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Foreword

As compact as it is, the title of the book *Hidden Hunger* by Hans Konrad Biesalski nevertheless packs in multiple meanings, as the hunger which it refers to is 'hidden' in at least three respects. First, hunger is hidden in the sense that it is not perceived by many people. Put bluntly, it is ignored. Second, hunger is hidden due to the fact that it is actively concealed, for instance for political reasons, by those who know very well where it exists and whom it affects. Third, hunger hides itself. The existence of a micronutrient deficiency is difficult to recognize and its impact is often only evident much later, if at all. Biesalski drags hidden hunger out from its lair and sheds light, in particular, on the widespread problem of micronutrient deficits. The fact that approximately 2.5 billion people suffer from some form of micronutrient deficiency has somehow barely found its way into the consciousness of the general public. It is vital and urgent that we uncover the many faces of hidden hunger and shine light on the ensuing problems which plague its victims. It lies with us as a society and with our politicians to take the necessary measures to finally put an end to it. To overcome hidden hunger, organizations that are already active in the fight against hunger will need to join governments and companies in increasing and widening the scope of their efforts to combat it. The corporate sector also needs to be on-board when it comes to developing effective measures for eradicating hidden hunger.

New insights into dietary problems are daring us to come up with solutions.

Has everything already been said about hunger that can be said? Is it not simply a matter of raising our voices a little louder and perhaps putting a new spin on facts that have been known for a long time? From a scientific perspective, the answer is clearly "no". There have been a series of new discoveries in dietary research which must first make their way into the mainstream so that they can provide the necessary impetus for change in politics and society. Innovations are being brought forth across the board. In the meanwhile, we have also gained a better understanding of the causes of food *in*security. Important discoveries have been made in research over the past two decades, among which are the following three:

1. It is clear that focusing on calories ignores important aspects of hunger. It is necessary to consider all of the factors of a healthy diet, one which provides all of the essential nutrients, particularly micronutrients. These factors must then be adjusted for the various age groups, especially in the case of small children.

2. Campaigns to fight poverty have been expanded in scope to include the institutional and legal aspects of malnourishment and undernourishment, for instance the right to food and the relevance of water, health, and care.
3. Static concepts have been replaced by 'vulnerability', or threats to the general living conditions which encompass undernourishment and the legacy of hunger over generations. We are presented with a vivid picture of the tragic relationship between undernourished mothers and their underweight babies.

In the past three years, new research and knowledge transfer have given rise to efforts to Scale Up Nutrition (SUN). This endeavor combines new research with established facts with the goal of taking more steps to improve nutrition during babies' first 1,000 days, beginning with pregnancy and ending with year two. Biesalski points out a number of successful new initiatives, as well as insights which have yet to be acted upon.

The solutions are there, but they are neither simple nor do they come cheap.

The scarcity that has led to price fluctuations on the agricultural markets in the past few years and the increasing number of hungry people around the world have put issues of global food security firmly in the spotlight, particularly the two questions "How can the current hunger situation be quickly resolved?" and "How can food security be guaranteed in the future without causing damage to the environment?". These are by no means new questions. The only new issue is the urgency with which they have been placed once again on the political and public agendas. Also new is the differentiated view of the situation thanks to recently gained scientific insights, which will allow us to face the issues involved in hidden hunger.

Fundamental to an improvement in the state of nutrition is a sustainable increase in agricultural production, particularly in Africa, Asia, and Latin America. In many regions of the world, not enough healthy and affordable foods are being produced. Hunger is not merely a distribution problem. Hunger is still predominantly a rural problem, thus overcoming it depends largely on being able to work and earn money. Boosting agricultural production, including small-scale farms, and extending the rural infrastructure are key elements of nutritional policy. These major investments must quickly be enlarged. The problems affecting food security cannot be solved with supposedly cheap, quick-fix measures.

Remarkable progress has recently been made in the war on hunger. A few noteworthy examples of dietary initiatives are the cash transfer programs to the poor in Mexico and Brazil, as well as the school meals programs which have been started in parts of Africa and Asia. Even if the goal of improving the micronutrient supply to millions of people is clear, it is nonetheless essential to apply an intelligent combination of measures which specifically address the problems. This includes industrial food fortification, biofortification (crop cultivation), and/or micronutrient supplements, all of which can complement one another—being ineffective on their own. The victims of hunger must not be the 'recipients' of such programs. Instead, they must be actively involved as decision-makers in the design and execution phases. Otherwise, the results are often less than satisfying.

Biesalski explores the possibilities and the limits of these and other initiatives in a knowledgeable manner.

I hope this work finds a broad audience who will feel inspired to take the necessary steps to put an end to hunger. Hunger must not remain hidden any longer—when it comes to eradicating hunger, what is needed is less tolerance and less patience.

Bonn, 2013

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And They Lived Hungrily Ever After

What may perhaps sound like merely a trite and ironic twist to the happy end of many of the Brothers Grimm's fairy tales actually sums up the bitter reality for many persons on the planet—namely those who suffer from malnutrition. Individuals who have just barely enough to eat and survive, but not enough to actually live, trapped on the border between life and death—a 'life' which seems to offer chances for improvement, yet has no future.

Whenever we see a report on the evening news about a massive famine which killed thousands, we generally first become aware that there are people on the planet who live in poverty and starvation. It is important, however, that we differentiate between 'hunger' and 'starvation' as these are two very different conditions. Hunger is a two-sided coin. It refers simultaneously to that which is visible and can be subjectively and objectively viewed, and that which is hidden.

This less-visible hunger, which even those afflicted do not see until very late, is known as 'hidden hunger'. Currently, three billion people are affected by it. Year after year, it is hidden hunger, and not the physical torture of starvation, which is responsible for the deaths of millions of men, women, and children. Chronically malnourished women and children, most of all are the ones who face the highest risk of suffering illness or death before having taken their first real steps in life.

Poverty and chronic malnutrition are inseparable, and yet the connection is very often overlooked. This combination dictates the daily activities of some 2.5 billion people. Despite numerous attempts to remedy this predicament and even more cries for change, there have hardly been any improvements during the past 25 years. In fact, the growth-centered globalized economy has led to even greater poverty levels, whereby the poor remain in the background. They may move temporarily to the forefront whenever a region is struck by famine, but then they inevitably disappear again into the shadows of the abyss.

Hunger: A Baseline Study of the Current Situation

1

In her eyes, Hassan was simply gigantic, although he was admittedly somewhat smaller and frailer than the other children. He took care of his sister, Suheila, who lay sleeping in Fatima's arms. Hassan would take her down to the river to play with tiny self-made wooden ships, that is, as long as the river still bore water. He built a tent made of leaves for her to shield her sensitive baby skin from the sun's hot rays. Fatima would hear Suheila giggling with delight whenever Hassan had her in tow, lying across a light blue plastic bag bearing the seal of UNICEF and appearing to drift on the wind like a feather. Hassan was 3 years old when he died. On the way to Mogadishu, beneath the heat of the midday sun, they stopped to take a short rest. With his sister sitting beside him, Hassan silently drew his last breaths. The fever and diarrhea had set in a few days earlier. His tired sister would let herself be pulled along by him if Fatima was not there to carry her. When he became unable to hold Suheila's hand any longer, he looked at her with his gentle smile and sat down along the wayside. Fatima attributed the diarrhea to the water, as was the case with so many other children. There was no milk to be had since the supply stations set up by the World Food Programme (WFP) were few and far between, the closest one being a three-day journey on foot. Were it not for the blockades set up by the Al-Shabaab militia, they might have arrived in Mogadishu earlier. Hassan, her husband, had wanted to accompany the children, but was afraid that seeing an adult male would cause the militia to attack them. And so Hassan stayed behind, also in order to look after Hassan's sick brother and his aunt, who were both unable to walk any more. Someone was needed to take care of all that was left. The animals they had kept were long since dead. He wanted that his son, his pride and joy, would survive at least. Day by day Fatima saw how Hassan gradually lost his connection to the outside world, how his smile became dazed and distant and she knew that Hassan was the second of her three children that she would lose.

Twenty thousand Hassans die of starvation everyday in countries all around the world where poverty and malnutrition are the status quo. Death in such cases is caused not so much by an acute shortage of food, but rather as the result of a gradual weakening of the body caused by malnutrition, which, in turn, makes such

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individuals incapable of surviving even short periods of food scarcity. For children, the setbacks that they suffer in their overall development resulting from malnutrition start even before they are born.

Hunger: What Exactly Is It?

To many, hunger is a state of being, a daily condition, a general feeling of angst. It is what causes both people and animals alike to throw caution to the wind, ignore their natural inhibitions, and set out in search of food. Hunger is an acute condition which evolves from a feeling of discomfort into an aggressive impulse to search and hunt for sustenance using any means necessary. This feeling is expressed in everyday language when we say that we are 'famished', or hungry as certain predatory animals, such as a lion, bear, or wolf. From an evolutionary point of view, becoming aggressive while on the hunt for food is an essential regulatory mechanism aimed at preserving the species. The process is guided by a multitude of biological activities, involved in which are numerous complex hormones in the metabolism and the brain. As we have seen in the past and will continue to see in the future, hungry 'masses' of people are a danger to any society as their potential for using violence in their hunt for food cannot be calculated or predicted. This fact should not, under any circumstances, be forgotten, even if those masses of people who face starvation seem hardly in a position to mobilize themselves beyond their respective geographical regions. Yet sooner or later, as history shows us, these hungry people are going to rise up and, in their search for food, start heading toward the (not merely proverbial, but—as seen by millions on the Internet—true) land of milk and honey. In the same way climate wars (which are also nothing more than an expression of mass hunger) are already being fought, internal strife will turn into external conflict and 'hunger wars' will be waged.

This visible side of hunger is the securing and consuming of food at any cost. It makes no difference what kind of food it is, only that it is edible and helps to still the hunger pangs for a short while. The other side of hunger is hidden hunger, chronic malnutrition—a perpetually harmful situation, which is neither felt by those who suffer from it, nor does it prevent its victims from surviving and carrying on in their impoverished state of existence. For every starved child, there are ten children suffering from hidden hunger and each of whom may ultimately die of starvation at any time, as well. Herein lies the real tragedy, namely that we only focus our attention on those who did not make it and not on the ones who perhaps still have a chance.

Hidden hunger is a state of chronic malnutrition, whereby one's very last energy reserves are not utilized to search for food, but rather are 'saved'. Seen from an evolutionary point of view, this is a very logical process. The 'saving' of energy, however, is only possible as long as the body still has reserves—starting with the small amounts of fat that are left in the body and then the protein in the muscles. After these reserves are gone, the body starts to metabolize the depots that are

essential for performing bodily functions. In the end, the body consumes itself by attempting to extract the remaining bits of protein and energy that are contained in the vital organs. This leads to stints in growth and development among children and to varying degrees of incapacitation and limited mobility among adults.

The story of human nutrition covers a broad spectrum: from the consumption of luxury goods by some to the hungering of others. In other words, it is a story of the haves and the have nots: those who can afford to buy high-quality foodstuffs and those who are not as fortunate. It is also influenced by the years of plenty and the years of belt-tightening, whereby for some individuals, every year is plenty while for others, every year is very lean.

One result of this historical dichotomy was the creation of emergency food reserves for difficult times. Learning from history and wanting to avoid the horrors of famine and revolts inspired by famine, governments today keep emergency stockpiles of food for their citizens. Oftentimes these are not produced domestically, but instead are cheap imports from overseas. Food to be kept in case of an emergency may also come from territory gained through expansion, stolen from another country, or purchased. These safeguarding systems, which have been evolving over the past few centuries and continue to exist in many areas, are partly responsible for the bleak and hopeless supply situation and the ensuing chronic malnutrition in many countries in Africa and Asia.

The principle of better nourishment for the rich and poorer for the poor has endured and poses a major problem in the fight against hunger. In terms of quantity, enough food is produced on the planet to supply each person with the minimum amount of energy (2,400 kcal) required on a daily basis—even in light of the growing world population. Three basic foodstuffs supply 50 % (in some countries even as much as 80 % and more) of people's daily caloric intake: rice, wheat, and corn. In rich countries, by contrast, these crops provide roughly 30 % or less of the calories consumed by the average person. People living in rich countries can even join the 'low carb' trend and opt out of eating carbohydrates completely! When it comes to just having a full feeling in our bellies, each of us is probably prepared to just eat rice or mashed potatoes for a while and perhaps a bit of vegetables or an egg. But we know very well that this kind of diet is neither what we would call healthy, nor is what we understand by the word 'nutrition'.

Worldwide Hunger

Every few years a region of the planet is struck by famine. It happened in 2011 in Somalia, in February 2012 there were alarming reports about an impending famine south of the Sahara. These famines and others are caused not only by the blocking of access to food as a means of political pressure by the local militias, but also due to the fact that the starving inhabitants often have no other choice than to revolt. To fully comprehend the different dimensions of hunger, one can hardly rely on numbers alone. Instead, one must experience them first-hand, either as a victim or

as an 'onlooker'. One chilling account is Michael Buerk's film about the massive famine in Ethiopia in the year 1984, during which roughly 1 million people starved to death. The film clearly shows the two sides of hunger: on the one hand, the panic and aggression that breaks out whenever food is being distributed and, on the other hand, the quiet desperation and depression that victims fall into while waiting for the next hand-outs. Caught up in the middle of this are the children. Without any means to defend themselves, all they can do is cry and waste away in the chaos.

We are moved to pity and the desire to help those afflicted when we see news reports about a recent hunger crisis, whereby another few thousand people are dying of starvation. Ultimately these numbers, as abhorrent as they are, serve only to shock us until the next famine, already in progress, makes its way into the news reports. This horrible situation is perpetuated by the millions of people around the world who currently live under the threat of starvation. A slight change in such outside influences as the price of staples or a dry period is enough to plunge thousands of men, women, and children into starvation in one fell swoop.

The progression of mankind from food gatherer and hunter to stationary farmer seemed to signify an end to the threat of starvation through the ability to stockpile reserves. Yet this only led to a new problem that has continued to affect the issue of world hunger to this day. Nobel laureate economist Amartya Sen sums up the situation in the following way: Hunger crises have less to do with the availability of food than with the ratio of the purchasing power of those who buy foodstuffs versus that of those who sell it. This explains the unfortunate and persistent correlation between poverty and hunger, two plights which, hand-in-hand, affect not only developing countries. The most colorful and wonderfully varied market is clearly of no benefit whatsoever to the poor, who cannot afford to purchase any of the produce on offer.

World hunger can essentially be attributed to the following key factors: wars and climate change, leading to the migration of peoples in search of nourishment, and a global economy which places profit above moral obligation.

Returning once again to the situation in Somalia: in the meanwhile, an 'all-clear' was given in January 2012 with regard to the situation there. The hunger crisis was reported to be under control, meaning that nobody was starving after days of having nothing to eat. Thanks to shipments of rice and corn, the stomach of the people were full enough to prevent them from starving. On top of that, the German foreign minister pledged the generous sum of six million euros to help alleviate the crisis. Yet that figure amounts to less than the combined annual salaries of the executive board members of the large banks and industrial firms, and is less than 0.5 % of the minimum amount which, according to UNICEF, is needed to hunger in the region to a halt, albeit temporarily. Compared with the so-called bailout package, it is merely bagatelle. Returning to the agenda means preserving the status quo. According to the International Food Policy Research Institute (IFPRI), the 'business as usual' attitude will lead to a further rise in the number of undernourished individuals by the year 2015 and not, as outlined in the Millennium Development Goals (MDGs), to that number being cut in half (Shengen 2010).

