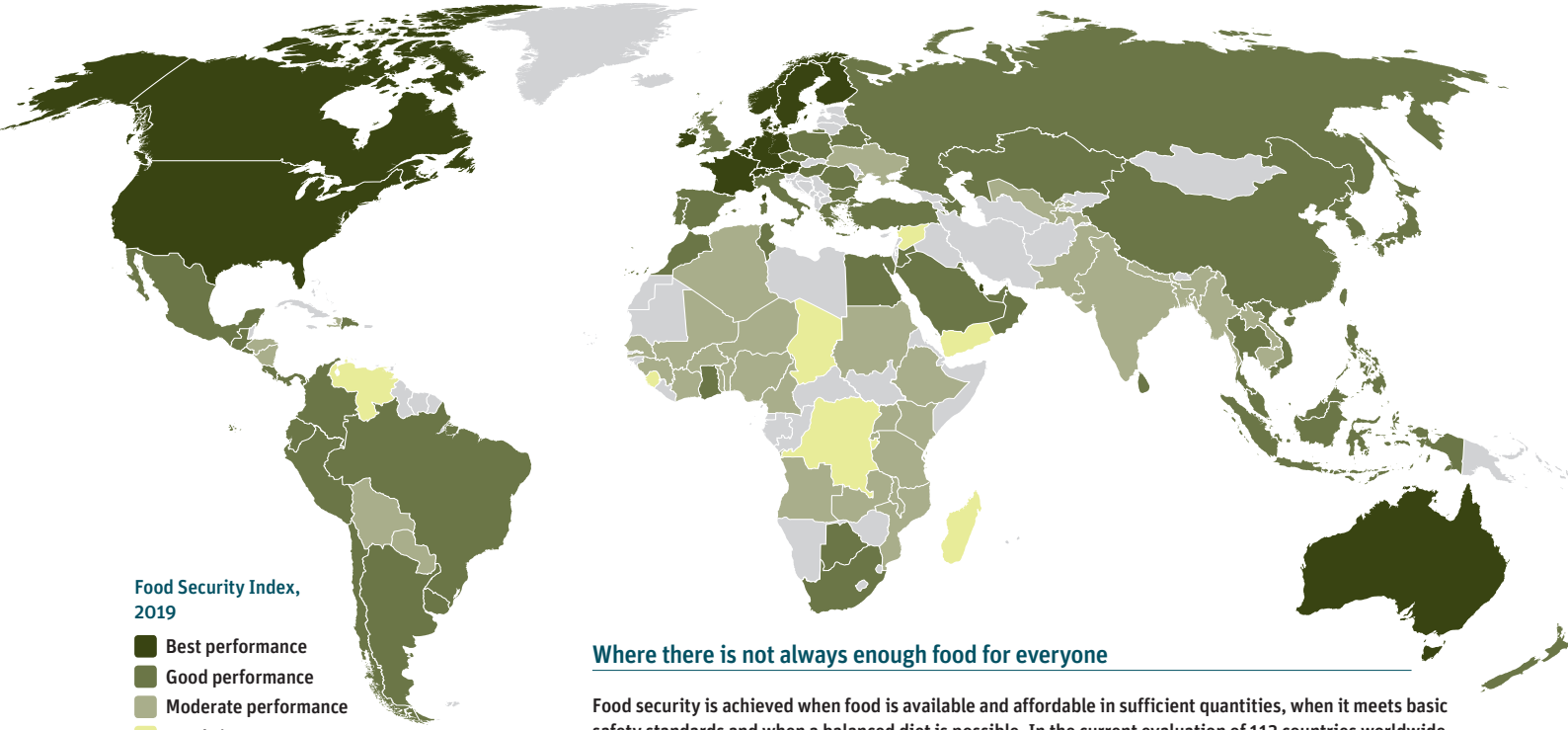
BEST PRACTICE

Nigeria: Escaping the cycle of poverty

The name of the social enterprise Babban Gona, Hausa for "Big Farm", refers to the idea behind it: Several small farmers join together to form "Trust Groups". Together, they benefit from a whole package of services and products that Babban Gona can offer them by cleverly exploiting the economies of scale that the company has as an organisation. This enables it to raise capital cost-effectively through partners from the private sector and development finance, and offer members loans at far better conditions than traditional banks and microfinance institutions, which charge annual interest rates of 30 to 60 percent. The farmers do not receive money, but quality seeds, fertilisers and pesticides for the amount borrowed. Thanks to bulk buying, Babban Gona can also offer these products at a reasonable price. Local employees ensure that the goods are delivered to the right place at the right time. They advise the farmers on the quantities they need and on how to use the products optimally to achieve good yields without harming the environment. At harvest time, Babban Gona provides the farmers with airtight bags that protect the crop from spoilage. The organisation collects the bags in central warehouses to sell them at the best possible price. The company deducts the respective credit amount from the profit that each member makes for their consignment and keeps a small part for itself. In addition, it charges fees for registration, advice and training courses.

The fact that Babban Gona has been making net profits since 2016 alone speaks for the success of the system. The farmers now reap significantly higher harvests, have lower post-harvest losses and generate more income. With the help of Babban Gona, they have been able to increase their yields on average to 2.3 times the national average. "I used to harvest 35 to 40 sacks of maize in my fields," says farmer Haliru Sale from the village of Pampaida, "nowadays, I produce more than twice as much thanks to this programme and training."

In the 2019 season, Babban Gona's "Trust Groups" counted almost 20,000 farmers in various regions of Nigeria. Kola Masha has set the target of one million by 2025. Including the farming families, this would provide for the maintenance of five million people. Masha is convinced: "If Nigeria uses its gifts effectively – land, water, labour and markets – it can become a global agricultural powerhouse."[2]



(Data basis: Global Food Security Index[9])

Where there is not always enough food for everyone

Food security is achieved when food is available and affordable in sufficient quantities, when it meets basic safety standards and when a balanced diet is possible. In the current evaluation of 113 countries worldwide, external influences on the supply of food were also taken into account. For example, the extent to which climate change has an impact, the extent to which water or soils are endangered and how well the respective country can adapt to changing conditions. In 2019, only some countries along the Mediterranean coast, Ghana, Botswana and South Africa fell into the second best category "good".

"The farmers work hard, but they remain poor," says Kola Masha. With Babban Gona (see box on previous page), he wants to change this: "We create reliable, worthwhile employment opportunities so that young people can stay in the rural areas." Because if they see only drudgery but no future prospects for themselves in the villages, they set off for the big cities – where there are hardly any jobs either. Or they let themselves be recruited by Boko Haram. One of Boko Haram's strategies is to attract unemployed young people with financial incentives.[1]

Rapid change is necessary

Nigeria is the most populous country in Africa, with around 200 million inhabitants. Nigeria's agriculture accounts for around a fifth of the country's economic output.[3] But it is not able to cover the entire food demand. Meanwhile, the expenditure on imports is rising.[4] Women in Nigeria have an average of 5.4 children.[5] The population is expected to almost double by 2050. Rural areas are showing the highest population growth rates, but offer hardly any employment opportunities. In 2018, around 55 percent of 15- to 35-year-olds in Nigeria either had no job or were underemployed with less than 20 hours per week.[6]

The country thus exemplifies the transformation that is needed on most of the continent: farmers must produce more in their fields to secure food for the growing population. At the same time, agriculture must create jobs. Not so much in production itself, because through modernisation and mechanisation fewer hands will be needed in the long term. Instead, it is important to build up upstream and downstream value chains that have hardly existed up to now, from the rental and repair service for agricultural machinery to the factory that processes raw produce. And because the population is growing rapidly, change must happen in the shortest possible time. Leapfrogging is therefore an indispensable prerequisite.

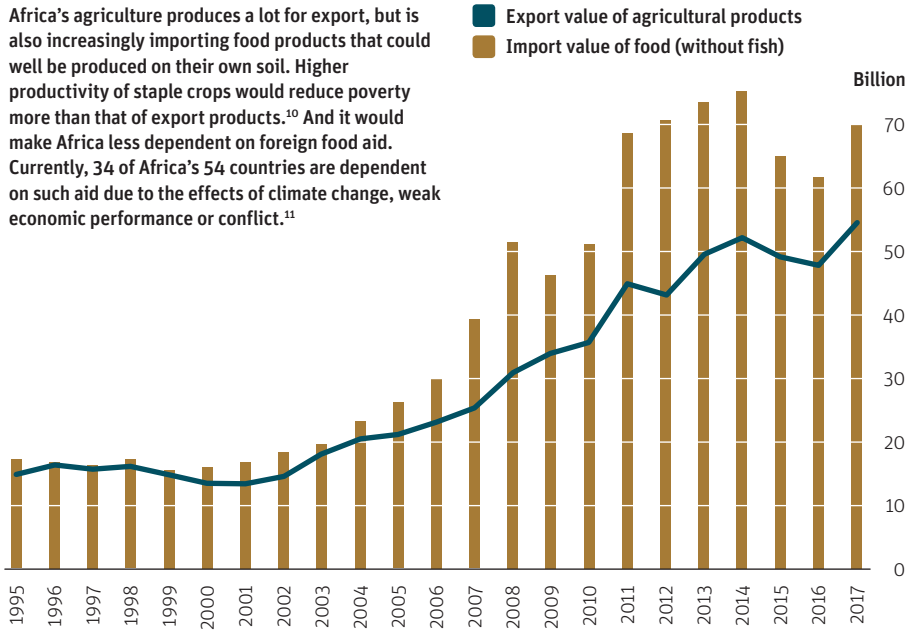
Once self-sufficient, today dependent on imports and aid

The coronavirus pandemic has once again made it very clear that Africa must ensure food security and free itself from dependence on imports and food aid. Until the 1960s, Africa's farmers were able to provide sufficient food for their own population, at that time about 300 million.[7] Today, Africa is the region of the world most affected by undernutrition. It is estimated that around 20 percent of the 1.3 billion Africans have less food available than would be necessary to "lead a normally active and healthy life". According to this definition, almost 31 percent of the population in Eastern Africa is undernourished, 26.5 percent in the heart of the continent, and only 7 percent in North Africa.[8]