Millennium Development Goals and Worldwide Hunger

In the 1990, MDGs were announced as a political answer to worldwide hunger. As such, they include the roadmap for making headway, as well as the documentation of concrete steps taken in the fight against hunger.

The MDGs (see Box 1.1) were adopted by the 55th General Assembly of the United Nations on September 6, 2000. The overriding objective was a 50 % reduction in poverty by the year 2015. The starting point was provided by some rather dry statistics:

- More than 1 billion people currently live in a state of extreme poverty (20 % of the world's population have less than $1 a day at their disposal).
- 700 million individuals are undernourished.
- 120 million children have no prospect of receiving an education.
- More than 20 % of the world's population has no access to clean drinking water.

Box 1.1 Millennium development goals

1. The eradication of extreme poverty and hunger
   - The reduction of persons who have less than the equivalent of $1 a day to spend by 50 % from 1990 to 2015.
   - The reduction of persons who have less than the equivalent of $1 a day to spend by 50 % from 1990 to 2015.
   - Full-time employment in decent jobs for all persons including women and adolescents.
2. Primary school education for all
   - The guarantee that all children worldwide, both girls and boys, are able to finish their primary school education by the year 2015.
3. Gender equality/strengthening the role of women
   - The elimination of the gender gap in primary and secondary level education ideally by 2005 and in all levels of education by the year 2015.
4. A reduction in the infant mortality rate
   - Between 1990 and 2015, a reduction in the mortality rate of children under 5 years of age by two-thirds (from 10.6 to 3.5 %).
5. An improvement in mothers' state of health
   - A reduction in the mortality rate of mothers by three-fourths in the period 1990–2015.
   - The availability of reproductive health care for everyone by 2015.
6. Efforts to fight HIV/AIDS, malaria, and other serious illnesses
   - Bringing the spread of HIV/AIDS to a halt and creating a turnaround by 2015.
   - The providing of medical treatment to all HIV/AIDS-infected persons by 2010.
   - Bringing the spread of malaria and other serious illnesses to a halt and creating a turnaround by 2015.

7. Ensuring environmental sustainability
   - The pursuit of sustainable development in the political agendas of individual states and the curtailing of the destruction of natural resources.
   - A reduction in the loss of biodiversity and a significant curbing of the loss rate by the year 2010.
   - A decrease in the number of persons without permanent and guaranteed access to hygienically sound drinking water by 50 % (i.e., from 65 to 32 %) by 2015.
   - A marked improvement in the living conditions of at least 100 million slum dwellers by 2020.
8. The creation of a global development partnership network
   - Further steps toward developing an open, rules-based, predictable, and nondiscriminatory system of commerce and finance (a commitment to responsible leadership in government, to development, and to a reduction in poverty at both national and international levels).
   - Special consideration for the needs of the least-developed countries (the lifting of trade barriers, debt relief and cancellation, special aid for countries which actively work to combat poverty).
   - Accommodating the special needs of smaller, land-locked, and island-based developing countries.
   - Wide-ranging measures on both national and international levels toward dealing with the debt crises faced by developing nations.
   - The drafting and implementation of strategies for creating meaningful and decent work for young people in collaboration with developing countries.
   - Ensuring access to essential medicine at reasonable prices for persons in developing countries in cooperation with pharmaceutical companies.
   - Working together with the private sector to make certain that the benefits arising from new technologies, especially information and communication technology, can be utilized by developing countries.

To this day, not a single one of these goals has been even remotely achieved, although headway has been made. MDG 1 (the eradication of extreme poverty and hunger) is still merely an illusion. Both the number of people living in extreme poverty and those suffering from undernourishment have decreased only marginally.

According to the World Bank's definition, 'extreme poverty' equates to earnings of less than $1.25 per day. This is the case with 1.4 billion people. A further 2.6 billion earn less than $2.00, and those individuals who earn less than $3.00 a day are also in no position to adequately nourish themselves on a permanent basis.

In Thailand, a person who is responsible for cleaning sailing yachts that are moored in the harbor at Phuket (itself a rather privileged position) takes home 800 baht, roughly €20, in a month. In the least, the manager of the cleaning staff earns

the 'proud' sum of 1,200 Baht, roughly €30 per month. In both cases, large families with many hungry mouths must often be fed with that money.

Let us be clear once and for all about what that means: 1,000,000,000 undernourished men, women, and children! More specifically, there are 1 billion people who consume less than 1,800 kcal of energy per day and do not have the means to alter the situation.

> The WHO defines hunger in terms of the minimum daily requirement of energy, which currently stands on average at 1,874 kcal per person. Any less than that amount and one's ability to do even light manual labor is restricted. The minimum amount according to the World Bank lies at 2,200 kcal a day, any less than that representing 'absolute poverty'. With an intake of 2,200 kcal, light manual labor is still possible. The balance of energy and manual labor depicts the ratio of nutrition to productivity and, ultimately, the potential of individuals to free themselves from their state of poverty.

One dollar a day is not enough for one person to consume the daily minimum of 1,800 kcal, let alone an entire family. And then there are the family's expenses other than food. For these individuals, the situation not only concerns their daily survival, but also the realization and the acceptance that there will be nothing for them to eat—in the evening, tomorrow morning, or perhaps even for the next two days.

UNICEF gave a résumé of the results of the MDGs 20 years after their publication and 5 years ahead of the envisioned target date (UN 2010). The lofty goal of "eradicating extreme poverty and hunger" remained unaccomplished in 2010 and would also not be achievable by 2015. In 1990, the percentage of people living in extreme poverty was 38 %. Prior to the economic crisis in 2008 and 18 years after the proclamation of the MDGs, the figure dipped down to 31 %, but only to rise back up again to 37 % in 2011 during the crisis. In 1990, 20 % of the world's population went hungry. This figure sank to 16 % before taking a clear upward turn after the crisis in 2008. The tragic chain of events, climate change and dry periods resulting in price fluctuations, which in turn lead to food crises, is, along with other local occurrences, the reason why the percentage of hungry persons has remained largely unchanged. The ultimate consequence of this situation is that the physical and mental development of those persons who are undernourished is curbed from the very start of their lives. Thus, entire nations have no chance at economic development since their collective human resources are lacking and whole generations are without any hope or prospects of improvement. These people are trapped in a vicious circle, a merry-go-round which they cannot influence and most certainly cannot get off 'freely'.

Where Do We Stand Today?

Each year, the world's population grows by some 80 million people. That means that everyday an additional 220,000 people need food. An estimated 30,000 of these people will be sitting in front of a more or less empty plate. Others, by contrast, will have more on their plates than they can possibly eat, leaving the rest to be thrown away. So ultimately these 30,000 individuals begin their lives having a far less chance to develop adequately.

As ambitious as the MDGs may be, they did seem at the time to be achievable. Yet developments over the past 22 years show that the number of persons suffering from hunger has remained unchanged (see Fig. 1.1).

The total number of persons living in a state of hunger has essentially remained the same since 1969. The most noticeable change is in Asia (excluding the south), where by the year 2007 the number of undernourished persons had diminished from 500 to 200 million. In contrast, the number of hungry persons in Africa, especially in Sub-Saharan Africa, has continued to rise until the present day. One major reason for this is the financial crises of 2008 and 2011. The consequences of the latter became visible in 2012.

At the beginning of 2011, the Food and Agriculture Organization of the United Nations (FAO) observed: Although worldwide hunger is on the decline, it is still unacceptably high. The most recent economic crisis of 2011 put an end to this 'apparent' trend and sent the number of hunger-stricken persons further upwards, while simultaneously increasing the probability of increasingly severe hunger crises.

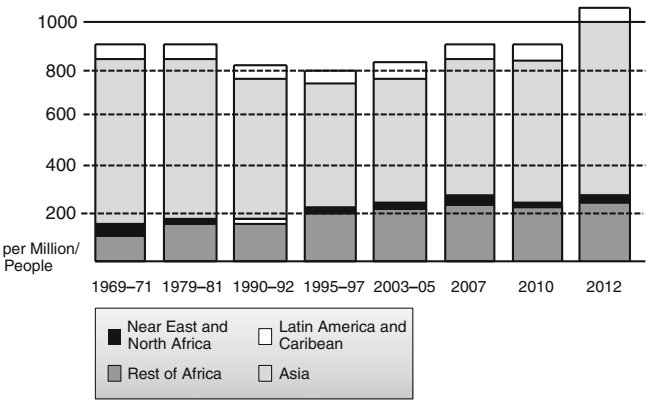

Fig. 1.1 Undernourished persons (in mil.) worldwide since 1969. Between 1990 and 2015 the numbers of undernourished persons were supposed to be cut in half in accordance with the Millennium Goals. Contrary to this lofty target, however, they have risen further (Fischer et al. 2008; input from FAOSTAT.fao.org 2011, 2012)

Somalia: 400,000 Children are in Danger of Starvation

The children in East Africa are the ones who are suffering from the hunger crisis most of all, with hundreds of thousands of them on the brink of starvation. Muslim countries and Great Britain have increased their assistance to the stricken country, however the UN still has only half of the $1 billion necessary.

Nairobi—as many as 400,000 children in Somalia are going to die of starvation—unless help arrives immediately. That was from a report by the British Secretary of State for International Development, Andrew Mitchell after visiting Mogadishu.

According to the World Bank, 29,000 children under the age of five died in Somalia during the past 3 months. Overall the lives of more than 12 million people are in danger due to the worst drought in 60 years. (*Der Spiegel*, 17 Aug. 2011)

What is unique about hunger crises? Why do we refer to it as being a 'crisis' when it has long been known that 1 billion people are starving? Is that not already in itself a crisis? The crisis brings to light the razor's edge separating a state of barely surviving and starving to death due to the fact that the ones who are starving are no longer scattered across the globe, but rather find themselves huddled together in refugee camps of 450,000 or more, predominantly women and children. Basically, what we have is a situation whereby all the persons living under the threat of starvation are not spread out across the country, but rather they are suddenly concentrated in one place. Their misery and imminent demise suddenly come into view. We first take notice of the situation when the threat of mass starvation looms large, and not as long as these people are 'only' undernourished.

However, a hunger crisis is only the tip of the iceberg, which alerts us of danger when we spot it on the horizon. A good 90 % of the problem lurks under the water's surface. When the tip of the iceberg has 'melted' and, apart from a few thousand individuals who died of starvation, the hungry masses are momentarily provided for with food, everything goes on in its usual way.

For every child that dies of starvation, there are at least ten others whose plight first becomes obvious once it is too late. Hunger, in terms of malnourishment, is not a passing condition and feeling in the lives of these children, but a permanent state much like the razor's edge on which they travel. One can only wonder why this dire situation does not attract more constant attention. The answer lies in the fact that this is indeed an on-going condition which cannot be resolved by temporarily shipping food aid and, with 1 billion people affected, is beyond our ability to imagine. The suffering and hopelessness of each individual victim does not make it onto our radar.

'Hunger crisis' is the technical term used to describe an on-going situation when it becomes clear that there is far less available to the inhabitants of a certain region than the 1,800 kcal/day needed to survive. The recent warnings concerning the drought, 50 % loss of crops and impending famine in the Sahel, particularly in Niger, Mauretania, Mali, Chad, Burkina Faso, and Nigeria, are a good example. When we help to provide food aid with our donations as a means of offsetting these losses, we assume that the threat of people starving is eliminated. In a narrow sense, this is true, provided of course that those in need actually receive the aid. In reality, the saving of lives today is nothing more than the prolonging of an extremely precarious existence—until the next hunger crisis.

Hunger: A Quantity Issue: Being Full and Peaceful Is (Not) Enough!

In order to predict hunger crises in the hope of planning relief efforts as early as possible, the respective organizations, such as the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) use a variety of techniques which express the state of nutrition in different countries in plain figures.

Undernutrition is, according to the FAO, an intake of calories expressed as daily Dietary Energy Consumption (DEC) which is less than the Dietary Energy Requirement (DER) (Cafiero and Gennari 2011). Using this formula, the number of undernourished or hungry persons in any population can be calculated. To determine the DEC, factors such as gender and light manual labor are taken into the equation, as well as data regarding the average daily requirements from the Food Balance Sheets (FBS). The percentage of undernourished individuals is projected based on the averages values over a 3-year period. Hence the term 'undernourishment' is expressed strictly in terms of quantity, whereby the undernourished are understood as having an insufficient energy intake in relation to their physical workload. As a result, the phenotype undernourished individual is underweight and 'unproductive'.

Malnutrition in contrast is a qualitative description, i.e., those persons affected by it have a deficiency of one or more nutritional components without necessarily consuming too few calories. If the average caloric intake of the population is calculated as being sufficient, no measures are undertaken to determine what percentage of that population is malnourished. By definition, a person who is undernourished is malnourished. Yet the opposite is not true, namely a person need not be undernourished to be malnourished and may even be overweight. The phenotypical malnourished individual is recognizable either due to symptoms arising from a specific nutritional deficiency (e.g., iron deficiency anemia) or because he or she often falls ill or shows signs of a developmental disorder (stunting).

Food Balance Sheet

So how can the number of undernourished individuals be determined on the basis of a quantity-based analysis (kcal/day)? The FAO relies on a theoretical model to estimate the extent of world hunger which is not undisputed. The basic premise rests upon the assumption that hunger is the result of not consuming enough energy (kcal), a view shared by the WHO. The calculation follows five steps:

1. First, the total amount of food available in a country is taken from the Food Balance Sheet, a compilation of data regarding the amount of food which is produced, bought or sent into the country as food aid.

Table 1.1 Food balance sheet for Sri Lanka

Years	Calories/day			Protein in g/day			Fat in g/day		
	Total	Vegetable	Animal	Total	Vegetable	Animal	Total	Vegetable	Animal
2005	2403	2294	136	60.1	44.8	15.3	42.1	35.8	6.3
2006	2419	2263	156	60.4	42.9	17.5	43.3	36.2	7.1
2007	2369	2212	157	59.6	41.2	18.4	48.8	41.9	6.9
2008	2552	2396	155	61.3	43.1	18.2	45.1	38.2	6.9
2009	2434	2276	158	61.6	43.3	18.3	47.4	40.3	7.1

2. Next, the percentage of food which is either lost or is to be used for other purposes than human consumption is subtracted.
3. Then the food is equated into calories.
4. The distribution of food among the households and then within the individual households is approximated.
5. Based upon these data, the prevalence of undernourishment is estimated.

If we take Sri Lanka as an example (or any other country for that matter), it becomes clear that the quantitative approach to hunger can lead to incorrect conclusions by those in charge of providing help (see Table 1.1).