One reason is that altogether, the productivity of the African agricultural sector is low. The Green Revolution, which dramatically increased the area and labour productivity in Asia and Latin America from the 1960s onwards, left Africa virtually untouched. The continent resembles a patchwork of very different ecological, cultural and socio-economic conditions for agriculture and livestock farming.[13] There were no public programmes and no coherent policy to introduce the entire package of the Green Revolution on a large scale: improved seeds, fertilisation with the three nutrients essential for plant growth, nitrogen, phosphorus and potassium, irrigation of fields, chemical plant protection, mechanisation and training of farmers in efficient farming methods. In the 1980s and 1990s, African governments bought debt relief and new loans with "structural adjustment programmes". In the course of this they reduced subsidies and other expenditures for agriculture. At the same time, the devaluation of currencies made the prices of fertilisers and other means for enhancing production, most of which were imported, more expensive.[14]

Expensive imports

Africa's agriculture produces a lot for export, but is also increasingly importing food products that could well be produced on their own soil. Higher productivity of staple crops would reduce poverty more than that of export products.[10] And it would make Africa less dependent on foreign food aid. Currently, 34 of Africa's 54 countries are dependent on such aid due to the effects of climate change, weak economic performance or conflict.[11]



Value of food imports and exports of all African countries, in billion US dollars, 1995 to 2017
(Data basis: FAOSTAT[12])

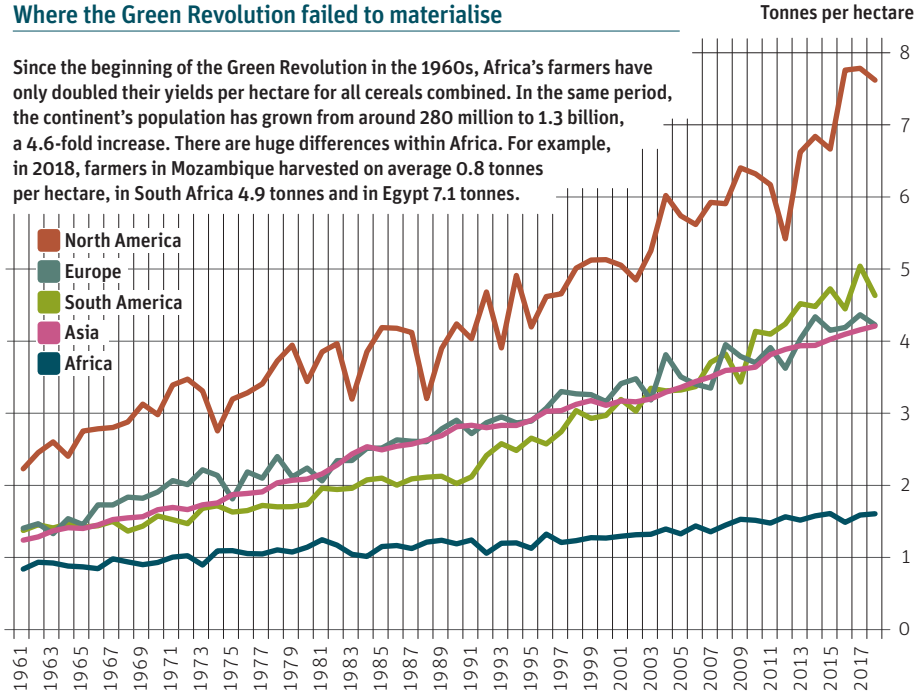
Without smallholders there would be more hunger

To this day, livestock farming and the cultivation of field crops are mainly in the hands of small family farms. The majority is poor. What smallholders laboriously produce by hand mainly serves their own needs. Almost all of them rely on rain to irrigate their fields. Smallholders have hardly any access to capital to invest in seeds, fertiliser and other inputs. In many places, there is a lack of secured land rights because the land is owned by municipalities or the state and its use is not regulated.[16] Women in particular are disadvantaged in terms of access to financial systems, income and land rights.[17] Often there is a lack of storage facilities to store surplus crops protected from moisture and storage pests until sale. Thus, on average across Africa, 25 percent of the food produced is lost after harvesting. In the rest of the world, the figure is 15 percent.[18] In the remote regions of Africa, there is a lack of infrastructure and means of transport to bring grain, vegetables, eggs or milk to market. Small farmers are therefore often forced to sell their products to middlemen at prices far below the possible market prices.[19]

Nevertheless, according to international agricultural experts, smallholders are the "key to food security".[20] In sub-Saharan Africa, very small farms with an area of up to two hectares cover around 30 percent of the food requirements. All smaller farms with up to 20 hectares cover over 75 percent.[21] Therefore, efforts to increase the productivity of African agriculture and to double or even triple production by 2050 must first and foremost be devoted to smallholders.[22]

Where the Green Revolution failed to materialise

Since the beginning of the Green Revolution in the 1960s, Africa's farmers have only doubled their yields per hectare for all cereals combined. In the same period, the continent's population has grown from around 280 million to 1.3 billion, a 4.6-fold increase. There are huge differences within Africa. For example, in 2018, farmers in Mozambique harvested on average 0.8 tonnes per hectare, in South Africa 4.9 tonnes and in Egypt 7.1 tonnes.



Yields for cereals, in tonnes per hectare, 1961 to 2018
(Data basis: FAOSTAT[15])

Agriculture as a motor for socio-economic development

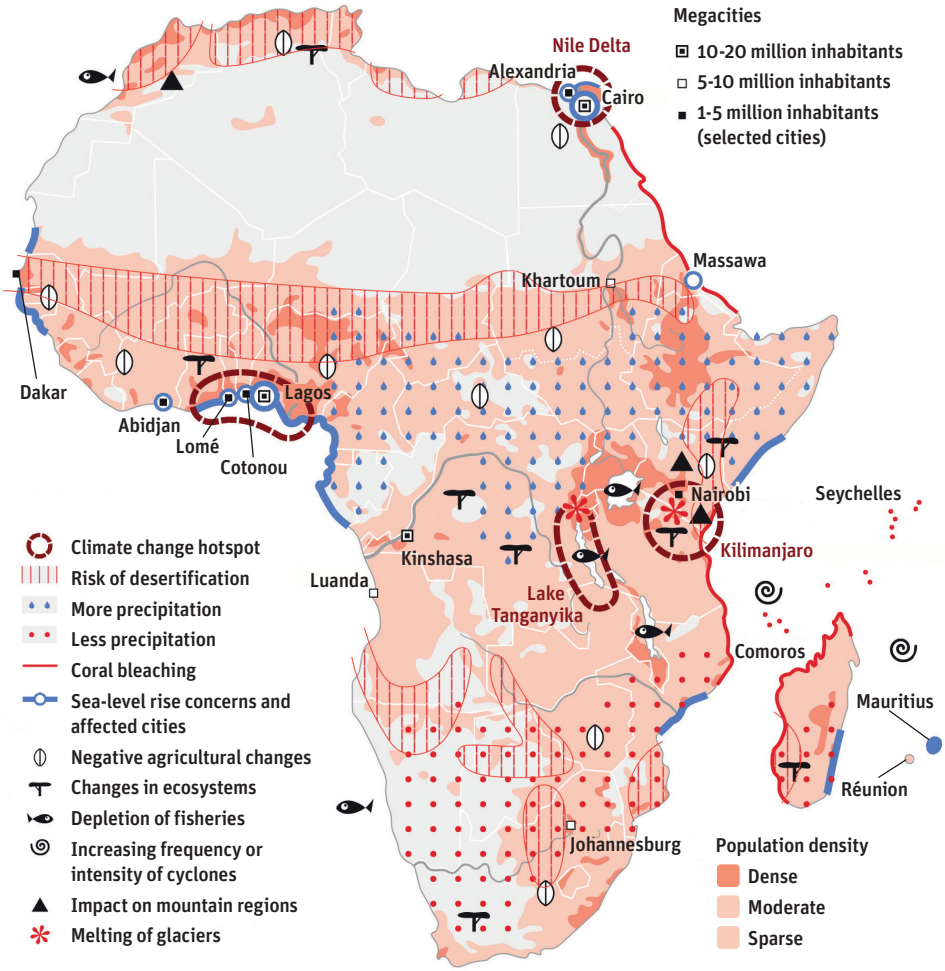
Although Africa's agriculture is currently unable to feed its own population, it has the potential to become an engine of transformation for the continent. This sounds like a bold statement in view of the challenges described. But the prerequisites are given: Africa has at least a quarter of the world's land used for arable and livestock farming.[23] A large reservoir of labour is available. Above all, in the course of the last few years, both governments and international development cooperation have come to realise that the urgently needed leap forward in development must start with the agricultural sector, which has not received much attention for a long time.

The Nigerian Akinwumi Adesina, president of the African Development Bank, warned at the beginning of 2019 that, if nothing happens, African food import expenditures could increase so much that macroeconomic stability would be increasingly difficult to maintain. "Africa should produce what it eats, and Africa should add value to what it produces," said the farmer's son and trained agricultural economist Adesina: "I want to get young people into agriculture as a business, because agriculture is the biggest money-making market globally. Nobody drinks oil. Nobody smokes gas, right? But everybody eats food. And you've got a population of 1.2 billion people you have to feed."[24]

5.2 Skip harmful developments

Developing large parts of Africa's seemingly inexhaustible land reserves for agricultural use is not desirable because natural areas must be preserved. Or it is not possible because the areas are unsuitable or difficult to use.[25] According to new calculations it is not even necessary: it would be sufficient to manage the existing areas more intensively in order to not only feed the people sufficiently, but to even make Africa a net exporter of agricultural products.[26]

However, Africa's farmers cannot follow the model of the industrial production methods of farms in large parts of Europe, America or Australia. The productivity of those is at the expense of the environment and the global climate: it is accompanied by massive water consumption and contributes significantly to greenhouse gas emissions. Besides the combustion product carbon dioxide, these include methane from the stomachs of ruminants and nitrous oxide rising from unused nitrogen from arable land. Massive nitrogen fertilisation, whether mineral or organic, also pollutes groundwater and surface water with nitrates. Monocultures and chemical-synthetic pesticides and weed control agents are causing a loss of biodiversity.[27] In the former developing countries of Asia, too, the Green Revolution has led to undesirable developments and damage, such as soil salinisation through increased evaporation in irrigated fields without adequate drainage. Agriculture always interferes with nature. However, if it does so to the extent described, it deprives itself of its own foundations in the long term.



Regional differences in the effects of climate change and population growth in Africa
(Source: IOM[31])

In addition, climate change is already having a negative feedback effect on agricultural productivity and thus also on the food supply of a growing world population. Sub-Saharan Africa is one of the regions with the highest risk of crop losses due to climate change.[28] The Sahel countries, from Mauritania to Sudan, have already experienced the most significant and sustained decline in precipitation worldwide since scientific measurements began.[29]

Towards a "greener" Green Revolution

Africa's agriculture must therefore make leaps and bounds in several respects. It must increase its productivity in a more environmentally friendly way than has been the case in the more developed regions of the world. This means – in the sense of leapfrogging – to get more out of the existing areas, but to minimise the harmful effects. It must also be prepared for the consequences of climate change from the outset. The aim is "sustainable intensification".[32, 33] In other words: Africa needs a "greener" Green Revolution.

Of course, this cannot be done in one big bound. It rather happens in many different and even small steps or jumps which nevertheless can have great effects. The key point is to use all available means and methods based on the latest state of knowledge. The use of information and communication technology means a great leap forward for African agriculture. However, it is at least as important to breed high-yielding and robust varieties and to give small farmers access to such improved seeds. Training and educating the workforce and promoting entrepreneurship are important steps on the path to transformation, as well as creating a favourable political framework for production, processing and trade.[34]

In the meantime, even managers of large agricultural corporations have understood that their previous business model of optimising their profits by selling the largest possible quantities of seeds, fertilisers and pesticides is obsolete. The damages caused by excessive use of those are too obvious.

Here drought, there flooding

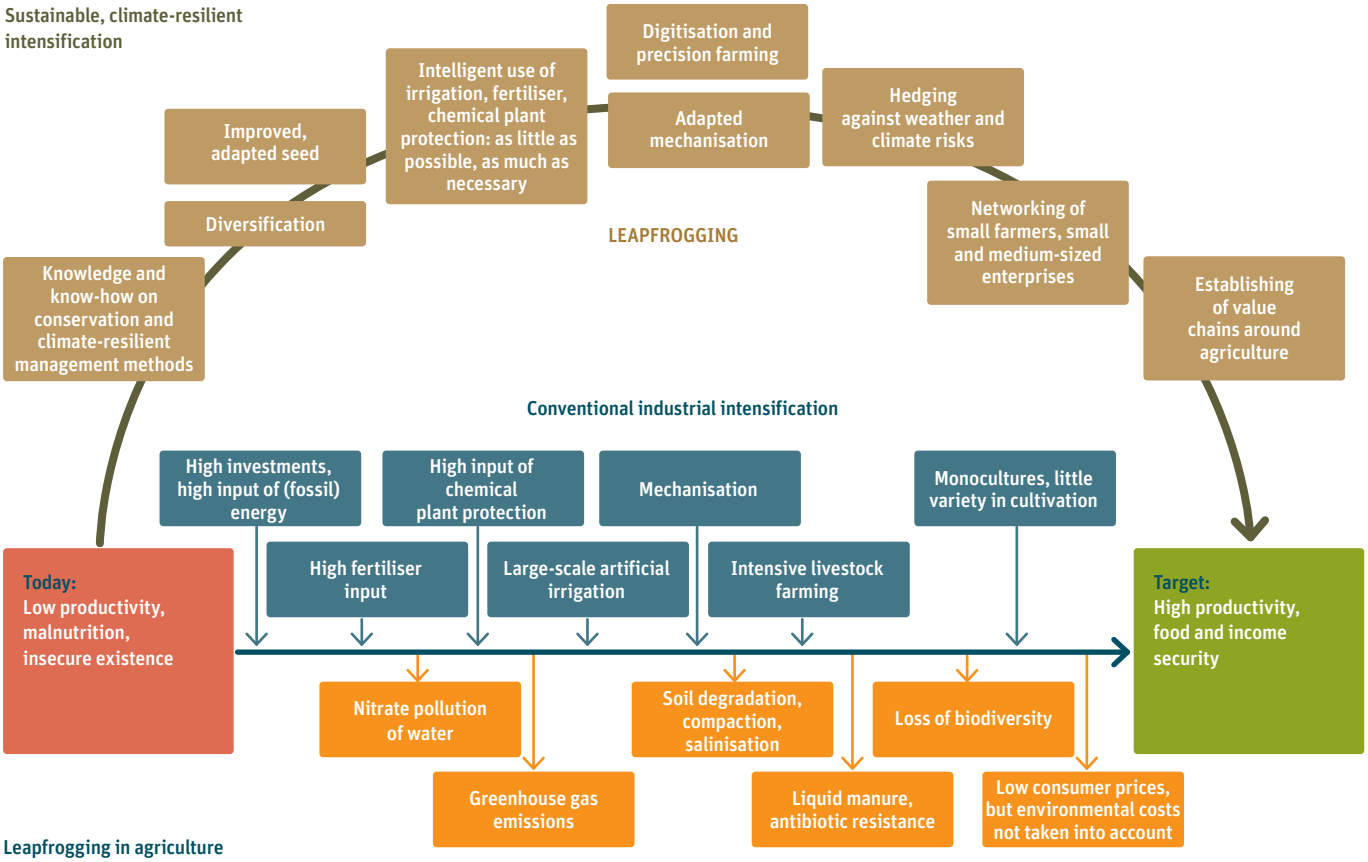
Sub-Saharan Africa is also massively affected by food insecurity because farmers can rely less and less on rain falling at the right time and in the right quantity. As a result of climate change, average temperatures have risen by 0.5 degrees over the past 100 years. Forecasts predict a further warming of 1.4 to 5.5 degrees by 2100. This makes precipitation patterns even more unpredictable, and storms and other natural disasters more likely.[30]

These companies can fundamentally reorient themselves – and leapfrog in doing so – by no longer making profits by the amount of sales, but instead by offering a service. It could, for example, sell customers the guarantee that they will achieve a certain yield per unit of land. The agricultural company then determines how much fertiliser and pesticides are needed for the agreed harvest and now has an interest in the customers using as little as possible, because the company bears the costs. Ecological and economic optimisation thus becomes the new business model for the company: if the yield remains below the agreed value, it reimburses the farmer for the difference. If the yield is higher, the company and customer share the profit.[35]

The following subchapters provide an overview of the most important starting points for small steps and larger leaps as well as a selection of particularly promising projects and innovations, which – provided they are scaled up – can initiate a transformation process in Africa based on agriculture.

Increase productivity, avoid damage

Africa's farmers must become more productive quickly in order to feed the growing population. In doing so, they must avoid the harmful developments that the intensification of agriculture in the industrialised countries and the Green Revolution in Asia have brought with them. At the same time, they must adapt their farming methods to the already noticeable impacts of climate change. The basis for this great leap are research, development and dissemination of technical and social innovations, as well as knowledge transfer and entrepreneurship.



Leapfrogging in agriculture
(Own representation)

5.3 Produce more, but ecologically and "climate-smart"

There is not a single path to the goal of sustainable intensification. Rather, there is a wealth of different approaches, each of which is suitable for or must be adapted to specific local conditions. This is particularly true for Africa, with its many different climatic zones, soils and farming practices.

However, there are some characteristics that all approaches are oriented towards. They prefer plant and animal breeds that produce good yields without the need for fertiliser or concentrated feed, respectively, and without external intervention. They use as little as possible of production-enhancing agents such as mineral fertilisers or chemical-synthetic substances for the control of pests and undesired plants. Instead, sustainably intensifying approaches use the available knowledge about ecological interrelationships. This includes, for example, fighting parasites with their natural predators, replacing mineral fertilisers by growing nitrogen-fixing plants, reducing nutrient losses by introducing animal dung into the soil or preventing erosion by mulching with plant cuttings. Last but not least, this reduces the cost of energy or fertiliser.[36]

Many roads lead to the same end

A variety of processing methods and concepts can be summarised under the overarching term of sustainable intensification. It is not always clearly defined what is hidden behind these terms, and they often overlap in terms of content. The following overview makes no claim to completeness.