At first glance two things are noticeable: The percentage of valuable animal-based foodstuffs remained unchanged throughout the entire period of observation. The percentage of protein in relation to the total calories is roughly 11 % and does not meet the minimum level of 15 % set by the WHO. At 17 %, the amount of fat is far below the required 30 %. Hence, 72 % of calories are derived from carbohydrates and this presents a further problem since carbohydrates in this region are mostly obtained from cereal products. Cereal products are rather poor sources of essential nutritional components, such as vitamins and minerals. The people in Sri Lanka seem to be well-fed (with a daily consumption of more than 1,800 kcal/person), yet they are certainly not well-nourished!

Because the FBS only allows for a quantitative assessment of hunger, UNICEF's analysis of the situation came to the surprising conclusion that despite sufficient caloric intake, there appeared to be signs of inadequate nutrition among the population:

In a country where the inhabitants do not suffer from food shortages and have access to excellent, free health care for mothers and children, it is paradoxical that close to a third of all children and a fourth of all mothers are malnourished. (UNICEF Annual Report 2007).

- Every fifth child born has a low birth weight. 29 % of children under the age of five, in some districts as many as 37 %, are underweight.
- 14 % of all children under the age of five suffer from acute malnutrition, or so-called 'wasting'.
- 58 % of all children between the ages of 6 and 11 months and 38 % of all children between 12 and 23 months are anemic.

Table 1.2 The ten most important staple foods in Sri Lanka (FAOSTAT.fao.org 2007)

Staple food	Daily amount (kcal/pers.)
1. Rice	942
2. Wheat	309
3. Coconuts	258
4. Sugar	249
5. Coconut oil	82
6. Beans	56
7. Fish	42
8. Bananas	37
9. Cassava (manioc)	32
10. Fats, meat	29
Total calories/day	2,036

The apparent paradox, having enough to eat and being nevertheless malnourished, can be explained by simply taking a closer look at the figures in the FAO's statistics.

For Sri Lanka, a nutritional overview is given in Table 1.2, which presents a detailed yet mere quantitative view of the situation. It must be noted that the daily caloric intake an average value is which does not apply to every individual, most especially the poor.

1,758 kcal are distributed among the four staples rice, wheat, coconuts, and sugar. It is precisely those staples which could satisfy the nutritional needs of the population, especially of children, which are in extreme short supply. On the surface, as the FAO also announced, there is enough food for everyone. Therefore, there is no need for concern—or is there?

Once rice has been husked, only a small amount of B vitamins and absolutely no fat-soluble vitamins remain. It also contains only slight traces of minerals with the exception of magnesium. Certain B vitamins (B1, B2, and niacin) are contained in wheat, albeit in very small concentrations (<10 % the RDA of 100 g) and the minerals iron and zinc are difficult for the human body to absorb. Coconuts also contain very small traces of vitamin B (B1, B2, B6, folic acid), as well as vitamin C.

So all in all, 90 % of the calories consumed on a daily basis contain only a small amount of water-soluble vitamins. The amount of fat-soluble vitamins, such as vitamin A and C, is also negligible. The same is true with pro-vitamin A and a number of other micronutrients. According to the quantity-based assessment of nutrition, the food supply is nevertheless sufficient. A full stomach is simply not enough!

The quantitative analysis indicates that the inhabitants of Sri Lanka are sufficiently nourished. The fact that the quality of food is by no means sufficient and,

consequently, the population suffers from malnutrition is hardly given any consideration. Moreover, the situation is perceived as a paradox due to the fact that false interpretations rest upon assessments made by UNICEF:

> **Micronutrient deficiency, a condition which jeopardizes growth and development among healthy children, is less widespread, nevertheless it poses a serious health threat. The most common deficiencies among women and children** are iodine, which is essential for bodily and mental development, iron, a lack of which causes anemia and hampers the cognitive development of children, and vitamin A, needed for healthy eyesight and the immune system. One-third of children under 6 years of age are found to have a vitamin A deficiency and half of the children between the ages of five and ten do not receive enough iron. Every fifth child suffers from an iodine deficiency—the biggest and, at the same time, most preventable cause of bodily and mental illnesses. (UNICEF Annual Report 2007).

It is often overlooked that behind each of the deficiencies described by UNICEF due to an unbalanced diet there are further deficiencies that are not yet visible, yet which have a negative impact on a child's development. Likewise, a lack of other micronutrients than the three mentioned can lead to stints in development long before symptoms develop.

The fact that both the FAO and the WHO define hunger in purely quantitative terms, i.e., the result of too few calories, misses the mark. Even if the subjective aspect of hunger, the empty feeling in one's stomach, is addressed by this definition, there is another aspect of hunger which is left out in the cold: the body's craving for essential nutritional components. That is what is meant by 'hidden hunger'.

The quantity-based approach of the FBS leads us to believe that when a country produces more rice or wheat, the number of hungry people decreases since the distribution of those calories between the households presumably remains the same. In other words, the fruits of labor have provided a surplus for all to enjoy. The fact that the truth of the matter might be completely different is illustrated by recent reports from India. According to an article in the *New York Times* from June 18, 2012, rice and wheat production has risen in India so dramatically that the country is now in a position to export both crops, yet the number of undernourished persons is the same as before. A corrupt system and a lack of regulation are the reasons that only 41.4 % of wheat which is purchased by the government to be given to the hungry actually makes it to the afflicted families. There are apparently a number of stations along the way at which wheat is siphoned off with the intent to sell it for a profit somewhere else. In India, productivity and national per capita income have more than doubled in the last 10 years. The number of hungry persons, on the other hand, has not decreased, but has even risen from 17 to 21 % since 1997 (FAOSTAT 2012). In times of economic boom, the number of undernourished persons has grown in India by 65 million, in Pakistan by 14 million. These figures may very well be even higher since the FBS does not allow for a very precise analysis.

The FBS is a statistical tool which relies on average values and does not distinguish between the income levels of the different households and therefore does not differentiate or take into account the disparity between families with a

high income (i.e., well above the average) and a low income (i.e., well below the average). A significantly more accurate picture is presented by studies that take into account the adverse effects of undernourishment.

Global Hunger Index

The child mortality rate is the most sobering indicator of undernourishment and malnutrition. It is taken into account by the WHO's Global Hunger Index (GHI) for assessing the food security situation in different countries. Since undernourished children are always malnourished as well, they are counted solely among the former group. Strictly malnourished children, in other words those children that have a caloric intake above the minimum, are not considered and herein lies the problem. With such methods of analysis, it is difficult enough to identify the problem of hidden hunger, let alone attempt to rectify it.

Unlike the FBS, the GHI focuses on the negative effects of hunger. By doing so, the consequences of inadequate nutrition for those affected are more closely examined. However, only data for the particularly tender age of 6–59 months are collected. Mothers, pregnant women, and newborns fall here by the wayside.

Even the GHI only deals with the negative impact that inadequate nutrition (regardless of calories) has on one's health and development to a partial degree. It focuses far more on the impact that events have on the magnitude of hunger using three equally weighted factors:

1. the percentage of undernourished persons in the respective population (insufficient calories)(UP),
2. the percentage of undernourished children under age five (UK),
3. the child mortality rate for children under age five (USMR).

The index is then calculated using the following formula: GHI = UP + UK + U5MR/3. The highest possible value is 100. Such a score would mean 100 % in all three categories, which is just as improbable as reaching an index of 0! The higher the score is, the greater the hunger. An index of 10 depicts a serious condition, whereas a score of 30 sends alarm bells ringing.

With the GHI it is possible to track developments in specific countries. In South-East Asia, North Africa, and Latin America, the index declined in the years 1981–2006 and currently stands at around 10. Consequently, the nutritional deficiencies in these regions are categorized as less serious. A closer look reveals that using the child mortality rate as an indicator of poor nutrition addresses only part of the problem. Children who survive are not necessarily better nourished and may have been fortunate thanks to other health measures, such as better hygiene and vaccinations. One must not forget that slight shifts in the political or political landscape of these countries may suddenly send the index upwards.

The index has also shown a clear improvement in South Asia, where it has descended from an *extremely alarming* 40 to a 'merely' *alarming* 30. No such improvements have so far been observed in Sub-Saharan Africa, where the index

has been somewhere between *very serious* and *alarming* for at least the past 30 years. The situation is particularly alarming in countries which have been the scene of wars or on-going conflicts. The index also stands in close correlation to the national income, although these countries often have no respective data to draw upon. The lower the per capita income level, the higher the index. What ensues is a vicious circle of conflict and poverty, a merry-go-round of hunger which pulls more and more people on board.

If one observes the worldwide distribution of the Global Health Index and its development over the last 20 years, once can see that only a very few countries have achieved a reduction in score by 50 %. On a global scale, a reduction in the score has been achieved. In Africa, however, the number of undernourished children and the child mortality rate for children under five has barely diminished. If we look at South Asia, the number of child deaths has decreased, partly due to improved hygiene and medical treatment, yet the percentage of undernourished persons (based on weight and energy intake) has hardly fallen since 1996. One can hardly speak of an improvement in nutrition in this case. The same applies to Africa, where the percentage of persons who do not consume enough calories is clearly greater because there is simply not enough food to go around.

From the nine countries in which the GHI has risen, eight of these are in Africa and the other is North Korea. Since the GHI reflects the relationship between income levels and poverty, this fact is hardly of any surprise. However, when the total revenue of a country rises, is apparently in itself not sufficient enough to lower the percentage of those living in poverty and, consequently, the GHI as well. In South-East Asia, for instance, there was an 8 % in poverty, while the GHI only nominally decreased by 3 %. Thus an increase in a country's GDP is by no means a safe indicator whether or not the population is well nourished. The GDP itself says nothing whatsoever about the distribution of food within the population (as dependent upon availability, access, and price).

The GHI is indeed a valuable tool for assessing the hunger situation in a country since it shows negative trends at an early stage, therefore allowing them to be slowed down through rectifying measures. In 2010, the highest alert status was given to the Congo, Chad, and Eritrea because they had a GHI of over 30. At that time, there was no data available for Somalia, which suffered a severe famine in 2011. An appraisal of the situation by means of the GHI also went begging, although relief organizations had strongly warned of an impending catastrophe.

What exactly does the GHI actually show? In short, it is a fever thermometer which indicates the threat of a hunger crisis. The higher the number of undernourished and starving children, the higher the probability that this number will make a sudden jump if the amount of food available shrinks due to, for instance, bad harvests, price increases, or war. That also means that the children living in a country with an alarmingly-high GHI are already walking the fine line between survival and death by starvation, a fact which is in itself unacceptable. Such an existence means that children are quite simply excluded from enjoying a real life. They receive no education, they suffer from hampered mental and bodily development and, after they turn five, become 'statistically' irrelevant.

If the predicted crisis does in fact turn into reality, the GHI rises from *alarming* to *extremely alarming*. Emergency staple food supplies are then shipped to the affected regions in order to mathematically reduce the number of undernourished individuals by means of increased caloric intake. An increase in calories can easily be achieved with rice or corn. Certainly a portion of rice can make a child temporarily feel full and, as a result, not suffer under the usual agonizing hunger pangs. This seeming feeling of fullness is an illusion due to the fact that a portion of rice, corn, or cereal is absolutely insufficient for meeting a child's required daily amount of protein. This is evident from the both the short and long-term effects of hunger. The immediate effects, emaciated children (are able to) send waves of aid flowing into the affected region, whereby the long-range effects, chronic undernourishment, or malnourishment, are glossed over. The children stay undernourished, the severely weakened perish in the crisis, and everything returns to the old routine.

Hunger: The (Less) Obvious Consequences

Just as there are methods for calculating the number of undernourished persons or the probability that a hunger crisis will occur, there are also methods for assessing the general state of health of hungry persons and the effects of hunger that they have suffered. The phenotypical form of undernourishment, the visible reduction in body weight, is just a visible as obesity and can be measured and categorized using the Body Mass Index (BMI). The formula for calculating one's BMI is:

$$\begin{aligned} \text{BMI} &= \text{mass(kg)} \Big/ (\text{height}(m))^2 \text{ or} \\ &= \text{mass(lb)} \Big/ (\text{height(in)})^2 * 703 \end{aligned}$$

A person whose score is under 18 is considered to be underweight, and a score of 25 or higher indicates overweightness.

Undernourishment

Undernourishment, always accompanied by malnutrition, leads to immediate developmental constraints for children which can be measured on the basis of predefined parameters. Other adverse effects can appear much later, for instance during adolescent years or in adulthood, which can also lead to serious mental and bodily handicaps.

There are three phenotypes of undernourishment:

1. low bodyweight in relation to body size (wasting),
2. body size which does not correspond to one's age (stunting),
3. body weight which does not correlate with one's age (underweight).

The Anthropometry of Hunger In order to describe the physical development of children, an international system of reference values was established. In order to arrive at an exact definition of physical development, the scale includes bodyweight, weight-for-age (W/A), height-for-age (H/A), and weight-for-height (W/H). The individual's W/H is then set against a reference value based upon a healthy person of the same age and with the same bodyweight. If the weight or size of the individual is more than two standard deviations (SD) under the normal value (−2 SD), then the person is considered to be underweight (W/A) or stunted (H/A). We refer to a situation as wasting when an individual's W/H is −2 SD.

A diet that does not correspond to one's required daily amount of calories (depending upon one's age and workload) results in a person becoming underweight. Being underweight is thus initially a sign of insufficient energy intake, just as overweightness is a sign of too much energy. On a short-term basis, this is certainly not a cause for alarm. In the long run, however, this can be a sign of undernourishment and malnutrition.

Wasting (W/H > −2 SD) is the most serious of undernourishment and it affects 10 % of children under age five (i.e., 55 million children). 3.5 % of children younger than five (i.e., 19 million children) suffer from a severe case of wasting (>−3.5 SD). Wasting is a visible signal of on-going and acute undernourishment, depending upon the original bodyweight of the individual and it is the result of an insufficient diet (in both the qualitative and quantitative sense) or a serious illness.

Children who suffer from wasting (imagine the emaciated children lying in the arms of their equally emaciated mothers) can only be helped by means of targeted nutritional intervention. It is the children with flies swarming around their faces, toothpick-like legs which seem too brittle to support them, and the marks of suffering stamped on their facial expressions. As long as they are still not completely crippled, they march to meet their life's sad end, although life for them was only just beginning.

Stunting (H/A < −2 SD) Children who suffer from stunting deviate from the average height of children in the same age group and population group by more than two SD. Unlike wasting, stunting is the same as being underweight since it is the result of chronic malnutrition. Those affected suffer from growth disorders and mental handicaps.

It is an established fact that stunting is the direct result of the extreme poverty which exists in many countries. 90 % of all children who suffer from stunting reside in 36 of the poorest countries on the planet (Black et al. 2008).

Being Underweight is the result of chronic undernourishment. Unlike stunting, which inhibits growth, this is not the case with those who are underweight. Underweight children are more or less always malnourished.

The prevalence (frequency of an illness within a given population) of these three afflictions (being underweight, stunting and wasting) is estimated in 139 countries by the WHO (de Onis et al. 2004): In 2004, 20 % of all children under the age of five worldwide coming from middle to low-income families had a weight-for-age score of > -2 SD, indicating that they were underweight. The highest prevalence was in South Asia (33 %) and East Africa (28 %).