Agroecology: On the one hand, the term refers to the scientific discipline concerned with the "integrative study of the ecology of the entire food system, including its ecological, economic and social dimensions".[37] On the other hand, it also refers to the corresponding practice. Depending on the source, agroecology can be equated with **organic farming** or goes beyond it by combining traditional customs with modern knowledge.[38]

Organic farming combines land use and livestock farming in order to achieve largely closed cycles. As far as possible, it avoids external means of enhancing production such as synthetically produced nitrogen fertilisers or chemical-synthetic pesticides, which are completely prohibited in **biodynamic agriculture**.[39]

Integrated agriculture aims to work according to agroecological principles as far as possible and economically viable. This can mean, for example, using biological methods to combat insect pests, as long as the losses stay within limits, but applying chemical-synthetic agents if this is not sufficient.[40]

Climate-smart agriculture: "Climate-smart" is any agricultural method that increases productivity while reducing greenhouse gas emissions as far as possible and at the same time building resistance to the effects of climate change. This includes all **conservation farming** methods that preserve moisture and nutrients in the soil. First and foremost, that means to refrain partially or completely from ploughing after the harvest, to allow dead plant material to remain as a protective mulch layer until the next sowing (**no-till farming**). Ploughing little or not at all helps to keep the carbon bound in the organic substance in the soil instead of letting it escape into the atmosphere as carbon dioxide. This is why ploughless cultivation also falls under the term **carbon farming.**

Another conservation method is to cultivate different types of crops, either simultaneously (**intercropping**) or consecutively (**crop rotation**) instead of just one cash crop. In particular, pigeon peas and other legumes, which can bind nitrogen from the air with the help of bacteria in their roots, improve soil fertility in a natural way. **Agroforestry systems**, in which mimosa or other nitrogen-fixing tree species grow between the crops, also have a preservative effect. In general, trees provide shade, retain groundwater, bind carbon and thus help to mitigate the effects of climate change. Their fruits or nuts can be used to enhance nutrition and income opportunities.[41]

System of Rice Intensification: The method developed in Madagascar to sustainably intensify the wet cultivation of rice is based on the following principles: planting young seedlings quickly and at large distances, preferably using manure, and keeping fields only moist instead of flooding them. This means that more weeds grow, but yields are higher despite lower seed input. This production method also releases less methane into the atmosphere.[42]

Variety on fields and plates

One undesirable development of the industrial agricultural system is the dwindling diversity in the fields, and thus the dependence on fewer and fewer crop species.[43] In Africa, too, the globally most important staple foods rice, maize and wheat have prevailed. Maize has pushed back the formerly widespread millet species sorghum and has become Africa's most important crop. Among other things, it promises higher yields, it is easier to process than sorghum, and there is technical and financial support for its cultivation.[44] Meanwhile, Africa's maize yields are far below the global average and are rising at a much slower rate. Climate change is likely to affect production in the future.[45]

One strategy against this is diversification. Diversification in the field makes agriculture itself more environmentally and climate-friendly.[46] In addition, more diversification is good for health: where people are poor and live predominantly on maize porridge, there is often "hidden hunger", i.e. deficiency symptoms that inhibit the development of children in particular and lead to secondary diseases. Although the grain is satiating, it lacks those amino acids that the body cannot produce itself. Pulses can close this gap. The simultaneous production of vegetables and fish in an almost closed cycle, called aquaponics, also brings more variety onto the plate (see box to the right).

More crop per drop or every drop counts

The elementary prerequisites for sustainably intensified arable farming in Africa include healthy soils, adapted crop varieties and a balanced nutrient supply, as well as the efficient use of water. There are different approaches for innovative and efficient irrigation, depending on the region and farm

BEST PRACTICE

Uganda: Learning, not only for agriculture

Something went thoroughly wrong with the development in Africa, the Ugandan agricultural engineer Mwalimu Musheshe found: "On the one hand there was this dependence on development aid, and on the other hand on the state. But neither was able to change much because they always focused on solving a single problem. That has not changed to this day." Musheshe wants to approach rural development differently. In 1987, he and a few colleagues founded the Uganda Rural Development and Training Program (URDT).[51] It is located in the small town of Kagadi, 250 kilometres west of Uganda's capital Kampala. The basic idea of the programme: "We don't ask, How can your problem be solved? We ask, What do you want to achieve?"

URDT staff therefore went to the villages and encouraged the inhabitants to set goals for their future. However, the meetings were mainly attended by older people. In order to reach rural youth, URDT founded various educational institutions that aim to turn disadvantaged boys and especially girls into self-confident experts in sustainable development. Among other things, they learn how to manage agriculture in cycles on the school farm and they practice passing on information and knowledge in their own radio programmes.

URDT has also founded an institute for vocational training and young leadership. In two- or three-year courses, it trains, among other things, future farmers in adapted methods and entrepreneurial thinking. Finally, URDT also runs the African Rural University (ARU), a university that trains exclusively women as ambassadors for "grassroots innovation". They disseminate the URDT method of developing individuals' own ideas and goals for their future and conduct training courses in villages. They also learn how to run agriculture productively and sustainably with simple means.

This includes, for example, the proper composting of organic waste using worms in so-called vermiboxes. After two to three months, the worms have multiplied considerably. They serve as feed for chickens or fish, but can also be used in bio-toilets, where they convert human excrement into aseptic organic fertiliser for banana or coffee plantations within three years. Aquaponics is also one of the sustainable technologies: it combines fish farming with soil-independent cultivation of vegetables and other foods in an almost closed cycle. The system uses the nutrients contained in the feed for and excretions of the fish for fertilisation, and the water, which has been purified by bacteria, for irrigating the plants.

"We teach adapted techniques, not only to pupils and students, but also to village communities and groups of farmers who visit our demonstration farm," explains Jerome Sengonzi, Dean of the university. Sengonzi emphasizes that the entire agricultural sector is included in the teaching from farm to household, from the production of renewable energy from biogas to the marketing of healthy food. Because, he says, "That is what rural people imagine for their future: first, health, and second, a regular income."[52]

size. Terraced fields on slopes prevent precipitation from draining away too quickly. Raised beds, i.e. slightly elevated rows of plants with ditches in between, prevent waterlogging. Rainwater collection tanks, manual or solar-powered pumps replace the energy- and time-consuming task of fetching buckets of water from wells or rivers. Pumps are particularly efficient in connection with special pipelines for drip irrigation which bring the precious water directly to the plants. Soil sensors and satellite data help to water only when needed.[47]

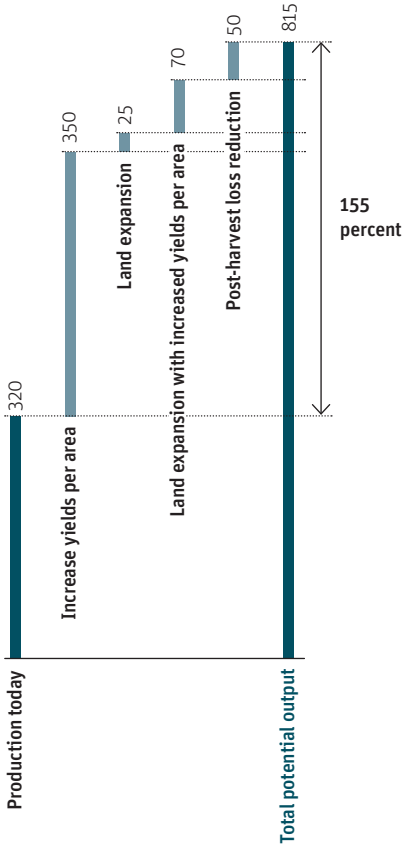
Research and know-how are the foundations

There are many ideas for sustainable intensification, diversification and adaptation to climate change – also from universities and organisations in Africa. The global report on "Agriculture at a Crossroads", which the World Bank and the United Nations published in 2009 after extensive hearings and consultations with stakeholders worldwide, summarises how available knowledge, technology and research on agriculture can be used and disseminated to "reduce hunger and poverty, improve livelihoods and health in rural areas and promote equitable, ecologically, economically and socially sustainable development".[48]

The report makes it clear that the various methods for sustainable intensification have another thing in common: they are knowledge intensive. Farmers who are environmentally and climate-conscious and meanwhile remain competitive make use of current knowledge and innovations, but also draw on lost traditional knowledge.[49] Smallholders in particular are often sceptical about changes and innovations.[50] The various techniques and methods for sustainable intensification require access to up-to-date information and training.

Small seeds, big effect

According to model calculations, Africa's agriculture could produce up to two and a half times as much grain as it does today if it exhausted all the possibilities. Increasing the yield per hectare brings the highest gains. However, to do so, sub-Saharan Africa (excluding South Africa) needs eight times more fertiliser, six times more hybrid corn seed and would have to invest in irrigation and infrastructure. An expansion of the areas under cereal cultivation by 20 million hectares would increase production, especially if higher yields per hectare can also be achieved there. However, this expansion is not desirable for nature conservation reasons. It would make more sense to reduce post-harvest losses.



Potential of various factors to increase cereal production in Africa, in millions of tons
(Data basis: FAO/McKinsey[53])

5.4 It all starts with adapted breeds

"Seed is to agriculture what microchips are to information technology," is how the late Harvard development expert Calestous Juma described the central role of improved varieties – that is, bred for higher yields and more efficient cultivation – in increasing productivity.[54]

The majority of African farmers still retain seeds from each harvest for the next growing season. Sometimes they share especially good ones with others.[55] There are several reasons for adhering to this informal system. The farmers do not have reliable access to improved seeds, cannot afford them, or both. Many are generally sceptical about commercial products. They do not see why they have to buy hybrid seed* every year. Sometimes they have had bad experiences with seed that has failed, on their own or their neighbour's field, be it because of counterfeit merchandise, through fraud such as stones mixed in[56] or through incorrect use.[57]

However, with self-propagated seed, the average yields of African staple foods such as maize, cassava or millet are far below what is possible with improved, quality-tested seed. In addition, properties such as resistance to increased drought or new pests are in demand today.[58] The widespread use of new breeds – including by smallholders – therefore plays a key role in the "greener" Green Revolution in African agriculture.

* Hybrids use a biological specialty: through conventional crossing of parent plants, each of which has been fertilised with itself over several generations (inbreeding), a certain trait is more pronounced in the first generation of offspring. This characteristic weakens in the following generations. Hybrid seed produces higher yields, but must be produced anew for each season from parent inbred lines.

"Genetic leapfrogging"

New breeds do not necessarily result from genetic engineering. Thanks to gene probes and other molecular biological methods, the time-consuming conventional crossing procedure can be shortened considerably. The recently added technique of genome editing makes it possible to modify individual genes with pinpoint accuracy using "gene scissors". So far there is no international agreement on whether or not "edited" plants are to be classified as genetically modified.[59] However, the case is clear with genetic engineering, i.e. when genes from other varieties or even other species are inserted directly into the genome. Seed manipulated in this way is being criticized. Arguments critics put forward are, for example, that the diversity of cultivated varieties is being lost, and that the health risks associated with consumption of genetically engineered foodstuff have not been adequately researched.[60]

In most African countries there is no legal basis for the cultivation of genetically modified plants and their use in food. One exception is South Africa, where the authorities decide on each application for approval individually on the basis of the Genetically Modified Organisms Act.[61] In Burkina Faso, Sudan and Nigeria only the cultivation of genetically modified cotton is permitted.[62] In the meantime, however, other countries are also working on corresponding regulations. Some have permitted field trials and granted approval for individual products.[63]

For Calestous Juma and many others, modern breeding methods of all kinds are among the innovations that must be used for the sustainable development of Africa. If every application for approval of genetically modified varieties is carefully examined, Juma argues, the risks are negligible compared to the benefits. For example, breeds that are able to ward off parasites or harmful insects on their own, need fewer pesticides to grow, thus reducing the risks to human health and species diversity. They also reduce the enormous losses due to plant diseases or pests that happen already now and are becoming increasingly widespread with climate change. As a latecomer, Africa's agriculture could skip problems brought about by the earlier Green Revolution by "genetic leapfrogging", writes Juma.[64]

Research for new varieties

In Africa, scientists in the National Agricultural Research Systems (NARS) as well as in international institutes**, in private sector companies as well as non-governmental organisations are working to develop high-yielding, robust and climate-resistant varieties. The government programmes in particular are mainly based on modern conventional breeding methods.[65] In gene banks and natural reservoirs, scientists systematically search for useful species-specific characteristics.[66] Also, they are opening up new options by decoding the genetic material. The DNA of the economically most important crops rice, maize and wheat has already been sequenced. An international consortium

** In the course of the Green Revolution, international research institutes were established under the umbrella of the Consultative Group on International Agricultural Research (CGIAR), with spin-offs in Africa as well. These include the International Institutes for Tropical Agriculture (IITA), for the Improvement of Maize and Wheat (CIMMYT) and the Centre for Rice in Africa (AfricaRice).

BEST PRACTICE

Kenya: Better housing thanks to improved seeds

In the East African "corn belt", shortened rainy seasons repeatedly reduce maize yields. This is why the Water Efficient Maize for Africa (Wema) programme was launched in 2008, with the aim of achieving significant productivity gains for smallholder farmers in Uganda, Kenya, Tanzania, Mozambique and South Africa. Several international, governmental and private sector organisations joined forces on the programme. Scientists from various research institutions contributed with their genetic material for the development of drought-tolerant varieties, Bayer Crop Science provided patented material royalty-free.

Under the programme, over 120 conventionally developed drought-tolerant maize hybrids were approved for marketing approval from 2013 onwards. The hybrids have been licenced to various seed companies to produce and market seed to farmers. In 2016, five genetically modified varieties with built-in protection against stem borers were approved in South Africa and are currently commercialised by smallholder farmers there.

The programme was coordinated by the non-profit organisation African Agricultural Technology Foundation based in the Kenyan capital Nairobi. Its project staff are often out in the field to see whether and how the products reach the smallholders and whether they are being used properly. Drought-resistant corn hybrids developed by Wema under the DroughtTego brand have enabled yields per hectare under drought conditions to be 33 to 54 percent higher than other commercially available hybrid varieties.[68] Fredrick Anjawa, a farmer in Buthere in the Kenyan county of Kakamega, has been able to improve his yields so much within two years that from surplus sold he could afford a new house. He calls it "the house that Tego built."[69]

based in Nairobi has now undertaken to analyse the genomes of one hundred food plants which are often eaten in Africa, but have been neglected by breeders until now. These include cassava, sweet potato, plantains and bitter gourd.[67]

Africa's seed sector – strong, but still to be further developed

It would be a great leap forward if a distribution, marketing and advisory system were to be set up in every country to ensure that farmers have access at all times to seed of tested quality at affordable prices – and apply it in an appropriate manner.[70] Experience from a German-Ethiopian programme shows that even poor farmers are willing to pay for seed if they can reliably count on a better harvest and can expect that the sale will yield more than they invested.[71]

The Kenyan-based Alliance for a Green Revolution in Africa (AGRA) has been working with the Program for Africa's Seed Systems since 2006 to develop a functioning seed sector in 13 sub-Saharan countries. In the course of this, almost 700 improved varieties from national and international research institutions have received market approval from the respective authorities by 2019. More than one hundred private companies have been established to propagate seeds and distribute them through a well-developed network of agricultural traders. The 13 countries concerned have a good chance of achieving food security, writes the American plant geneticist and AGRA co-founder Joseph DeVries. However, many African countries remain trapped behind a "low-yield seed barrier" with high rates of chronic child malnutrition because they are not investing enough in seed development.[72] AGRA has now shifted the focus of its work to advocating political reforms, patent protection and licensing regulations to make improved seeds generally available in Africa.[73]

BEST PRACTICE

Mali: Energetic entrepreneur

Maïmouna Sidibe Coulibaly grew up in Mali with her mother harvesting baskets of millet, sorghum, maize, rice and peanuts – just enough to feed the family. Today, 80 percent of the people in Mali still work in agriculture. However, they are unable to supply the population of the large, sparsely populated country in the west of the Sahel zone. 29 percent of the population are undernourished.[76] Mali is dependent on food aid.

Madame Coulibaly is making an important contribution to change this. The 60-year-old runs the seed company Faso Kaba. This company ensures that Malian smallholders can obtain certified seed reliably and relatively cheaply almost anywhere in the country, with which they can achieve higher yields than before, despite increased drought.

It all began in the 1980s in the USA. Coulibaly's husband Ntji had received a scholarship to study agricultural sciences. Maïmouna worked in the cornfields of Iowa and could hardly believe that they were so much bigger than those she knew from her childhood. In an agro-dealer shop whose shelves were filled with properly stacked, neatly packaged corn seeds of different varieties and brands, Coulibaly had the inspired thought: "I want that at home too!"

Back in Mali, her business idea met with discouraging reactions: no one would spend money on seeds, she heard everywhere. So she first worked for 15 years for an American organisation that supported village communities in Mali in building up cooperatives. Then Maïmouna Coulibaly went into business for herself with a corn seed shop. The demand was overwhelming. Soon supply bottlenecks became apparent. With start-up financing from AGRA (see left), the entrepreneur founded Faso Kaba ("Corn from the Motherland") in 2007.[77]

Faso Kaba is now the largest seed producer in Mali. The company has over 30 employees, a good half of them women, plus up to 80 seasonal field workers. In addition to maize seeds, the product range includes millet, sorghum, peanut, okra, onion, tomato and watermelon seeds, as well as fertilisers, pesticides and other agricultural supplies.[78]

In the Access to Seeds Index 2019 (see p. 73), Faso Kaba received an excellent rating in the area of marketing and sales: with 150 distribution points in the country, with demonstrations in fields, the company reaches around 300,000 small farmers every year. It is currently building a distribution network in seven other countries. According to the index, it is also remarkable that Faso Kaba has entrusted 25 smallholder cooperatives with the production of seed.[79] In 2017, Maïmouna Coulibaly received the Africa Food Prize. As the prize committee praised, with Faso Kaba she has "significantly improved food security and the income of small farmers."[80]

Reach small farmers

Two indices that evaluate the African seed sector focus in particular on how well it reaches small farmers. The Kenya-based organisation The African Seed Access Index (Tasai), founded in 2015 by two non-profit US initiatives, wants to work towards ensuring that the individual countries have favourable conditions for a "dynamic and competitive" seed sector. The Tasai index takes into account, among other things, the density of the network of state agricultural advisers or extension workers. For this indicator, the 17 countries studied achieved an average of 54 out of 100 points. Indicators such as the number of households per agro-dealer (59 out of 100) or the availability of seeds in small packages (66 out of 100) also show that there is still room for improvement.[74]

The Access to Seeds Index is compiled annually since 2016 by an independent foundation of the same name based in the Netherlands. It ranks the companies operating in sub-Saharan Africa on the basis of seven evaluations, the orientation of their business strategy towards smallholders, research, patent protection or training of smallholder clients, to name some. In 2019, the Kenyan private company East African Seed scored best in the index region of Eastern and Southern Africa. In Western and Central sub-Saharan Africa, the young Nigerian company Value Seeds was at the top. It was immediately followed by three global companies: Technisem from France, East-West Seed from Thailand and Syngenta from Switzerland.[75] This shows, as the Tasai also documents, that even international industry giants in Africa are increasingly focusing on the needs of small farmers. Not least because smallholders are considered to be the drivers of agricultural transformation – and thus the customers of tomorrow.

5.5 Farming with mobile phones and connected machines

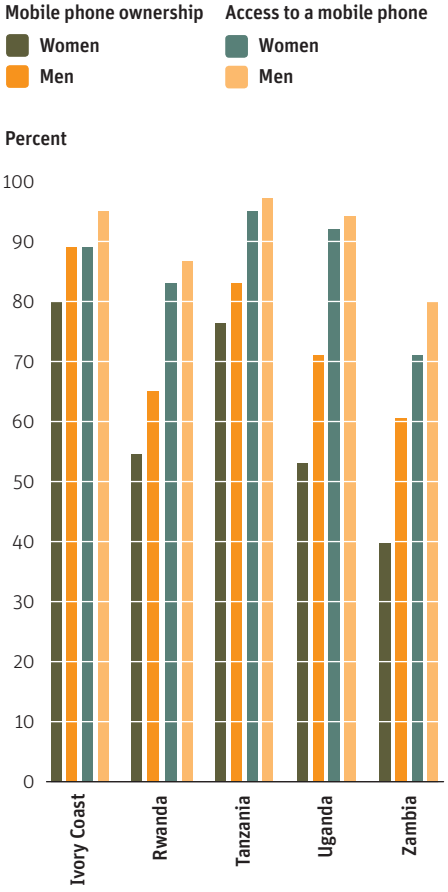
The mobile phone is the most important tool in the hands of farmers, says the Nigerian Akinwumi Adesina, agrarian economist and head of the African Development Bank since 2015.[81] Adesina is well aware of the boost that the ubiquitous mobile phone can give to agriculture in Africa. He was appointed Nigerian Minister of Agriculture in 2011. Within just a few months, he had implemented a mobile payment system for subsidies – and ended 40 years of corruption in the state distribution system for productivity-enhancing agents such as fertilisers and quality seeds at a stroke. Up to 90 percent of these products, which the government had bought for millions of dollars and distributed to central warehouses in order to sell them to smallholders at reduced prices, had regularly disappeared through dark channels.[82]

Information and communication technology (ICT) already contributes in various ways to quenching African farmers' thirst for knowledge and supporting them in sustainable intensification. The continent is not lacking in resourceful developers of apps and other useful ideas for the clever use of ICT in agriculture as well.