A more recent analysis (de Onis et al. 2011), which also included prospective figures, arrived at the following conclusion for the year 2010: 171 million stunted children (167 of them in developing countries). Between 1990 and 2010, the number of children suffering from stunting dropped from 39.7 to 28.7 % and is expected to continue to drop even further to 21.8 % (142 million) by the end of 2012. This has largely to do with the decrease of cases in Asia, which dropped from 190 million to 68 million. In Africa, the numbers have remained more or less unchanged: 40 % of children suffer from stunting, and from 1990 to 2010 the numbers rose from 44 to 60 million and are expected to climb to 65 million by 2020. If one takes children of average stature from the poorest countries and compares them with the stature of sufficiently nourished children or with the WHO standard value for that respective age, the difference in values among children two and half years old lies between six and nine cm (Save the Children Report 2012). If one compares stunting in relation to income in the eight poorest countries, the rate of stunting is twice as high among the poorest families, who earn less than $1/day, as it is among the wealthiest, who earn more than $2/day (Save the Children Report 2012).

Unlike wasting, stunting is a sure sign of an imbalanced diet, which in itself may contain sufficient energy. The most severe symptoms of wasting appear in the first 24 months of an infant's life and then slowly abate, whereas stunting becomes increasingly more prevalent in the first 24 months and then levels off. The damage done cannot be reversed. Put another way: Children who survive wasting thanks to caring intervention have the 'chance' to suffer the effects of stunting for the rest of their lives.

Physical growth which does not correlate to a child's age is the effect of a type of undernourishment which does not entail a lack of sufficient calories. Stunting can result from a shortage of nutrients which are responsible for furthering growth in a child's diet. This means that studies which focus exclusively on quantity, or the number of calories, overlook such children. Undernourishment is always more or less combined with a distinctive form of malnutrition. In cases of stunting, the

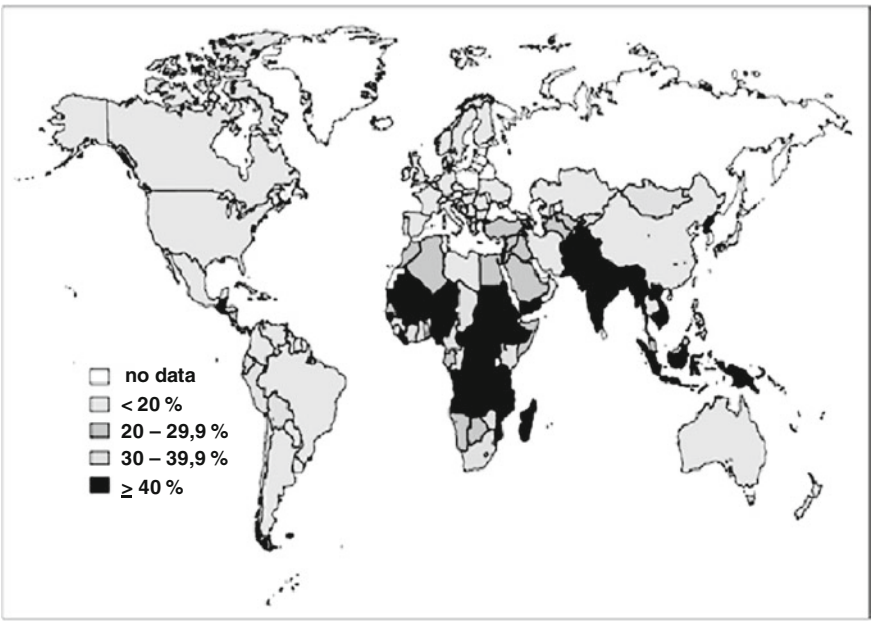

Fig. 1.2 Worldwide prevalence of stunting among children under the age of five. Stunting is by no means a phenomenon only occurring in developing countries. The poorer the country, the higher the rate of stunting among children (Black et al. 2008)

cause can be a case of malnutrition without the aspect of undernourishment. Herein lies the crux of the scandal. The dry statistics compiled by the leading aid organizations hardly include these children. They are overlooked simply because hunger is still defined in terms of available calories and the negative health effects of undernourishment are temporarily 'treated'.

Stunting as a sign of chronic hunger is by no means confined to very poor countries. Stunting and chronic undernourishment related to poverty also occurs in developed economies, albeit not as frequently. The same applies to poverty. Whenever the number of those living in a state of poverty increases, so too does the number of chronically undernourished persons. In effect, the poorer the country and the higher the rate of poverty, the greater the percentage of children affected by stunting. Stunting is a clear and visible signal for a low-quality diet much in the same way that obesity a sign of a high-quantity diet (i.e., a calorie surplus) (see Fig. 1.2).

Why Is a Full Stomach Not Enough?

Food security for the future is understood to be first and foremost the safeguarding of the food supply to ensure that calorie requirements of each individual are met. In 2002, the worldwide availability of calories was 2,804 kcal per person. Barring an increase in crop production and a change in the expected demographic developments, there will only be a maximum of 2,209 kcal per person by 2050.

One must also keep in mind that the basis for calculations regarding the projected availability of calories per person rests upon the fact that, in poorer regions of the world, up to 80 % of calories are obtained from grain (corn, rice, wheat, or cassava). Consequently, the availability of energy depends upon both the crop yields, as well as upon people's ability to obtain these staple foods. Such an increase in production coupled with a perpetuation of the current 'quantity matters' view leads us directly into hidden hunger's trap.

Just how conducive this false premise is to promoting hidden hunger and especially how children can be sufficiently-fed and yet still be undernourished is shown by studies conducted in Africa (Stephenson et al. 2010).

Persons who rely on cassava as their staple food do not receive sufficient amounts of protein or a number of micronutrients. Vitamin C is the only vitamin which is contained in 100 g of cassava to a noteworthy degree (30 mg/100 g), in addition to approximately 10 % of the recommended daily allowances of vitamin B, minerals, and trace elements. There is a complete absence of fat-soluble vitamins, such as vitamins E, D, and A. Children in Kenia and Nigeria, who rely on cassava for 45 % of their daily caloric intake, showed definite signs of not receiving enough protein, zinc, and iodine. The higher the percentage of cassava in a child's daily diet, the more pronounced this deficiency was found to be. Stunting was also more common among children who were 'better' fed with cassava.

A major cause of stunting among children with low-quality diets (i.e., primarily based on cereals with a low amount of micronutrients and a sufficient number of calories) is their increased susceptibility to infections, which, in turn, make micronutrients even more important for the body. What is more, infectious diseases often cause a loss of appetite—something probably everyone has experienced at one time or another.

Exactly how misleading the situation can be when stunting is understood to be a matter of quantity and not quality is shown by a study which followed in the footsteps of large-scale health studies examining the daily consumption of calories, especially in East Africa (2,245–2,618 kcal). The study came to the conclusion that the issue of malnutrition in Africa was overestimated (van Weesenbececk et al. 2009). The fact that the percentage of children in Africa with stunting lies between 30 and 60 %, depending upon the region, is mentioned, yet the underlying reason for this is left unexplained by the authors. This is the problem case in point. An all-clear is given when alarm bells are necessary.

Ethiopia, where the authors arrive at the conclusion that the situation is better than it was believed to be, is a perfect example of this fallacy. There the average daily caloric consumption lies at 2,004 kcal per person. The percentage of individuals that are undernourished in the entire population is 41 %. In other words, 41 % of the population has less than 1,800 kcal a day. Nearly 80 % of the daily diet consists of corn, wheat, teff (a type of millet), millet, and various roots (FAOSTAT 2007). These contain iron and zinc with a bioavailability of less than 10 %, as well as a very low amount (<30 % of the RDA-Recommended Dietary Allowances) of vitamin B (B1, B2, and B6). There is hardly any vitamin A, E, or C, or the various other micronutrients. The average daily consumption of meat and vegetable oil per

day (50 g/day), together with a small portion of vegetables is not enough to effectively compensate for the vitamin and mineral deficiencies.

Such a diet is not sufficient to supply the body with the nutritional elements it requires—not for children and most certainly not for pregnant women! The premise of merely counting calories, which has hitherto been the foundation of food security, leads us in the opposite direction and ignores the real issues.

Malnutrition

A person needs energy-rich food in order to maintain an energy-consuming metabolism, in addition to protein for muscles and organs and also transport proteins for many substances and to strengthen the immune system. Micronutrients are required to make all of the bodily processes possible and keep them functioning in the first place. For that reason, a distinction is made between micronutrients that are energy-supplying (fat, protein, carbohydrates) and those that are not energy-supplying.

According to the WHO, energy should be supplied to the body via micronutrients from the following sources and in the following amount:

- 30 % from fat,
- 15 % from protein,
- 55 % from carbohydrates.

A well-balanced diet containing an appropriate amount of calories should contain all of the necessary micronutrients. An unbalanced diet, however, may lack one or more micronutrients.

Malnutrition cannot necessarily be recognized by looking for typical symptoms, but rather the term describes a diet that is not appropriate for an individual within the context of their respective lifestyle, for example regarding his or her type of work, climate, and genetic factors. As such, malnutrition as a side effect of hunger or an unbalanced diet can be qualitatively classified into two categories:

1. macronutrient deficiencies,
2. micronutrient deficiencies.

Macronutrient Deficiencies This type of malnutrition, known as Protein Energy Malnutrition (PEM), involves a lack of protein and food containing enough calories. This term is applied when hunger is defined in terms of an insufficient intake of calories.

PEM has been referred to in the literature for more than 100 years. The outward appearance of PEM is the typical hungry person as portrayed by the media. Those affected either appear severely undernourished or display symptoms of edema, which are caused by a lack of dietary protein. Depending on the underlying cause, malnutrition is more specifically defined as being kwashiorkor, which is

predominantly caused by a lack of protein, and marasmus, which stems from a lack of both energy and protein.

Kwashiorkor was depicted in the literature in Germany at the turn of the twentieth century as an affliction among children whose diet consisted mainly of grain. It was referred to at that time as *Mehldystrophie*, from the German word for flour *Mehl*. This term already illustrates that an unbalanced diet, in this case only carbohydrates, can lead to deficiencies although energy is being supplied to the body in adequate amounts.

Due to the fact that children can easily appear to be neither hungry nor undernourished thanks to a diet rich in rice, corn, or other cereals that provide both protein and energy, the false conclusion was reached long ago that their diet is sufficient. This form of nutrition, however, as will be explained in the following, is hardly adequate to promote a child's development throughout the different stages.

Micronutrient Deficiency Unlike PEM, persons suffering from this type of deficiency may display no outward signs or symptoms. As long as no significant clinical symptoms appear, no consideration is given to the possibility of a micronutrient deficiency. This begs the question of whether a shortfall of the RDA Recommended dietary allowances pathologically significant is and, if so, how a diagnosis can be made.

Malnutrition as an illness does not mean that it is necessarily accompanied by typical symptoms, as is the case with specific micronutrients (e.g., scurvy when one lacks enough vitamin C or rickets in the case of too little vitamin D) and essential amino acids. Rather micronutrient deficiencies have been observed to cause symptoms that cannot be directly linked back to the deficiency itself, such as a weakening of the immune system and consequent increased susceptibility to illness, physical constraints, mental handicaps, memory loss, or mood swings.

Box 1.2 Adverse effects of malnutrition among children (WHO Expert Meeting in Geneva, March 16, 2012)

- 186 million children under the age of five (30 % of all children in this age group) suffer from stunting.
- 115 million children under the age of five suffer from wasting.
- 20 million children suffer severe and life-threatening malnutrition.
- 3.9 million children (35 % of all fatalities) die from a lack of breast milk (or from breast milk with not enough nutrients), as well as from a micronutrient deficiency, most especially vitamin A, iron, iodine, and zinc.
- In many countries, a child's diet after weaning (generally 6 months after birth) is not sufficient to provide it with the quality it needs for the first 2 years of its life.

Among undernourished children (see Box 1.2), some calculations put the number of children so undernourished that small changes in their food supply could be deadly at 10 %. That, however, is only the tip of the iceberg! Those children who survive are joined by others in the same situation. The tip of the iceberg remains visible, the great mass still lies hidden, as hidden as the danger itself, the hidden hunger which is the persisting cause of so many problems and which remains largely unchallenged. There is still too little which is understood about the problem and that the purpose of food is not only to fill up a person's belly. To say that full is the opposite of hungry is an enormous oversimplification.

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Hidden Hunger

2

A country road west of Kathmandu. Our bus broke down, a replacement should arrive sometime or another. A small group of aid workers, dieticians and agricultural experts is standing around and looking at the Dhaulagiri basked in the light of the setting sun. It will be getting cold soon, very soon and we start to wonder where we can find 'shelter' until our replacement vehicle gets here. We find ourselves among small fields with trees, if they can still be called that, lining the outer perimeters. Mostly, they are just a bare trunk without any branches except for a green cap at the very top from what was spared. The branches were all cut off to be used as firewood and now rise in smoke form from the reddish brown huts, which stand like tiny molehills in the smoky fields. At the side of the road, in front of one such hut a wispy man is standing and silently beckons us to come in by opening the door. The smell of soot and animals permeates the semidarkness of the inside of the hut. The man sets glasses down onto a wooden table and invites us to drink some tea. Tucked away in the background, a young woman stands in front of the soot-churning stove along with three children who smile as, full of curiosity, they inch their way toward us.

A boy, probably 10-years old, holds the hand of a girl as they approach. She appears slender and small, but in no obvious way undernourished. She looks up and smiles. Her eyes are strikingly expressionless and milky white. Prinuma, that is her name, is blind. On top of that, she is also deaf. Her situation could have been avoided had her mother received enough iodine and vitamin A during pregnancy. Iodine would have prevented the deafness she was born with, just as vitamin A would have protected her against blindness which occurs after birth and in a child's first few years if it is lacking. Prinuma must stay at home when her brother is at school. She relies on him to be her eyes whenever she leaves the house. And so she has no opportunity to develop and her brother has no possibility to help his father in the fields. Prinuma is one of the countless typical victims of hidden hunger.

Prinuma is not hungry in the sense which we know and experience. The bowl of rice and sometimes green leaves steamed in oil which she eats is enough to satisfy

H. K. Biesalski, *Hidden Hunger*, DOI: 10.1007/978-3-642-33950-9_2,

her hunger. However, it is a kind of red herring which diverts us from the real problem of undernourishment or malnutrition.

Nicholas Kristof, two-time Pulitzer prize-winner and columnist for the *New York Times*, describes hidden hunger in Guinea-Bissau:

> The most heartbreaking thing about starving children is their equanimity. They don't cry. They do not smile. They do not move. They do not show a flicker of fear, pain or interest. Tiny, wizened zombies, they shut down all nonessential operations to employ every last calorie to stay alive.

The World Bank, according to Kristof, has calculated that the financial crisis of 2008 has led to undernourishment, whereby a further 44 million children will be permanently stunted in their physical and mental development. The results of the economic crisis in 2011 will hardly be any different.

In Kristof's view, one of the biggest misconceptions of western nations is the assumption that malnutrition is another word for having too little to eat. Most of the time, malnutrition is analogous to a lack of iron, zinc, vitamin A, and iodine and one of the most effective strategies for eradicating poverty is a head-on fight against hidden hunger.