Under the title "Leapfrogging for Africa", the Food and Agriculture Organization offers hope: the costs of digital innovations such as apps, sensors, drones, satellites and much more are sinking. Low prices would make it easier for them to conquer the markets and establish themselves in Africa's agriculture.[83] There are already examples of how digitisation and mechanisation are making agriculture attractive again for young people and for returnees from the cities who see themselves as agricultural entrepreneurs or agripreneurs.[84]

Women in agriculture are handicapped in many ways

It is estimated that agricultural productivity in sub-Saharan Africa could increase by up to four percent and the number of hungry people could fall by 17 percent simply by closing the gender gap in digitisation. Women bear the main burden of work in the fields and pastures. In 2017, however, there were only 86 women for every 100 men with a mobile phone in sub-Saharan Africa and only 75 women for every 100 men with Internet access.[85]



Proportion of smallholders in selected African countries who own or have access to a mobile phone, by gender, in percent, 2015/2016
(Data basis: IFPRI[86])

The following selection shows the range of digital applications in the agricultural sector:

Apps for agriculture:

Similar to the health sector, mobile phones can be used in agriculture to offer advice and services, exchange knowledge and experience, obtain information on market prices or the weather, organise networks and much more. The applications available so far can hardly be counted. More and more new ones are being added, for simple mobile devices as well as for smartphones.[87] For example, with the help of the **Nuru** smartphone app, farmers can find out what is wrong with their cassava plants if, for example, the leaves suddenly show yellow spots. The app provides the diagnosis and tips for treatment and prevention.[88] Herders can use **AfriScout** to access up-to-date satellite maps to find grazing land and water for their animals.[89] Digital direct marketing systems such as **Twiga Foods**, **Ninayo** or **Farmcrowdy** enable farmers to avoid intermediate trade so that they have more of the revenues.[90]

Access to the financial system:

Africa has already made a greater leap forward in cashless payments by mobile phone than Europe. **MyAgro** in Mali works on this basis: registered farmers pay into an electronic savings account whenever they have a little money. This enables them to buy seed and fertiliser at reduced prices when the season approaches.[91]

Via mobile phones, banks, companies and non-profit organisations are now granting small and very small loans to people who normally have no access to financial systems. Through the commercial **DigiFarm** system, operated by the Kenyan mobile phone company Safaricom, small farmers not only gain access to credits, but also get discounts for agricultural products, receive agricultural and market information.[92]

Hedging risks:

Rural poverty also persists because most smallholders in Africa bear the whole risks of weather anomalies leading to yield losses, of livestock starvation or death from disease. They hardly know about agricultural insurance or reject it because they suspect it is associated with high costs and administrative work.

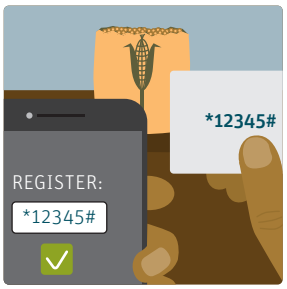
ACRE Africa (short for Agriculture and Climate Risk Enterprise) has found a way to overcome this hurdle. The company emerged from the Kilimo Salama project led by the Syngenta Foundation for Sustainable Agriculture and the World Bank. It has developed insurance products based on a weather index model that are tailored to the needs and habits of smallholders and sells them through innovative channels (see below). From its foundation in 2014 to 2018, the company has insured more than 1.7 million farmers in Kenya, Tanzania and Rwanda against various weather risks.[93] Recently, ACRE Africa began offering farmers the option of insuring corn fields against weather-related losses step by step when they buy seed from an agro-dealer: with Bima Pima, which means "insurance in affordable portions", they have the choice of extending protection throughout the entire growing season. A payment is made if the evaluation of data from weather stations and satellites shows that there has been little or no rainfall or flooding at the location in question.[94]

Pula Advisors, an international consulting firm for digitalised insurance services (InsurTech), also offers index-based agricultural insurance models for smallholders. However, satellite data may be discrepant or not resolved highly enough so that, for example, farmers may report a lack of rainfall, although the data indicate that

Insurance also for smallholders

Many African farmers are sceptical about insurance. They have to pay for something that only pays off later – or not at all if the insured loss does not occur.[96] But if Africa's agriculture is to continue to intensify, it needs insurance. Without insurance, every problem that arises becomes a risk of poverty. ACRE Africa's model of combining insurance with the promise of improved seeds is profitable in more ways than one: it protects farmers from losses. It builds trust because it is simple. And it allows seed and fertiliser companies to learn who is using their products and how.[97]

1 Farmer buys seed at the beginning of the growing season, for example at an agro-dealer.



2 Buyer finds card in the package, registers by mobile phone using the short number printed on the card and receives immediate confirmation.

3 Regional insurer locates policyholder via location services and tracks precipitation in the corresponding area via satellite.

there was rainfall. Pula therefore also works with area yield index insurances (AYII). These cover the case that the yield per area fall below the average amount expected in the respective region.[95]

Use data wisely:

Data and their intelligent use are central to the rapid transformation of African agriculture. With the help of modern resources and the participation of farmers, governments can create a reliable database for sensible planning and preparing for future challenges.[99] Ethiopia is comparatively well positioned in this respect. Among other things, the country produces maps on soil quality, which show where there is room for improvement.[100] Data and ICT are also a prerequisite for early warning systems to predict locust infestations and natural disasters such as floods, storms or droughts for a region in good time. Conventional weather stations are not able to do this. In Rwanda, the United Nations Development Organization (UNDP) has tested an innovative system in 2018 together with small farmers: sensors and measuring devices connected to the internet provided farmers with fast and relatively accurate information about changes on their mobile phones. It is planned to be installed throughout sub-Saharan Africa.[101]

High-tech in the field:

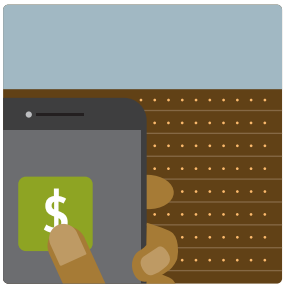
With the help of computers, positioning and remote sensing data, **precision farming** allows the exact nature of the soil and vegetation to be determined for every point in a field. This makes it possible to irrigate, fertilise or control pests only where necessary. This saves resources and reduces harmful side effects, but requires know-how and the appropriate infrastructure.[102]

Precision farming does not necessarily mean highly sensitive, expensive equipment. The Nigerian company Zenvus has developed the robust **Smartfarm** system specifically for small-scale African agriculture. It consists of sensors that are inserted into the soil at regular intervals. They measure the moisture, acidity and nutrient content of the soil at the respective location. Solar powered and wirelessly they transmit the measured values via the main sensor to a cloud server. The cloud server processes the data and sends the farmer detailed information about the condition of his farmland to his mobile phone.[103]

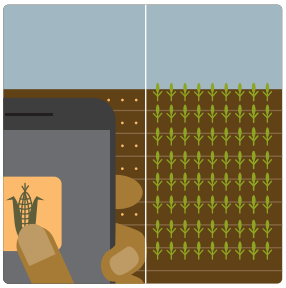
Drones with attached sensors or cameras can collect geodata more cheaply than satellites. They can also be used for monitoring fields, for precise application of seeds, or of microcapsules with fertiliser or pesticides.[104]

Car sharing for agricultural machinery:

Buying tractors and equipment for ploughing, sowing and harvesting more easily than by hand is not an option for most African smallholders. For some of them even a team of oxen is too expensive. Even if they could afford it, it is often not worth it because the areas are too small. There is a lack of nearby diesel supply, service and spare parts. Where tractor owners lend out their machines, problems often arise due to lack of coordination, improper use or fraud. **Hello Tractor**, a kind of "Uber" for agricultural machinery, is the answer. The Kenyan company has developed an inexpensive "intelligent" system based on GPS positioning and telematics. It is hidden in a small black box that manufacturers with their own fleet or contractors install in their rental machines. The technology makes it possible to monitor at any time where the tractor is located, whose fields it is on and how long it has been in use. Farmers enter on their mobile phone when and where they need a machine. Specially trained coordinators in the regions bundle the bookings and send the drivers off.[105]



4 **If the seed has not germinated after three weeks because there was too much or too little rain, the farmer can have the price of the seed reimbursed by mobile phone ...**



5 **...or get new seeds so the season does not go by unused.**

This is how a weather index insurance works
(Data basis: ACRE Africa[98])

5.6 From subsistence to "Agrifood business"

To sum up: The transformation of African agriculture must start with smalllholders. Because they are many. They produce up to three-quarters of the food consumed in Africa and a good proportion of export goods such as cocoa. The most important leaps and bounds on the road to transformation are efficient, environmentally friendly farming methods that are adapted to climate change, diversification, improved seeds, the use of information and communication technology, know-how and information.

But is that enough to become competitive? What are the chances of escaping the poverty trap with sustainable intensification? Can this be achieved if, as a result of population growth, less and less land is available per small farmer household?[106] How can women in particular, who often bear the bulk of the workload but have little to decide, develop an entrepreneurial spirit and visions for the future? Finally: how can urgently needed jobs be created when the increasing productivity and efficiency of agriculture requires fewer hands over time?

Sustainable intensification has a future

Among researchers the discussion continues as to whether agriculture based on ecological principles and minimising the burden on the climate can really produce the higher yields required for Africa's food security without additional land consumption. Analyses of successful projects and meta-analyses of various comparative studies between conventional and ecologically oriented agriculture strongly suggest that this is the case in developing countries. For example, a study of 40 projects of the British government's Foresight programme in 20 African countries from 2000 to 2010 showed that yields doubled. In these projects, a total of 10.4 million smallholders, who together farmed 12.8 million hectares, received support in applying conservation farming methods, agroforestry systems and integrated pest control.[107]

If smallholders bring nutrients into the soil with livestock manure and nitrogen-binding plants, they have less costs for mineral fertilisers.[108] In some places, they achieve higher revenues with products from organic production. Sustainable intensification can therefore help them to generate more income. However, smallholder households have very different opportunities for development, depending, for example, on the natural conditions on site or whether they have the knowledge and opportunities to intensify and diversify. A report by the Alliance for a Green Revolution in Africa (AGRA) on the transformation potential of small-scale agriculture distinguishes between different types of farms, each of which requires different forms of support and framework conditions in order to make the leap to competitiveness. According to the report, not all of them have a chance of success. Subsistence farmers are dependent on additional income from non-agricultural sources. Often this is not enough either.[109]

For some years now, the proportion of small farms with less than 5 hectares has been declining in some countries, while the number of medium-sized farms with 5 to 100 hectares has been increasing. Some of them belong to villagers who have successfully managed their farms and made money. In some cases, city dwellers, including university graduates in formerly good jobs earned enough to buy land and run an agricultural business and even create jobs for rural dwellers. Their interest in agriculture is partly due to the rise in food prices. In addition, some governments have abolished the traditional system of common ownership. This made it possible to buy land in the first place, but it has also led to a sharp increase in land prices.[110]

Compared to small farms, such medium-sized agricultural enterprises have many advantages: they can obtain the necessary funds for intensification more easily. They produce not only staple foods, but a whole range of plant and animal products that can be sold particularly profitably. The wider range and larger quantities also reduce the workload of buyers, bulk buyers, processing companies and supermarkets.[111]

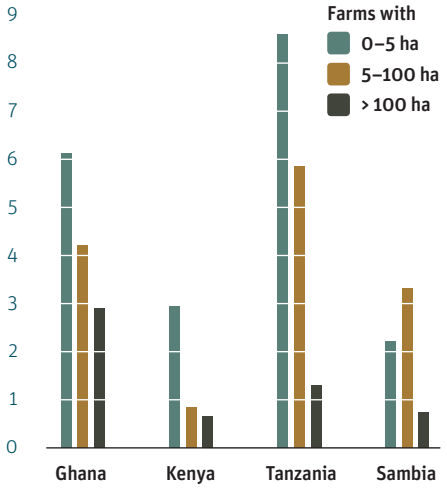
Winning together

Small farmers can hold their ground in this change if they join forces. In groups, networks or cooperatives, individual members can learn from the experiences of others, profit from cheaper bulk purchases of seeds and fertilisers, share the costs of machines, build up their own warehouses and processing plants, present a united front to buyers and much more.

In some West African countries, traditional savings and credit groups still form an informal rural financial system. Cooperatives have a bad reputation where once farmers were forced to join them by socialist governments. However, there is evidence that cooperatives, which were formed on a voluntary and profit-oriented basis, have improved the living conditions of poor people.[113] It is easier for organised farmers or producer organisations to find investors and private sector partners: small and medium-sized food processing companies, supermarket chains, beverage and food producers.[114]

Trend towards medium-sized farms

According to a study in four African countries, the number of medium-sized farms is increasing. Farms with a usable area of 5 to 100 hectares now account for around 20 percent of total agricultural land in Kenya, 32 percent in Ghana, 39 percent in Tanzania and over 50 percent in Zambia. In all four countries, their share of the total area exceeds that of large farms that are operated by both domestic entrepreneurs and foreign investors.



Areas used by farms of different sizes, in millions of hectares, 2015
(Data basis: Jayne et al.[112])

Smallholders have the best chance of becoming competitive in the long term if they offer labour-intensive, high-quality plant and animal products.[115] In 2010, the Tanzanian government brought investors and the private sector on board to promote commercial farming and a value-added chain for such products in a major 20-year initiative. Currently, the focus is on soy, tea, tomatoes, potatoes and dairy products. The initiative brings together small and medium-sized producers, processors and supply chains in the Agricultural Growth Corridor (SAGCOT). This is a broad strip in the south of the country which stretches from the port city of Dar es Salaam to Lake Tanganyika and has a good transport infrastructure.[116]

Farmers on the move to become "agripreneurs"

The idea that farmers are always entrepreneurs seems probably distant to many small farmers in Africa. A whole range of African company founders, foundations and international organisations are committed to awakening and promoting entrepreneurial spirit. The Ugandan Eric Kaduru is one of them. The now 36-year-old has quit his job in advertising in the capital Kampala to produce passion fruit in the rural west of Uganda together with his wife Rebecca. **KadAfrica** sells the produce to local and international companies that produce juice or fruit pulp from it.

But KadAfrica is more than just a farm. The social enterprise teaches young women from the region skills in agriculture and business management. The aim is to help 14- to 20-year-old girls who do not or cannot go to school any more to become economically independent. Since the majority of the rural households in the country are barely self-sufficient, field work is considered a task that is often left to wives and daughters, while sons are sent to school and are preferred in inheritance.

"It was not easy to convince people that agriculture can be a profitable business," says Kaduru. He succeeded by contracting three households that grow passion fruit for KadAfrica. The passion fruit plant climbs upwards on supports, leaving enough space on the ground for other plants to ensure the family's food supply. When the neighbours saw that this brought profits, they also got involved. Today, a whole network of smallholder households has become marketable in this way. KadAfrica also buys the harvest of the girls the company has trained. Recently, it started to produce fruit pulp in its own plant.[117]

Value chains drive development

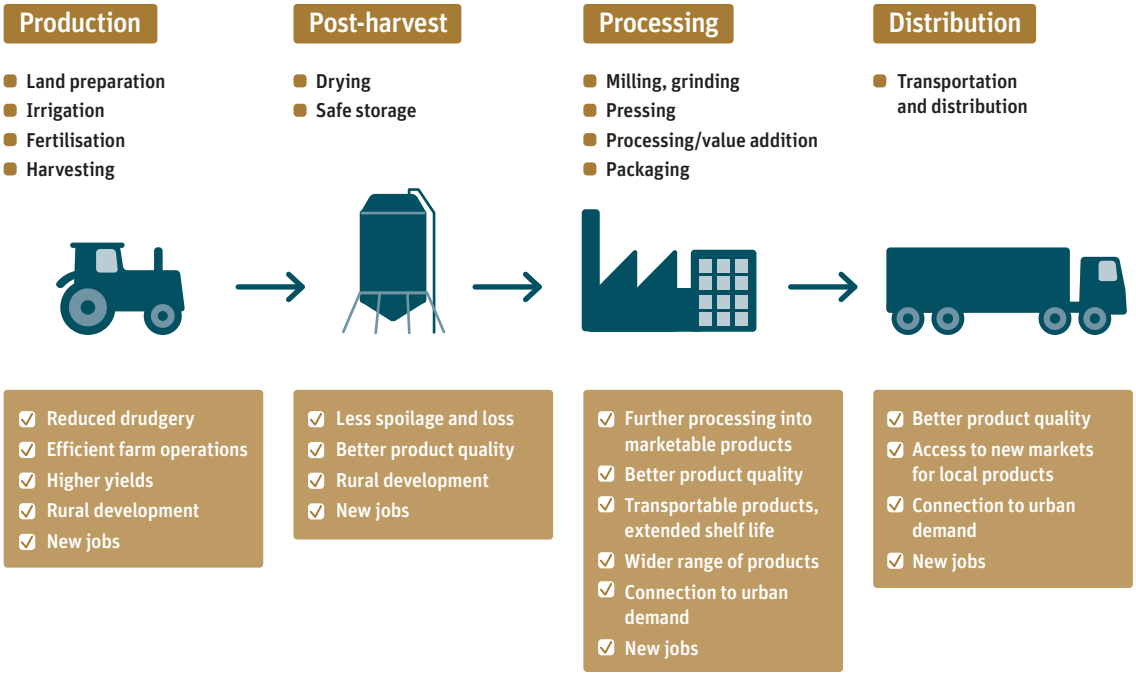
It is still an advantage that there is a large workforce available in the countryside. Especially the sustainable intensification in small farms requires many hands in the first place. If the digitisation and mechanisation of agriculture continues, they will become free, but not superfluous. If the infrastructure and the framework conditions are in place, jobs will be created in a growing industrial and service sector around primary agricultural production.[118]

The "upstream" division manufactures agricultural machinery, for example, and is building up a sales, maintenance and consulting network for this purpose. There is a particular demand for equipment that is suitable for ploughless conservation cultivation and for use by small farmers.[119] Small, cheap and easy-to-maintain tractors such as the three-wheeled **MV Mulimi**, which was developed by a university professor from Uganda,[120] or two-wheeled machines for pushing[121] have not yet found any investors and therefore not found the desired distribution.

There are also hardly any suppliers of innovative irrigation systems. So far, only six percent of Africa's arable land is irrigated, two thirds of which is concentrated in just five countries. So there would be a market. But even simple pedal or hand lever pumps, such as those available from the international social enterprise **Kickstart** for the equivalent of 50 US dollars are beyond the financial means of many smallholders.[122] Cooperatives could finance the cost of mechanically or solar-powered pumps and the associated drip or sprinkler systems.

Intensification from the field to the consumer

According to the international agricultural experts of the *Malabo Montpellier Panel*, Africa's governments, private sector, research institutions and development partners should "substantially" devote more attention and investment towards mechanisation of the agricultural value-added chain. Whether driven by muscle power, animals or motors, whether in production or along the entire supply chain, suitable equipment combined with training and qualification, contribute to a sustainable increase in yields, and create rural Jobs.[133]



How infrastructure and mechanisation advance the value chain
(Own representation according to Malabo Montpellier Panel[134])

The upstream sector also includes seed producers. Their number is already growing. At the same time, start-ups are sprouting, such as those that produce liquid fertiliser from human urine, or simple electricity-free cooling systems for rural dwellers.[123, 124] Agro-dealers offer not only agricultural products, but also **PICS bags**. American scientists originally developed these three-layer, hermetically sealable bags as Purdue Improved Crop Storage Bags to literally cut off the air supply for cowpea seed beetles, which in Cameroon caused massive post-harvest losses in cowpeas. PICS bags are now available in most African countries and are suitable for the safe storage of various agricultural products.[125]

Finally, a systematically developed, state-run agricultural extension service, such as the ones which have been set up in Ethiopia and Ghana, not only creates jobs and regular incomes.[126] It can also make a major contribution to the spread of sustainable farming methods.