The image of the emaciated and starving child is not representative of the entire issue at large, according to Shawn Baker of the Helen Keller Foundation. Behind every starving child, there are ten others who are not visibly hungry, but who suffer from malnutrition and thus from hidden hunger. An iron deficiency shows no visible symptoms and yet 42 % of pregnant women worldwide and 83 % of children under 5 years in Guinea-Bissau suffer from it.

Dimensions of Hidden Hunger

The human body extracts 51 different essential compounds from food which it cannot produce itself through metabolism. Among these, as far as well currently know, are amino acids, as well as 19 so-called micronutrients (vitamins, trace elements, and minerals), which exert a direct influence on physical and mental development, the immune system, and are vital to the body's metabolic processes. To date, it is only known what effects the lack of a certain few micronutrients have on the body by means of clinical symptoms, such as scurvy (due to a lack of vitamin C), rickets (caused by a vitamin D deficiency), beriberi (triggered by too little vitamin B), and pellagra (resulting from a niacin deficiency). This naturally does not exclude the possibility that the micronutrients which have hitherto been the object of less analysis, also have a major impact on our susceptibility to certain illnesses or the onset of such ailments later in life. Hidden hunger is mostly described in terms of a lack of vitamin A, iron, zinc, and iodine simply due to the fact that a deficiency of any of the these micronutrients can lead to visible, clinical symptoms which affect the most people worldwide.

When signs of a deficiency appear, this does not necessarily mean that only one micronutrient is lacking. The probability is actually high that others are lacking as well. Ultimately, we can only understand the lack of the above-mentioned micronutrients as being symptomatic of an absence of certain foods in one's diet. To make matters worse, nutrients are mostly activated in connection with other nutrients. An absence or an insufficient amount of a certain micronutrient is seldom not inconsequential to a metabolic process which is regulated by another micronutrient. In such cases, the corresponding clinical symptoms are easily overlooked.

The Key Players in Hidden Hunger

Focusing more closely in the following section on the key micronutrients involved in hidden hunger, namely vitamin A, zinc, iron, and iodine, does not exclude the possibility that there may exist other deficits, as well. Rather these key substances have been more intensively examined for many years and their role in hidden hunger is, as a result, better known. It should not be of any surprise if the cast of key players grows in the next few years when other micronutrients are added to the roster. There are already few candidates waiting in the wings, such as folic acid, vitamin D, and vitamin B12.

Classical vitamin research initially began with the observation that a certain diet could help to heal somewhat 'mysterious' illnesses, as well as trigger them. The ancient Egyptians described how to treat nyctalopia (night blindness) by eating raw liver in the Ebers Papyrus, the lengthiest still-intact medical papyrus roll dated 1,700 BC. Nyctalopia is caused by a vitamin A deficiency and liver is the best source of vitamin A. There are also countless descriptions of scurvy and how to treat it. Most of these were of no use until the connection was made between preventing scurvy with citrus fruits and sauerkraut, both of which are rich in vitamin C. The discovery of vitamin B12 saved the lives of many people who had been struck by the deadly illness pernicious anemia (Addison's anemia) caused by a vitamin B12 deficit. The discovery of other vitamins and their chemical composition made the causal treatment of illnesses, such as beriberi, pellagra, rickets, and cretinism, which had plagued humanity for centuries possible and were, in effect, signs of a micronutrient deficiency. From that point onwards, vitamins and other micronutrients became more valued for their medicinal properties.

Accompanying this discovery was the misconception, however, that vitamins should first be taken when clinical symptoms of a deficiency appear. This notion has survived to the present day. It is certainly not a fully false conclusion from an empirical-medical point of view. Modern nutritional science, on the other hand, must pursue the question of whether a nutritional deficiency carries with it adverse health effects and, if so, which ones in particular.

Once again to emphasize, hidden hunger may do its damage without any clinical symptoms or visible signs of illness. It is a situation whereby the body does not receive the micronutrients which it requires, as prescribed by

internationally recognized recommended daily allowances. The RDA of a particular micronutrient is based upon the amount of that micronutrient which a healthy person needs so that a vitamin deficiency is prevented. A so-called safety margin is calculated into the RDA to provide for those individual who require higher amounts for various reasons, such as their personal situation, workload, and genetic factors. Whoever consumes their RDA on a regular basis should have no need to worry about their intake of micronutrients. As far as we currently know, temporarily falling short of the recommended daily allowances does not carry with it any adverse health effects.

If a person does not fulfill their recommended daily allowances over a longer time period (i.e. weeks or months), this could result in a deficiency and lead to health issues sooner or later, depending upon the vitamin in question. It can take weeks or even months before the first clinical symptoms of a deficiency begin to appear. Depending upon the amount of shortfall, symptoms may not even appear at all. The on-going bodily changes which are not observed, however, are responsible for many of the damaging effects of malnourishment. Some examples include common infectious and parasitic diseases, and not least of all the high mortality rate among infants and mothers in developing countries. That is why it is both challenging yet vital to recognize cases of malnutrition as early as possible. Yet, the 'early warning systems' which are currently in place fail due to the fact that the human organism tries to compensate for deficiencies by redirecting certain micronutrients away from certain organs and into the bloodstream and to other organs in an attempt to keep levels constant. Thus, the deficiency is simply displaced. Early biochemical proof of a deficiency without the typical clinical symptoms is only possible with a very few micronutrients. The same applies to early clinical signs of a deficiency, since these are generally atypical and rarely lead to speculation that a micronutrient deficiency might be the underlying cause.

Vitamin D is currently the best example. We have fairly recently discovered that it is not the so-called active metabolite (1,25(OH)D3) which gives us an accurate picture of a person's vitamin D level, but rather the inactive, unhydroxilated form of vitamin D3 known as calcifediol (25(OH)D3). This inactive form must first be 'activated' in the kidneys and can then help to keep the skeletal system healthy. We now also know that this activation process can take place not only in the kidneys, but in other tissues as well. Thus, measuring the inactive form of vitamin D3 in the bloodstream is an important indicator of the supply of the vitamin to other tissues. According to intensive studies, if low amounts are detected in the blood, then there is a higher risk of illness and disease, including colorectal cancer, respiratory disease, bone disease (leading to falls), as well as pain in the muscles and joints in later years (Bischoff-Ferrari et al. 2010). These ailments are caused by a lack of the inactive form and ultimately the active form in the various tissues, not only in the bones, but also in the muscles, the mucous membrane, and the immune system. This link was only first discovered a few years ago.

Vitamin D is either absorbed by the body when we eat fish containing lots of fat (the only known source in fact), or it is produced in the skin from an inactive form with the help of sunlight. Persons living in regions with low amounts of sunlight, for instance those located in higher latitudes, are known to have critically low levels of vitamin D in their blood. Even in Germany, during the winter months, up to 50 % of the population share the same condition due to the reduced hours of sunlight. The German Society for Nutrition (*Deutsche Gesellschaft für Ernährung*/DGE) has recommended raising the recommended daily allowance from 5 to 20 µg/day as a result. Years ago, 5 µg/day was fixed as the recommended daily allowance since that amount is sufficient for preventing rickets. Nevertheless, this is not enough to avoid the epidemic diseases which have been the object of much study, but have hitherto failed to be linked to malnutrition. Also with regards to vitamin C, the RDA included a safety margin. This explains why children in Germany who only receive 50 % of the RDA of 5 µg do not show any symptoms of rickets. What developmental repercussions this will have for children who do not eat fish or are seldom outdoors, and thus do not synthesize vitamin D in the skin is still unknown because it has not yet been examined.

The adverse effects of hidden hunger involving a lack of vital micronutrients, especially in developing countries, have been more intensively studied by comparison. A better understanding of the biochemical properties of the individual micronutrients can help make the consequences of a deficiency more obvious before typical symptoms appear and to help explain these symptoms once they have developed (see Table 2.1).

Vitamin A

The Functions of Vitamin A

Like all other vitamins, vitamin A is an essential nutrient. Vitamin A is actually a group of substances, each of which affects and influences the body in a different manner. After vitamin A arrives in the intestines along with the food which once contained it, it is wrapped in fat particles (chylomicrons) and then transported to the liver. Because vitamin A is a rather seldom nutrient, the most common source in the food chain being liver, our human liver creates reserves designed to last in

Table 2.1 Occurrence of hidden hunger (WHO/FAO 2010)

Deficiency	Affected persons	Symptoms relating to a severe deficiency
Iron	Approximately 2 billion	Anemia
Zinc	Approximately 1 billion	Skin lesions/diarrhea
Vitamin A	Approximately 200 million	Blindness
Iodine	Approximately 750 million	Goiter/cretinism

most cases for 3–9 months, depending upon the amount stored up. When the need for vitamin A increases, for instance in cases of pregnancy, lactation, or infectious disease, the time period naturally is shortened. A lack of vitamin A in one's diet over a longer period does not necessarily lead to adverse health effects, as long as there are still some reserves in the liver. If the reserves in the liver are depleted over a longer time, however, then a vitamin a deficiency comes creeping up, at first without any typical clinical symptoms, but with adverse effects on one's health nonetheless. Vitamin A binds itself as retinol to protein particles RBP in the liver and distributed in controlled amounts to the bloodstream. It is extracted by various cells from the blood and, once inside the cells, starts to go to work.

It is a fairly well-known fact that vitamin A is important for the eyes. But in fact, it is only used to help the eyes distinguish between light and darkness. In a narrow sense, a minimum amount of eyesight would be possible without any vitamin A. However, there are a number of other important bodily functions which absolutely require the help of vitamin A, such as the regulation of healthy mucous membrane (e.g. in the lining of the intestines, the lungs, and the sinuses) and many tasks performed by the immune system Biesalski and Nohr (2004). We also need the active metabolite of the vitamin, the retinoic acid, which is formed within the cells to help produce neurotransmitters and protein compounds.

Box 2.1 An important duo: vitamin D and vitamin A

Like vitamin D, vitamin A is actually closer to being a hormone than a typical vitamin because of how it works. Both vitamins direct, in many cases jointly, the formation of protein compounds in the genes which are responsible for the growth and development of a wide range of cell types. This includes the cells of the immune system and, most especially, the mucous membrane lining of the respiratory tract, which acts as a barrier against microorganisms and thus protects the lungs against infection. The metabolite with the primary role in this process is retinoic acid. It is not contained in food, but rather small amounts of it are formed from vitamin A step-by-step in the cells by means of a highly regulated biochemical process. The retinoic acid in its chemical all-*trans* or 9-*cis* form is the key (ligand) for protein compounds which, after they have combined with retinoic acid, can read the genetic code and set protein synthesis in motion.

How Much Vitamin A Does One Need?

There is an inherent discrepancy which exists between the recommended daily allowance of a particular vitamin and an individual's personal requirements. The daily allowance is calculated according to how much of that vitamin or other essential nutrient is needed in order to alleviate the clinical symptoms of a deficiency. A person's own individual requirements may deviate from this amount, which is actually merely an average value for a certain population, depending upon certain factors, such as age, sex, current state of health, body weight, genetics, and other variables. This estimated average requirement (EAR) is sufficient for 50 %

of persons in a healthy population. The recommended daily allowance contains the EAR plus two standard deviations and should therefore be enough for the needs of 98 % of a healthy population. Essentially, these calculations are nothing more than educated guesses based upon the average needs of a healthy population base. Deviations from the mean caused by such factor as mentioned above are not accounted for.

The special quality of vitamin A is its ability to be stored by the liver. Together with vitamin B12, it is the only vitamin which can be stored in the liver over a longer time period. From the liver, both vitamins are then evenly secreted into the bloodstream. Depending upon how one's individual needs may have varied during the past few years, the liver should be more or less full. Since a drop in vitamin A in the bloodstream only happens a few days prior to the liver becoming empty, it is extremely difficult to measure how full of vitamin A the liver actually is. Ultimately, this means that the liver can only be guaranteed to be full enough of vitamin A for a period of several months when small amounts (adults 1 mg/day, children 0.2–0.8 mg/day depending on age) are regularly taken in one's diet.

Sources of Vitamin A

Pure vitamin A is only found as so-called vitamin A ester (retinol ester, esterified with fatty acid) in meat and animal products (see Table 2.2). Many people who find animal products too expensive to purchase, or choose not to eat them for other reasons, do not receive enough vitamin A. Retinol is synthesized from the breakdown of β-carotene, which is found only in plants and is a relatively poor source of vitamin A, apart from a few exceptions.

It is easy to see why it is problematic or even impossible for low-income households to get enough vitamin A. Although the RDA of 0.2 mg for children does not seem to be all that much, in fact it could be met by eating just a small bit of liver once a week, or even every two weeks, it is still out of reach for many poor families.

Clearly the missing sources of vitamin A, liver and eggs, in one's diet are responsible for the deficits, or even severe deficiencies of the vitamin, which go hand in hand with a lack of protein, themselves essential biochemical building blocks, as well. When protein is lacking, adequate amounts of the carrier protein for vitamin A (RBP) cannot be formed by the liver. As a result, the vitamin

Table 2.2 Amounts of vitamin A in different foods (average per 100 g)

Liver	2–10 mg
Chicken liver	1–5 mg
Beef	0–0.2 mg
Butter	0.2–0.5 mg
Milk	0–0.1 mg
Egg yolk	0.3–0.5 mg
Fish	0.1–0.3 mg

remains in the liver and does not find its way to the tissue where it is needed rendering the stores of vitamin A useless. Infectious diseases can also have a negative impact on the body's supply of vitamin A and carrier proteins since the former is needed in higher quantities, while the latter is cleared out the blood more intensively by the kidneys.

Vitamin A Deficiency and Its Effects

If the amount of vitamin A taken is not appropriate to one's needs over a longer time period, the level of retinol in the blood drops, despite the fact that levels in the blood had been consistent during much of the shortfall. The WHO therefore determined the minimum level of retinol in the blood to be 0.7 μmol/l, anything below that potentially leading to clinical symptoms of deficiency. Normally, children have a fairly constant level somewhere between 1.0 and 1.5 μmol/l. Among adults, the level is generally around 2–3 μmol/l. The absolute blood value at any particular time is therefore no indicator of an individual's general retinol level. This must be measured instead over a certain time period.

It is only when the reserves in the liver have been depleted that the typical symptoms of a vitamin A deficiency begin to appear (see Fig. 2.1 and Table 2.3). The first sign is night blindness, which for many children is hardly perceived as being disturbing. After a while, however, small white spots start to appear on the surface of the cornea, a first sign of xerophthalmia. These spots contain malformed

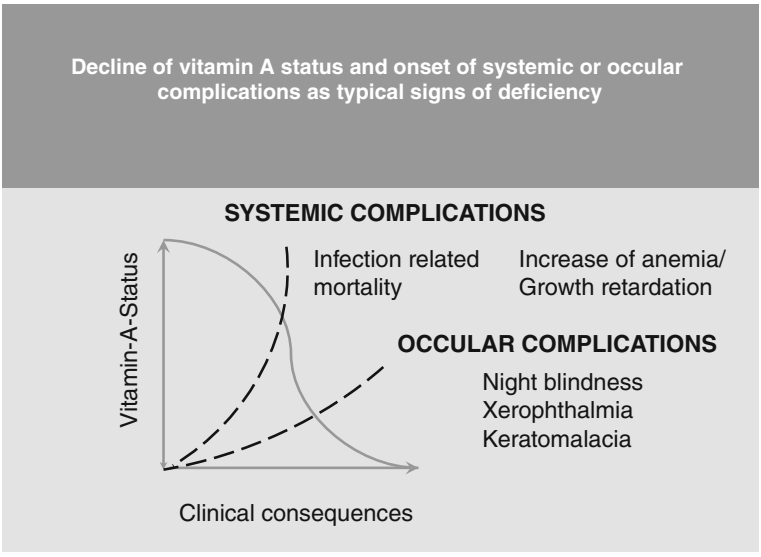

Fig. 2.1 Vitamin A can perform all of its necessary functions, provided the amount is sufficient. Once the liver's supplies start becoming depleted, so-called systemic effects begin to take hold. Visible symptoms affecting the eyes appear only when the vitamin A reserves become substantially depleted (modified according to Sommer 1997)

Table 2.3 Occurrence of clinical vitamin A deficiency symptoms

Xerophthalmia	3–4 million children
Blindness	0.5–1 million children
Night blindness	3–6 million mothers
Preventable deaths	1.5–3.5 million

cells since vitamin A is responsible for cell development and it is not available. These defunct cells, known as the squamous epithelium, form small cavities in which bacteria can collect and dry out the cornea. The next stage is xerophthalmia or inflammation around the eyes, and if left untreated it may be followed by an ulcer-related loss of vision (keratomalacia).

Up to half a million children go blind every year before they reach their second birthday (WHO 2004). Early preventative measures, even as simple as providing vitamin A supplements, would be enough to prevent this from happening. A total of 14 million children suffer from a loss of vision leading eventually to total blindness—often times in one eye first and later in the other eye.

This sad situation has even further social implications. Provided the child survives at all, it will always need an accompanying person. The quality of life for these children in a world of poverty and hunger has sunken to the lowest possible depths imaginable. The situation with preventable blindness is further complicated by difficulties arising when vitamin supplements are distributed, as well as by skepticism on the part of mothers who do not believe that such pills can actually work based on negative experiences in the past. Some children swallowed the pills the wrong way and others had diarrhea at the time making it impossible for the vitamin A to be absorbed, and thus to be of any benefit. Curious forms of superstition have also been known to present an obstacle to a child's receiving supplements. In a province in Ethiopia, the supplement program failed because young boys who went blind were believed to be punished by the spirits of the forest and the wind for once having "peed into a rainbow".

If there are clinical symptoms of a vitamin A deficiency, it is possible to prevent blindness by means of vitamin A supplements. Yet, one must not fool oneself into thinking that the actual problem can be solved with a one-off dose of vitamin A supplements. It is a diet lacking in vitamin A which caused the deficiency in the first place. Foods containing vitamin A also contain a plethora of other micronutrients which are, in such cases, not being supplied to the body either. The absence of clinical symptoms also does not under any circumstances guarantee that a person is not suffering from a deficiency, particularly in the case of vitamin A.

When vitamin A-rich animal products are missing from one's diet or are consumed rather seldom, the deficiency which occurs normally cannot be compensated for by eating provitamin A-rich foods, such as mangoes, carrots, and palm oil. Besides which, these items are more luxury goods than affordable foodstuffs for most poor families. According to calculations made by the WHO (2003), 30–50 % of children in developing countries have a vitamin A deficiency, most of them without any visible clinical symptoms.

The 'mild' case of a vitamin A deficiency which might not show itself needs to be distinguished from the severe case whereby the symptoms are obvious and typical. Less people are affected by the latter problem than by the former. In regions which have a higher population of children with (night) blindness, it must be assumed that the general population itself suffers from a vitamin A deficiency which does not reveal itself through a high frequency of clinical symptoms.

A mild vitamin A deficiency is a hidden danger lurking in hidden hunger. In this case, what you do not know can harm you severely. This is a contributing factor to the high mortality rate worldwide. Children with a vitamin A deficiency are especially susceptible to death caused by an infection of the respiratory system. Since the mucous membrane lining is underdeveloped and does not function properly, the barrier to protect and clean the tract is gone. This paves the way for bacteria to settle on the lining and exacerbate respiratory diseases (Biesalski and Nohr 2003). A susceptibility to anemia also has been observed to accompany a vitamin A deficiency, and is therefore not exclusively the result of a lack of iron. Just giving vitamin A supplements to children can prevent infections, and hence reduce the child mortality rate by as much as 50 % (Sommer 1997).

Pregnant women who do not have a proper diet, usually eating primarily cereal products containing neither vitamin A nor provitamin A and only a small amount of zinc, cannot supply the micronutrients needed by the fetus from their own tiny reserves. As a result, children born of these women have very small vitamin A reserves at birth, especially when their siblings were born within a relative short time frame. Similarly, the composition of the mother's breast milk, i.e. its concentration of vitamin A, iodine, and vitamins B1, B2, B6, and B12) depends upon her diet. Therefore, a newborn infant cannot make up for the micronutrients it is lacking by drinking breast milk if the mother herself is malnourished. Expectant mothers who are thought to suffer from a vitamin deficiency or have given birth multiple times within a relatively short time span should be given vitamin-rich food or the respective vitamin supplements or fortified foods without delay. The rule applies here too that vitamin A on its own can be effective. However, in combination with other micronutrients it is certainly even more potent.

Hampered lung development and neonatal vitamin A deficiency cause children to become more prone to infectious diseases, even during their first few months. Children born with marginal vitamin A reserves are much more likely than children born with ample reserves to die from diarrhea (50 % more likely) or from measles (40 % more likely) before the age of five (Beaton et al. 1993). However, if these children are given vitamin A during their first 6 months, the mortality rate drops by more than 50 % according to some studies (Humphrey and Rice 2000). Remarkably, getting enough vitamin A also has an impact on the child's later development. According to the latest findings, children born of mothers who took vitamin A during pregnancy have significantly healthier respiratory system during their first 12 years (West and Mehra 2010). Foremost attention must be given to ensuring that expectant mothers get all the vitamin A that they need. That way, the fatal vicious circle of vitamin A deficiency can finally be broken.

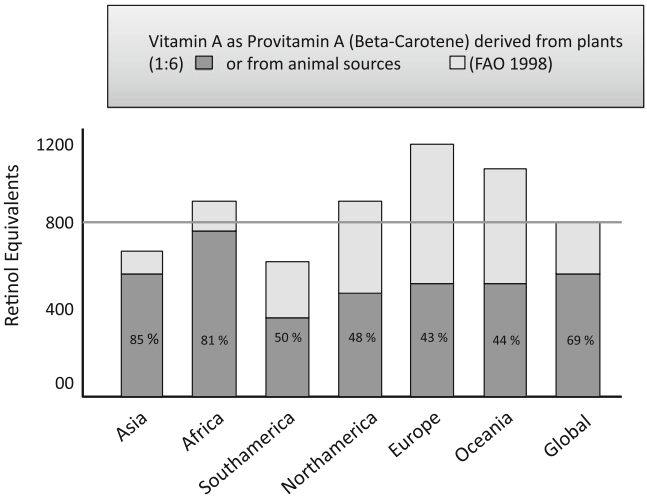

Fig. 2.2 Daily vitamin A sources: plant-derived versus animal-derived. The calculation of RE from plant-derived provitamin A rests upon the conversion factor (1:6). If the more realistic factor of 1:12 is used, the dank gray bars are cut in half (FAOSTAT.fao.org 1998)

The ProVitamin A Problem

Vitamin A is a unique member of the micronutrient family. The special feature of vitamin A is that it can be produced within the body using β-carotene. This 'home-made' vitamin A substance is referred to as provitamin A. β-carotene, which is split up and can be processed by our metabolism, is found exclusively in plants. In developing countries, 80 % of the population's supply of vitamin A comes from foodstuffs containing β-carotene (see Fig. 2.2).

In order to reach the RDA for vitamin A, children must take 3 mg of β-carotene with their food, adults twice that amount. How does this process happen? To understand the transformation of provitamin A into vitamin A, studies of the metabolism were conducted more than 30 years ago which showed that 6 mg of β-carotene consumed produced 1 mg of vitamin A. The amount of provitamin A being metabolized is measured in retinol equivalents (RE). It was assumed at the time that the conversion rate of vitamin A from β-carotene was 1:6 (i.e. 1 mg of retinol was produced from 6 mg of β-carotene). Therefore, 6 mg of β-carotene became the equivalent of 1 RE. Although we know nowadays that the conversion rate is much lower (1:12 and even lower according to some studies) (Grune et al. 2010), the historical ratio of 1:6 has been kept. If this outdated information is used to assess whether or not a person receives enough vitamin A, it can lead to a false conclusion and a false sense of security.

Children in countries with a low GDP rely mainly on provitamin A-rich fruits and vegetables for their vitamins, including mangoes, pumpkins, carrots, and a limited number of green leafy vegetables. Sources of preformed vitamin A are either rare, completely unavailable, or are rejected for a variety of reasons.

Figure 2.2 illustrates clearly the different animal and plant-based vitamin A sources worldwide and, likewise, documents the inadequate sources of vitamin A in countries in Asia, Africa, and South America. Once again, the RE conversion rate of 1:6 was used for this assessment. Using the 6:1 conversion rate for RE, it becomes clear that the RDA for vitamin A can hardly be achieved by relying on foods containing provitamin A (see Table 2.4). However, if we apply the more up-to-date and universally accepted 12:1 rate of β-carotene to vitamin A, the only way to ensure that people living in developing countries receive enough vitamin A would be to increase their consumption of animal-based foods. Since this is highly problematic many families, other methods must be sought, such as β-carotene-enriched foods, in order to ensure that people living in poorer countries met the RDA of vitamin A.

Persons whose main source of vitamin A is fruits and vegetables would need to eat at least 100 g of the varieties listed in Table 2.4. Certain taboos, however, can make this a case of easier said than done. Mangoes, for example, are considered in many regions in Africa to be food for apes. The idea of a person eating one is a comical one for the inhabitants, who therefore refuse to eat them. Offering one to somebody as food would also cause great laughter. In other regions where mangoes are accepted as food for humans, they are often only available during certain seasons. Thus, an important source of vitamin A can only be eaten a few months in the year.

Moreover, the prices for staple foods (rice, wheat) also play a big part in the context of vitamin A since the ability of most poor families to purchase fruit and vegetables depends upon how much money is left in the budget after the basics have been bought. A study conducted in Indonesia strikingly illustrates what impact the diet of a family as a whole has upon the progression of a vitamin A deficiency. The study involved analyzing the eating habits of 43,000 families and documenting the occurrence of night blindness resulting from a vitamin A deficiency within the same group. How much the families spent in various categories, such as fruits and vegetables, meat and eggs, and grain (primarily rice) and nongrain-based foodstuffs was recorded on a weekly basis. A trend then started to become visible: The higher the family's total food bill, the lower the occurrence of night blindness. The same was true for fruits and vegetables, meat, eggs and non-

Table 2.4 Amounts of vitamin A in different foods (average per 100 g)

Food	Amount (mg)	RE (6:1)
Green leafy vegetables	1–5	166–833
Carrot	3–6	500–1,000
Squash	2–5	333–1,000
Mango	0.5–10	83–1,666
Spinach	1–3	166–500
Sweet potato	0–6	0–1,000

grain foodstuffs. However, if the expenditure for grain-based foodstuffs rose at the expense of fruits and vegetables, and especially meat, there was a marked increase in night blindness among the women in the family (from 34 to 141). The results of this study clearly illustrate that a severe vitamin A deficiency accompanied by clinical symptoms can only be prevented by means of a diet which includes both provitamin A from vegetable sources and vitamin A from animal-based products (Campbell et al. 2009).

Conclusion

Vitamin A is necessary for healthy development and the appropriate amount of it must be taken throughout pregnancy and childhood. Sources of preformed vitamin A, being more expensive, are hardly available to the inhabitants of poorer countries. Although provitamin A can be obtained from a number of sources (mangoes, squash etc.), misconceptions and/or financial hardships prevent these sources from being utilized on more than just a seasonal basis, if at all. Possibilities to 'expose' an inchoate vitamin A deficiency have not been possible due to insufficient analytical methods. Pregnant women and small infants are especially at risk of suffering adverse effects related to a vitamin A deficiency.

Zinc

Functions of Zinc

Zinc is needed by the body for various metabolic processes and to build body substances. The human body itself contains around 3 g of zinc, 90–95 % of which can be found in the muscles and the bones. A range of other organs also store up small amounts of zinc as temporary reserves, regardless of the amount zinc in one's diet.

Zinc is quickly extracted from the food we eat, absorbed by the intestines, and then stored in the liver. It combines with a transport protein and is then released into the bloodstream. If less zinc is consumed, the percentage of zinc extracted can be increased by the body. In addition, cells in the small intestines which release the zinc they have when they die can then be reabsorbed by the body. Similar to vitamin A, the concentration of zinc in the blood can be regulated homeostatically, meaning that the level is kept constant preventing an analysis of how much zinc is present in one's cell tissue or in one's diet.

Zinc is particularly important for the immune system, which it supports in a variety of ways. It is also essential for maintaining the body's two important protective barriers: mucous membrane and the skin. Similarly, zinc enhances the skin's own healing ability.

How Much Zinc Does One Need?

As with other micronutrients, it is hardly possible to calculate how much zinc a particular individual needs. Children in different age groups need to have different

amounts of zinc in or with their food. The recommended spread is: 2 mg/day for the first 6 months, 3 mg/day for children 6 months to 2 years old, 5 mg/day for 2–8 year-olds and 11 mg/day for children 8–18 years old. These amounts can vary, both up and down, from country to country.

Sources of Zinc

With the exception of oysters, which contain 86 mg/100 g, there are no ideal sources of zinc. Meat and animal-based products all contain widely varying concentrations of zinc (see Table 2.5). 100 g of liver or lamb contain 5–6 mg of zinc.

It is just about possible to reach 10 mg of zinc a day, if one eats a well-balanced diet containing, for instance a variety of the foods listed in Table 2.5. To eat a well-balanced diet, however, requires the financial means to do so. The animal-based foodstuffs are an important source of zinc since their bioavailability is higher than plant-based sources, with the exception of nuts. This means that grain and cereal products, especially soybean meal, are important as secondary sources of zinc.

Zinc Deficiency and Its Effects

Due to the fact that zinc is involved in a number of metabolic processes, it is extremely difficult to recognize early symptoms of a zinc deficiency (see Table 2.6). The early stage of a zinc deficiency is characterized, among other signs, by a decrease in the number of lymphocytes, which are an essential part of

Table 2.5 Amounts of zinc (mg) in different foods (average per 100 g)

Fruit	0.5
Oil and fat	0.5
Vegetables	1.0
Nuts	2–3
Soybean meal	5–6
Miso/tofu	<1.0
Corn	1–3
Lentils	1–3
Millet	0.5–2
Cereal products	1–5
Meat and sausage	1–6
Fish	1–2
Cheese	2–4
Eggs	1–1.5
Dairy products	<0.5

Table 2.6 Clinical symptoms of an advanced zinc deficiency

Symptoms	High-risk groups
Stunting, delayed puberty, diarrhea, loss of hair, cankerous oral mucosa, alteration of the nails, and weakened immune system	Pregnant and nursing women, vegans, persons with digestive disorders (e.g. resulting from a parasitic disease)

the immune system. These so-called T cells and B cells are the immune system's first line of defense and are responsible for inactivating foreign particles as quickly as possible and for saving a 'copy' of the inactivation process in the immune system's memory banks. Because a zinc deficiency often goes hand in hand with a lack of vitamin A, the immunologically vital mucous membrane lining of both the respiratory tract and the complete digestive system is further weakened.