The "downstream" value chain must also continue to develop. The demand for processed, safe, supermarket-ready food is increasing. And the realisation is gaining ground that it is better to draw the added value from the processing of raw products in the country rather than to let foreign companies draw it and then sometimes even have to re-import their products.[127] Already, 40 to 70 percent of consumer costs for food are accounted for by processing, packaging, transport, marketing and trade. Many more jobs could be created in African countries.

In addition to the large corporations, small and medium-sized companies that process raw products into tomato puree, instant maize porridge or fruit juices are playing an increasingly important role.[128] In Ivory Coast, for example, a bank clerk trained as a chocolatier. In cooperation with a women's cooperative, he now refines cocoa beans in the country into fine chocolates.[129] In Senegal, a young veterinarian and entrepreneur produces yoghurt and other products from local milk. In doing so, he has helped small-scale herders in the north of the country to earn a regular income for the first time and to send their children to school.[130] In Zimbabwe, a scientist is trying to build a

breeding, processing and distribution system for insect-based food which is rich in proteins and nutrients.[131] In Kenya, an entrepreneur has great success with Mhogo cassava flour.[132] These businesses in turn depend on others, who, for example, manufacture grinders, presses and other machinery or take care of logistics.

The establishment of such an "Agrifood" complex would be a great leap forward and could eventually become the transmission belt for general development. For this to succeed, Africa's farmers, but also small and large companies, domestic and foreign investors need suitable framework conditions. They need governments that follow up their commitments to do more for the development of agriculture with action.

5.7 What is to be done?

Necessary leaps in development in agriculture

In 2003, the Comprehensive Africa Agriculture Development Programme (CAADP) set the framework for the required agricultural policy reforms in the member states of the African Union (AU). They have committed themselves to invest at least ten percent of national budgets in agriculture, increase the gross domestic product of the agricultural sector by six percent annually and raise research and development in the agricultural sector to world standards.[135] In 2014, the AU has also set itself the goal of ending hunger on the continent by 2025, halving poverty through agricultural transformation and tripling intra-African trade in agricultural goods and services.[136]

Implementation has made only slow progress so far.[137] Great leaps are needed to transform smallholder agriculture and achieve prosperity through an efficient agricultural and food sector. The states must set the framework to enable the transformation of agriculture. The necessary impetus must come from entrepreneurial farmers and entrepreneurs.

Create favourable framework conditions

For farmers and investors alike to engage in innovation, they need a climate of stability, security and trust. To achieve this, governments must first and foremost:

- **Make peace.** Conflicts contribute significantly to the fact that in some African countries large parts of the population cannot be reliably supplied with food or go hungry.[138] An early warning and prevention system for local escalations of violence based on the model that Nigeria, for example, has successfully established for disease outbreaks, would be an enormous leap forward.[139]

- **Regulate land rights.** Secure rights of ownership, power of disposal as well as fair access to land are indispensable prerequisites for the sustainable intensification and development of agriculture. If land reforms become necessary, all stakeholders must be involved. Ethiopia, Rwanda and Ghana provide good examples of successful land reforms.[140]

- **Create legal certainty and transparency.** Farmers as well as founders of processing plants and investors need certainty that the applicable standards are observed and infringements punished, that property and personal freedom are protected and that fees and taxes are not levied arbitrarily. Corruption, nepotism, fraud and arbitrary authority are obstacles to development.[141]

Develop comprehensive strategies and implement them consistently

Some countries already have strategies for the transformation of their agriculture. Some have even made visible progress on this basis, such as Ethiopia.[142] Strategies must:

- **Be geared to the needs of small farmers.** Smallholders need access to capital, improved seeds, fertilisers and other means for increasing production. They need access to information and communication technology that makes their work easier and connects them to the markets. They need framework conditions to enable them to form networks or cooperatives. In particular, the role of women in smallholder households must be strengthened. Small-scale agriculture must become commercialised and offer attractive employment opportunities for young people.[143]

- **Support sustainable intensification.** At the same time as increasing productivity, conservation farming practices adapted to climate change and regional conditions should be promoted. There are enough international and African institutions that have gained experience and can be consulted. The experience of small farmers must also be included. Sustainable intensification makes progress when successful examples and methods are adopted, combined and disseminated.[144] Projects of the British Foresight programme have demonstrated that higher yields can be achieved with sustainable farming methods (see p. 76).

- **Qualify farmers and agricultural advisors.** Well-trained extension workers give smallholders access to information and know-how on a basis of trust, they can, for example, offer training or organise field visits. Where there is a lack of qualified advisors, farmers must be provided with information via online training or mobile phones. The advisors themselves need higher education and access to research results in order to contribute to the development of rural areas beyond the agricultural sector. With the African Forum for Agricultural Advisory Services, the AU has in principle created a platform for promotion of this.[145]

- **Create jobs in and around agriculture.** A value chain must be created around primary agricultural production, which creates jobs and income. If planned with foresight, a developed agricultural and food sector could even favour the emergence of smaller urban centres in the countryside and slow down migration to the cities. The company KadAfrica links production, processing and connection to the markets in an exemplary manner (see p. 77). Hello Tractor, the digitally supported "Uber" service for agricultural machinery, helps small farmers to mechanise their work and at the same time creates jobs upstream (see p. 75).

- **Invest in rural infrastructure.** Roads, mobile phone and Internet connections are indispensable prerequisites for the transformation of the rural economy, as are good framework conditions and support programmes for the development of a decentralised power supply, if possible with renewable energies, and innovative irrigation systems. Warehouses and better road connections enable seamless supply chains and reduce post-harvest losses which can be enormous in some cases.[146]

- **Keep the big picture in mind.** Plans for different areas, such as land reform, digitisation or infrastructure development, must be interlinked.

- **Set and review targets.** Indicators must be defined to compare the starting and end points of a project and thus measure its impact. **The basis for this is a good database.** Quantitative indicators, such as the number of farmers living below the poverty line in an area, are just as important as qualitative indicators, such as the results of household surveys on the use of fertiliser and high-quality seeds, nutrition, income or satisfaction.

- **Watch for distortions.** State subsidies must be taken into account when evaluating successes. Between 2006 and 2011 Zambia, for example, recorded an impressive increase in maize yields. However, this was mainly due to the subsidisation of fertiliser for large farms. The small farmers hardly benefited from this, poverty did not decrease.[147]

Hold the private sector accountable

Africa's agriculture is dependent on the private sector for the necessary infrastructure to be created and for technical and socio-economic innovations to take hold. Governments must not only guarantee security but also provide a business-friendly environment. They must:

- **Encourage entrepreneurship.** Africa's education systems are hardly equipped to promote individual strengths and entrepreneurial skills. Politics and society should highlight successful "agripreneurs" or founders of small and medium-sized enterprises in the agricultural and food sector as role models.

- **Coordinate investments.** Governments must promote advisory services or incubation centres for start-ups. They must create opportunities for investors and start-ups to network. Both African and foreign investors should be involved.

- **Facilitate the establishment of companies.** For example, by establishing special industrial zones for the processing of agricultural products from the region. The African Development Bank supports such plans. Ethiopia is in the process of setting up such industrial zones, as is Nigeria.[148]

- **Use public-private partnerships.** The states of Africa must harness the economic power and the potential of companies to bring programmes and projects for the sustainable intensification and transformation of agriculture to a successful conclusion. They must take advantage of the fact that large agricultural corporations in particular are trying to make up for the loss of trust they have suffered in the public sector through social commitment and innovative business models.[149] The growing field of social enterprises (for example Babban Gona, see p. 62) also depends on cooperation with governments, to the benefit of both.

Benefit from digitisation

The use of information and communication technology is virtually synonymous with leapfrogging. Farmers must make use of the possibilities offered by ICT. And governments need data, in order to be able to develop strategies at all, to plan and set up early warning systems for disasters, to control land rights or illegal use of land, to make forecasts of population figures and migration, and much more. What is necessary for this:

- **A fair and transparent regulation for the handling of data.** It creates a basis of trust for users and service providers alike.

- **The use of existing data.** Within the framework of CAADP, the African Union has created the openly accessible agricultural database Regional Strategic Analysis and Knowledge Support System (ReSAKSS). Among other things, it provides information on progress in the development of individual indicators by country. It also provides government agencies with a tool to plan and to evaluate successes involving all stakeholders in the agricultural sector.[150]

- **The collection and exchange of data.** Governments should make data on the agricultural sector available to companies, development organisations and other countries as a basis for decision-making and planning. To facilitate exchange and comparability, countries should agree on common standards.

Enable free trade

For this, governments must:

- **Boost domestic markets.** They must support farmers to produce more, but also help local companies to produce more processed food for their own market from raw materials. In this way the added value remains in the country and many expensive imports can be eliminated, as well as absurd "re-imports" of consumer goods such as chocolate or cashew nuts.[151] Domestic demand then helps decide what farmers produce and what they earn the best money with.

- **Flexibly close off their own markets.** This makes sense in the early stages of the transformation in order to avoid exposing farmers to global competition all of a sudden. For a limited time, governments must protect farmers against, for example, cheap imports of milk powder and other products from the industrialised countries, while at the same time negotiating better conditions for the export of African products.

- **Strengthen intra-African trade.** Governments must dismantle customs barriers in order to enable exchange across African borders. The previous approaches to create regional single markets or even a free trade zone for the whole of Africa must be vigorously implemented. This also includes expanding transport connections across borders.

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