Very similar to vitamin A, a difference in the concentration of zinc in the blood and the start of a deficiency only becomes noticeable once the reserves have largely been depleted. To analyze other tissue for traces of zinc, say hair follicles, would not yield any conclusive results. When a person is in a constant state of hunger, the concentration of zinc in the blood actually increases since it is released from atrophied muscles back into the bloodstream. Despite the inconclusiveness of the results obtained, blood samples from large populations of people are taken, analyzed, and compared in order to give a picture, albeit a rather fuzzy one, of whether or not these groups are getting the amount of zinc they require.

Zinc deficiency resulting from malnutrition is a leading contributor to illness worldwide and is directly responsible for the deaths of 2 million people each year (WHO 2002). The difficulty in assessing zinc levels in the blood lies partly in the body's ability to regulate the amount as mentioned above, and also in the differences in bioavailability of various foods.

As in the case of vitamin A, a small child will not receive an adequate amount of zinc if the mother suffers from a poor supply of zinc herself. Zinc can easily be extracted from the breast milk; however, the amount contained in the milk decreases dramatically after approximately 6 months. Therefore, mothers need to have sufficient amounts of zinc during pregnancy to give their unborn children a secure starting position.

If a child's diet consists mainly of wheat and cereal products after weaning and contains no animal products whatsoever, his or her zinc supply will become critical. The recommended daily zinc allowance of 12 mg/day for pregnant women is hardly feasible in poorer countries at the moment. As described earlier in the case of vitamin A, a vicious circle begins. The vortex of malnutrition pulls mother and child inside, one generation after the next.

Globally, the prevalence of zinc deficiency among children under the age of five is estimated at 31 %. In South Asia, it is believed to be 80 % (IZiNCG 2006; Table 2.7).

Table 2.7 Zinc deficiency among children under age five (disease control priorities in developing countries 2006)

Region	Prevalence (%)	Deaths (in 1,000)
East Asia/Pacific	7	15
Eastern Europe and Central Asia	10	4
Latin America and the Caribbean	33	15
Middle East and North Africa	46	94
South Asia	79	252
Sub-Saharan Africa	50	400

Children with a zinc deficiency often suffer from uncontrollable diarrhea, pneumonia, and increased susceptibility to malaria. Even a moderate zinc deficiency is enough to promote infection, especially in the intestines. Diarrhea inhibits the proper absorption of micronutrients, which further exacerbates the situation faced by these children. The mortality rate of children suffering from a zinc deficiency is 20 % higher in cases of diarrhea, 25 % higher in cases of pneumonia and 60 % in cases of malaria compared with children who get enough zinc (Black et al. 2008). More children die from severe diarrhea than from malaria, tuberculosis, and HIV combined. A total of 1.9 million deaths are counted each year. Most of these deaths could have been prevented, had the children received enough zinc in their diets to boost their immune systems. Numerous clinical studies have revealed that providing zinc supplements can reduce the intensity and duration of severe diarrhea by 25–30 %, as well as the occurrence and severity of infections to the respiratory system by 45 % (Dinghri et al. 2009; Shankar and Prasad 1998). The noteworthy observation was also made that receiving zinc supplements can also help reduce the rate of malaria by 35 %.

Another valuable facet of zinc can be noted during early childhood development. Stunting is an early sign of zinc deficiency in a child's first 2 years. For this reason, zinc deficiency alone is believed to be a cause for developmental disorders which occur during early childhood (Cole and Lifshitz 2008). A meta-analysis of 36 studies which examined the effects of zinc supplements on stunting among children under the age of five showed that zinc did indeed have a positive effect on promoting growth (Imdad and Bhutta 2011).

Conclusion

The many beneficial effects which zinc has on the immune system explain the severe consequences of a zinc deficiency. Diarrhea caused by zinc deficiency reduces the amount of nutrients absorbed during digestion and increases the risk of further deficiencies.

Iron

Functions of Iron

Iron is primarily responsible for the transport and distribution of oxygen in the body. Oxygen which is inhaled by the lungs is bound to iron atoms in the hemoglobin in the red blood cells. After it separates from the iron atom, oxygen ultimately reaches the organs and tissues of the body via the bloodstream in the tissue. If not enough iron is available, the cells and tissues of the body do not receive enough oxygen, which has serious consequences for their ability for function properly. Iron also plays an important role in a number of metabolic processes which involve oxidation and reduction.

How Much Iron Does One Need?

Children in their first year should take 11 mg per day. The RDA for boys aged 1–17 is 8 mg per day and for girls it is 15 mg per day due to iron lost during menstruation. The RDA for pregnant women is between 27 and 30 mg per day. Getting a sufficient amount of iron is difficult to impossible for people whose diet is primarily vegan, as is often the case in poorer populations. Obviously much more iron is needed during pregnancy. For that reason, it is recommended that pregnant women double the amount of iron they take with the food they eat, from the RDA of 15–30 mg/day. This is already difficult for women living in Europe to achieve, not to mention for women living in poorer regions and those who have already given birth before. Their reserves are as good as empty from a lack of intake resulting from undernourishment, as well as increased demand during pregnancy.

Sources of Iron

Approximately two-thirds of the body's iron is found in the hemoglobin in the blood and the myoglobin in the muscles. The rest is scattered in the liver, spleen, intestinal lining and bone marrow.

A well-balanced diet, as it is understood and enjoyed by most people in Central Europe, contains roughly 12–18 mg of iron a day. A third of this iron is so-called non-heme iron, which is found in plant-based foods and is not as well absorbed by the body as heme iron, which is found in animal-based food.

Essential sources of iron are liver, as well as legumes, despite their poor bioavailability. Beef, meat products and plant-based foods are only suitable sources of iron if consumed in greater quantities. Only a well-balanced diet can guarantee a sufficient supply of iron to the body (see Table 2.8).

The variety of different foods in one's diet has a vital impact on the bioavailability of iron, or, in other words, the ability of the body to extract it from food. The bioavailability of iron from animal-based foods is 15–30 %, which can be quadrupled in combination with foods rich in vitamin C (i.e. containing 75–100 mg). In comparison, the bioavailability from plant-based products lies between 2 and 8 % at most. The more flour is ground, the less iron it contains.

Table 2.8 Amounts of iron in different foods (average per 100 g)

Liver	15–30 mg
Liver-based products	3–10 mg
Meat	3–5 mg
Sausage	1–5 mg
Poultry	2–3 mg
Parsley (dried)	90 mg
Mint (dried)	80 mg
Pumpkin seeds	10 mg
Millet	10 mg
Soybeans	8 mg
Amaranth	8 mg
Beans	6 mg

Another disadvantage of plant-based products is that they contain a variety of substances, such as calcium salts, dietary fiber and phytic acid, which further lessen iron's bioavailability.

Iron Deficiency and Its Effects

When the amount of iron in a person's diet is reduced, this affects, first of all, the reserves, which begin to become depleted. Next the number of red blood cells becomes smaller and then, much later, the metabolic processes which require iron are inhibited. There are 1–2 billion people in the world who have clear symptoms of iron deficiency anemia. Many more people suffer from so-called subclinical iron deficiency (ACC/SCN 2000). This involves a deficiency whereby there are, at first, no clear symptoms of anemia, but rather a high risk that it may develop as soon as their intake of iron further decreases or they lose larger amounts of blood due to illness or, for instance, menstruation. Children are especially at risk of developing iron deficiency anemia. This is less the case in more economically developed countries, excluding of course the poorer sections of the population. Children who come from mainly vegetarian families are also at a greater risk.

42 % of all pregnant women and 47 % of all preschool children in developing countries suffer in varying degrees from iron deficiency anemia (Kraemer and Zimmerman 2007). The prevalence within the world population varies widely and is by no means confined to countries in Africa, Asia and parts of South America. This applies to both children and pregnant women. A particularly problematic issue is anemia among children under the age of two since they require significantly more iron to grow. If iron is lacking, growth is inhibited and this affects other bodily processes, such as immunological response. In Africa, it is assumed that 50–70 % of all women are anemic, 5–15 % of which severely. The prevalence of anemia among schoolchildren in Africa is estimated to be 50 %.

Iron deficiency anemia among pregnant women is a major cause of perinatal mortality. Corrective measures leading to an elimination of the deficiency result in a reduction of this mortality rate by 20 % (Stoltzfuss et al. 2004). There are also documented accounts of how early and thorough treatment of anemia among pregnant women also improves the cognitive development of the children (Lukowsky et al. 2010).

The correlation between the household budget for food and iron (and not only this) was discovered in a study which examined the simultaneous occurrence of anemia among 109,100 mothers and their children in Indonesia for the first time (Souganidis et al. 2011). Simultaneous occurrence of anemia among mothers and their children was especially common in households with more than two children and which spent more on grain and cereal products than on other foodstuffs. Households which spent more on, and thus ate more, animal-based products had a 40 % lower rate of anemia.

The first symptoms of an iron deficiency, before it can be diagnosed in the bloodstream, are feelings of weakness and fatigue. This type of mild deficiency is of no further consequence to those afflicted, provided they do not do any manual labor. Otherwise, this mild deficiency causes restrictions to one's resilience and ability to work under pressure.

The risk of iron deficiency is particularly high during a baby's first few months due to the fact that, even if the mother gets enough iron herself, only 50 % of the baby's iron requirements can be met by drinking mother's milk. The mother may take sufficient quantities of iron during pregnancy, nevertheless, the iron reserves which a baby has at birth are very low in comparison to what it needs for the quick growth phase which lies immediately ahead of it. If a baby is stricken by an infectious disease during the first few months of its life, this can lead to a very quick emptying of its iron reserves. During breast feeding an infant receives less iron than it apparently needs, resulting in a risk of anemia. Therefore, it is advised that the infant receives an additional 3–4 mg of iron a day by means of supplementary food or vitamin supplements. The direct correlation between low birth weight and iron deficiency has led the WHO and UNICEF to recommend iron supplements to children with a low birth weight starting in the second month and continuing up until 24 months.

Children's particularly high risk of anemia during their first 2 years were recently documented as part of a study of people's diets in 11 developing countries. Among the 31,000 children who were examined, 50 % were found to be anemic (Gliason et al. 2003).

Chronic and severe iron deficiency negatively impacts the way the brain develops and hence behavior. Depending upon when the deficiency begins and how long it lasts, different regions of the brain can be impacted. A study of children with iron deficiency anemia has shown that they do not progress intellectually as well as children who do not suffer from iron deficiency anemia. Diverse tests were conducted in a number of studies which showed that iron deficiency during early childhood negative affects a wide range of abilities, such as reading, writing, making associations, and learning, which are influential elements

in determining a child's future career. These children also display handicaps with regards to certain aspects of their behavior, such as expressing fear and depression. It is noteworthy to observe that children coming from families with a low socioeconomic status, regardless of how well-educated the mother was, tended to be more strongly affected by these changes (i.e. until the age of 19) than were children coming from families with a higher status (Lozoff et al. 2006).

Deficits can rarely be evened out in later years and result in permanent handicaps to young persons' motor skills and energy, which they greatly need at this age and, as a result, hamper their general productivity. As we have already seen with other micronutrients, this deficiency propels the vicious circle of poverty and malnourishment.

Conclusion

Iron deficiency and anemia, which consequently ensues, is a worldwide problem and one which does not only affect the populations of developing countries. Despite the severe adverse effects which iron deficiency and anemia have on one's health, it has so far not been possible to establish measures for preventing iron deficiency, which continues to be overlooked, particularly in developing countries, because of the wide variety of food on offer.

Iodine

Functions of Iodine

Iodine plays an essential part in the forming of thyroid hormones. It is contained within the thyroid hormones and stored in the thyroid gland. From the thyroid gland it is delivered into the bloodstream and is used by the body for many vital processes, such as growth, and cellular development and functioning.

The thyroid gland stores iodine, i.e. builds up a reserve, so that it is always available when needed. If one has a regular intake of iodine, the reserves contain a 2 month supply. If, however, the reserves are not adequately filled, a deficit can quickly occur in times when the reserves are more heavily drained, such as growth spurts and pregnancy. This can lead to severe consequences. The thyroid hormone receptors in the nuclei of the cells, which attach to the thyroid hormones, are found in nearly all of the cells in the body and act in unison with the nuclear receptors of vitamins A and D.

How Much Iodine Does One Need?

The average daily intake of iodine is, depending upon the region, between 10–100 μg. The recommended daily allowance for adults is 200 μg.

Sources of Iodine

More or less everything which comes from the sea contains a lot of iodine. Particularly, rich sources of iodine are sea fish and sea algae. Due to the fact that

iodine is often added to table salt and animal fodder, it can also be found in butter, buttermilk, and bread. Depending on the species of fish, it contains between 50 and 175 μg of iodine per 100 g of fish.

Iodine Deficiency and Its Effects

There are between 1.5 and 2 million people worldwide who suffer from varying degrees of iodine deficiency, depending on how the figures are calculated. Developing countries are, once again, most heavily affected.

The number of schoolchildren with an iodine deficiency, especially in developing countries, is still very high (see Fig. 2.3). However, developed countries are also affected by iodine deficiency. Although the situation here has improved, thanks to the fact that iodine is added to table salt and animal-feed salt, there are still children and pregnant women who do not receive enough of this vital micronutrient. A study conducted by the Robert Koch Institute in 2007 involving 11,599 schoolchildren arrived at the conclusion that Germany had gone from being a country with an iodine deficiency to one with a low daily supply of iodine, meaning that it just barely meets the WHO's daily requirements for iodine (Thamm et al. 2007). The study found that 25 % of children in Germany had a mild iodine deficiency, while 17 % suffered a slightly more serious form. According to the authors, an improvement with regards to iodine can be attributed less to an increase in the amount of sea fish eaten than to the consumption of meat. This is explained by the fact that iodized salt is added to animal feed. It is especially important for children to get enough iodine since it is essential for their physical and psychological development. At least Europeans can be relieved by the fact that 'only' 3–5 million schoolchildren are affected by an iodine deficiency, in comparison to many African countries, where the figures are as high as 10 million (Andersson et al. 2012).

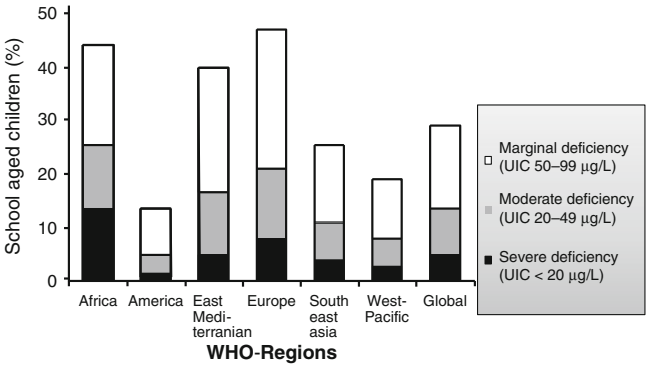

Fig. 2.3 Number of schoolchildren with a (mild, moderate, and severe) iodine deficiency as measured by iodine levels in the urine [UIC]. Despite preventative measures, many people in Europe are still affected, just as in Mediterranean and African countries (Andersson et al. 2012)

Iodine deficiency is particularly prevalent in countries where the soil does not contain much of the trace element, especially those in or near mountainous regions or which are often hit by floods. That is because the iodine in the soil is washed out by the water. In the former case, this can be in the form of glaciers and ice ages and in the latter flooding at river deltas, for example. Plants which grow in this soil absorb little iodine and thus cannot pass any along into the food chain. The RDA for children of 100 μg and for pregnant women 200–250 μg cannot (easily) be met by eating grain which was grown in soil with less than 10 μg of iodine per 1 kg of soil.

A problem which affects developing countries in particular are so-called goitrogens, which help to form goiters in the thyroid gland and therefore increase the severity of an iodine deficiency, while decreasing the gland's ability to function. Many types of vegetables, for instance broccoli and cabbage, referred to as cruciferous plants, contain glucosinolates whose degradation product competes with iodine to be absorbed by the thyroid gland. This also applies to cassava, beans, millet, and sweet potatoes. If these foodstuffs are not cooked enough, the goitrogens do not get destroyed and will then promote the growth of goiters. As a result, the negative effects of an iodine deficiency are further strengthened due to the inability of the thyroid gland to produce hormones (Zimmermann 2009).

In combination with an iron and vitamin A deficiency, the impact of an iodine deficiency on the body becomes even worse. Iron deficiency anemia reduces the production of hormones in the thyroid gland; vitamin A deficiency promotes the growth of goiters (Zimmermann 2009).

The visible effect of an iodine deficiency is the goiter, which develops due to constant stimulation of the thyroid gland by a growth hormone produced in the brain known as a thyroid-stimulating hormone. Since more iodine is retained by the thyroid gland, less leaves the body in the urine. Hence, an iodine deficiency can be detected by measuring the iodine concentration in the urine. As the thyroid gland enlarges, it loses its ability to produce enough thyroid hormones.

The need for iodine rises by 50 % during pregnancy for two reasons. First, the production of thyroid hormones (T4) greatly increases since the fetus is already capable of producing T4 and needs iodine to do so. Second, the amount of iodine which the mother loses is also increased.

Mothers who have enough iodine in reserve (i.e. in the thyroid gland) are not affected by this increase in demand. If they are affected, this can have serious consequences for the development of the fetus. Thyroid hormones are needed by the fetus to produce nerve tissue and for the nerve connections known as synapses. If the thyroid hormones do not get all of the iodine which they need, the adaptability of the brain to a range of outside impulses will be hampered. Children affected by this condition will no longer be able to develop properly, even if they are well-nourished later on. Further adverse consequences of an iodine deficiency include miscarriage, still birth, varying degrees of neurological disorder and cretinism. Deafness at birth is also not an uncommon effect. Provided the children survive, they will remain mentally handicapped in one form or another and will

therefore be limited in how they can grow and develop as individuals both physically and mentally.

Conclusion

The goiter which forms in the thyroid gland as the result of an iodine deficiency was long viewed as more or less a cosmetic issue. What an iodine deficiency actually means for a child's psychological development, both before and after birth, was overlooked. It was not until the 1980s that people started to become aware of the worldwide iodine deficiency. Programs aimed specifically at combatting the epidemic were started, which involved the adding of iodine to salt.

The Consequences of a Micronutrient Deficiency

Both sides of the coin—the causes and adverse effects of the above-mentioned micronutrient deficiencies—are nothing new and have been researched at length. It is therefore quite astounding that they are not considered when assessing the food situation in the world. Moreover, the 'hidden' deficits of vitamin A, zinc, iron and iodine are known and recommendations are given to avoid a deficiency, for instance by means of supplements or food additives. However, it is often overlooked that the underlying cause of such deficiencies is a diet which does not meet the nutritional needs of most people, not to mention children and pregnant women. It is also not enough to push for a diet which contains these four micronutrients, except in cases of acute, life-saving intervention. Hidden hunger must first and foremost be uncovered and then by all means avoided. The negative, in fact devastating effects of hidden hunger, cannot be reversed once the damage is done.

People who enjoy a well-balanced diet seldom have a single, isolated micronutrient deficiency. Normally, they suffer from a few deficiencies simultaneously, whereby there may be clinical symptoms or not, depending upon the severity of the deficit. People living in poorer conditions are particularly plagued by hidden hunger, and not just in developing countries, due to their one-sided eating habits. Hidden hunger cannot be eliminated solely by increasing the amount of calories a person consumes. This blinding misconception makes it more difficult to diagnose the problem and to mobilize those with the power to make a change. The victims are mothers and their children—handicapped for life. Those who suffer from hidden hunger often have a weak immune system, which makes them more susceptible to illness, and suffer physical and psychological disorders.

Certain deficiencies, for instance when one's diet does not contain enough of a particular micronutrient, lead to typical developmental disorders (see Table 2.9). However, these micronutrients are linked with one another in the most complex ways. So ultimately, it cannot be stated with certainty whether or not certain clinical symptoms (e.g. developmental disorders, high risk of infection) are the result of a single micronutrient deficiency, in this case vitamin A, or are caused by a combined deficiency of zinc, iron, iodine etc.

Table 2.9 Typical adverse effects of micronutrient deficiencies

Micronutrient	Adverse effects of a deficiency
Iron	Psychological and physical growth stunts pregnant women: higher mortality
Vitamin A	Blindness, respiratory infections Pregnant women: developmental disorders, respiratory disorders
Zinc	Psychological and physical growth stunts diarrhea (acceleration of deficits)
Iodine	Psychological developmental disorders Pregnant women: developmental disorders, deafness at birth

Depending on the severity and duration of the deficiency, the adverse effects will be more or less pronounced. Poverty and malnutrition often go hand in hand with a lack of education. The psychological disorders which underlie this educational disadvantage are caused partly by malnutrition.

A weakened immune system from the very beginning means that a person falls ill more often. Measles, tuberculosis, and malaria are common infectious diseases suffered by those with a micronutrient deficiency. Children who contract such diseases because of hidden hunger often fall seriously ill and frequently die.

The two phenomena, hidden hunger as both a result of and a typical sign of malnutrition, and contracting infectious diseases have a mutual influence upon each other. As a result, even a moderate form of malnutrition (i.e. showing no clinical symptoms) can have a strong negative effect on the body in the case of an infectious disease. The immune system, being already weakened, is in no condition to react and adequately protect the body. David Pelletier and his colleagues (1995) conducted research on the issue of child mortality in 53 countries and concluded that the negative effects of malnutrition were responsible for the worsening of the respective illnesses in 56 % of fatal cases. In some countries, the percentage was lower, for instance 13 % in Paraguay, and in other countries extremely high, such as India with 67 %. This is regardless of the severity of malnutrition itself. At least with regard to the total percentage of 56, only 17 % were in connection with severe malnutrition, while 83 % were cases of mild malnutrition, or the secret killer hidden hunger. Delaying and waiting for clinical symptoms to first appear before taking action is putting the lives of many children on the line (Pelletier et al. 1995).

Children who already suffered from malnutrition before birth will show varying degrees of psychological disorder later, which will become more pronounced as their sate of malnutrition continues throughout childhood. This fact was first discovered during follow-up examinations after the great famines which took place in the Netherlands, China, and the Ukraine in the twentieth century. Mental disorders are also caused by malnutrition which is not rectified during early childhood, or before the child turns two. A number of studies describe how a child's IQ

drops between 8–18 points, if they suffer malnutrition during early childhood (Fishman et al. 2004).

What does this all ultimately mean? Hidden hunger is the underlying cause of numerous developmental disorders which negatively affect people's lives, their chances, their futures, and so ultimately, this leads to more poverty and malnutrition. Hidden hunger is self-propagating and pulls one generation after the next into the vicious circle. The reduced level of productivity caused by these physical constraints affects both men and women. Large-scale population studies have calculated that for every centimeter less height a person has, his or her work capacity decreases by 1.5–2.5 % (Haddad and Bouis 1991). Productivity lost due to anemia in South Asia is estimated to cost the region $5 billion (Ross and Horton 1998). Handicapped psychological development also reduces the educational opportunities open to those afflicted.

The impact of chronic malnutrition on a child's educational path can be seen by comparing the academic performance of children with stunting and those without (Young lives 2008). In Ethiopia, children with stunting had 18 % more difficulty in writing and 15 % more problems in reading than those without the affliction.

All of these problems and their often life-long consequences could be prevented in many cases, if only the strategies which are conceived to combat hunger would focus on nutrition from the point of view of quality instead of quantity (kcal).

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Causes of Hidden Hunger

3

Even Hunger Needs Quality: Not Just Quantity!

Quality of Food

When we talk about high quality food in rich countries, we tend to think of products that are meticulously prepared, are particularly delightful to eat, or have special ingredients that we consider to be of a higher quality in comparison to those in similar products. This definition of quality is of mostly no interest to people living in countries with mass nutritional problems, although it is precisely here that this issue is of life and death importance. Quality in this case means, first and foremost, that food contains the essential micronutrients (i.e., vitamins, trace elements) and amino acids (protein building blocks).

Food quality can be calculated by means of the ratio of essential components (i.e., the percentage of the RDA) versus the number of calories (i.e., percentage of the recommended amount). This ratio, which is referred to as 'nutrient density', tells us how well adapted a particular food is for supplying micronutrients. The daily diet of individual persons or entire groups can be assessed using this ratio as a basis.

Food quality, or to put it another way, nutritiousness, is a fundamental part of food security and, as such, the basis for each person's nutritional requirements.

Food Security

If we define healthy food as that which has everything our body needs to maintain a good state of health, then the flip side, unhealthy food, are products which lack

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these vital nutrients (micronutrients, amino acids). Thus, when choosing what we eat, it is necessary that we have a variety of foods in our diet to ensure that we get all of the necessary amounts of micronutrients and amino acids.

Therefore, it is necessary for us to know what food we buy and eat contains and balance our diet to make sure that we receive enough calories, but that the RDAs for the different nutrients are met. The former involves nutrient density, the latter diet diversity. Provided that a wide variety of foodstuffs is available, a person must be in a position to first identify the nutrients contained in products (through proper education) and second to purchase them (by having enough money). Together, nutrient density and diet diversity make up food security.

Food security describes a situation in which all people have access to and the financial means to purchase safe, nutritious food that meets their own individual needs and tastes and ensures them an active and healthy life on a constant basis (FAO 2002).

This definition rests upon four fundamental pillars, the fourth of which was only added recently:

- availability of food,
- access to food,
- food quality (nutritiousness),
- stability of food prices.

The FAO's definition of food security includes the goal and hopeful vision of providing food to all hungry people on the one hand and the inherent dilemma contained within this vision, including many hurdles on the other hand. Food security for the entire world population is an ambitious goal, if not a completely utopic vision. Depending upon how this definition is applied to specific countries or population groups, one or more of the pillars will be missing. The causes of hidden hunger are closely tied to this four pillars.

The Four Pillars of Food Security

First Pillar: Availability of Food

The availability of food first and foremost means that a particular foodstuff is on hand to be purchased. It is dependent upon a variety of factors which are barely influenced by those who purchase the products. One such influencing factor is whether it is grown or produced locally or imported from another location. This is especially relevant in African countries where high transportation costs and especially challenging transport routes (i.e., poor road conditions, reduced technical possibilities, legitimate, and arbitrarily drawn borders) greatly affect

availability. The question of whether a particular foodstuff could be transported or locally grown is in turn dependent on the climate, the season, the quality of soil, and the technical possibilities available. One reason that certain products are not sold is because they cannot be supplied to the markets of local communities. Many markets have a limited assortment of produce because the potential buys cannot afford to purchase such products and there is thus no demand for them. In addition, the produce of local farmers cannot compete with cheaper imports—cheaper because of subsidized farming and pressure to keep import taxes low. Local farmers also have nothing left after they have provided food for their own families. Such a limited variety means that the assortment of food necessary for maintaining a balanced diet, one which contains sufficient amounts of vital micronutrients, is not available.

In short, availability of food simply means that various foodstuffs are able to be purchased by consumers. This conforms to the right of individuals to food, but falls short of fulfilling their right to nutrition. Whether or not the right to a balanced diet can be fulfilled or not depend on the second pillar: access to food.

Second Pillar: Access to Food

Access to a particular foodstuff means that it is both available and can be acquired by a person, for example by paying cash, bartering, or performing a service. The easiest way to accomplish gain access to a particular foodstuff is to successfully produce it yourself. The same is of course true with regard to availability. The best produced and most varied assortment are of no use to hungry persons who are hampered from purchasing the items because either war or transport issues prevent them from making it to market or due to the fact that they simply cannot afford to purchase the products.

The availability of food, as well as access to it, provides no guarantee whatsoever that the food itself fulfills its purpose, i.e., that it is sufficiently nutritious. That brings us to the third pillar.

Third Pillar: Quality of Food—Nutritiousness

The nutritiousness of food is the most important pillar in the concept of food security. Without it, a healthy, balanced diet is unthinkable. In this context, nutritiousness means that food has a high enough nutrient density, meaning that it contains sufficient amount of essential micronutrients, which can also be absorbed by the body (bioavailability). Since there is hardly any one single foodstuff that can supply a person with all of the essential nutrients that he or she needs, a person's diet needs to be balanced in order to ensure nutritiousness. This is what is meant by diet diversity.

Micronutrient-Rich Foods

If we classify food into different groups based upon how many micronutrients it can potentially supply and how much of it should be consumed daily, it quickly becomes clear that animal-based foods are of particular significance.

The foods listed in Table 3.1 only need to be consumed in small portions (<100 g) to fulfill the recommended daily allowance for specific micronutrients. Naturally, other foods also contain the respective micronutrients, but these must be eaten in larger quantities to provide a sufficient amount of micronutrients. Concerning the micronutrients which are essentially responsible for hidden hunger, there are only a very few sources which supply a sufficient amount. The most important source of vitamin A is liver, followed by fatty fish, such as eel and egg yolk. A good source of zinc is again liver, and, to a certain degree, meat and various types of cheese. It is more or less the same situation with iron. Liver once again tops the list of sources. Iodine comes primarily from fish and algae, which also are a good source of fatty acids and vitamin D. The list goes on and on. Yet, it does not take an enormous amount of imagination to realize that the foods just mentioned rarely find their way onto the tables of poorer families, if they make it there at all.

Worldwide 75 % of all calories (kcal) consumed come from wheat, corn and rice. More than 50 % of the protein eaten comes from foods with low nutritional

Table 3.1 The best sources (100 % RDA <100–150 g) of vitamins, as well as minerals and trace elements

Water-soluble vitamins	
Vitamin B1	Pork
Vitamin B2	Liver, milk
Vitamin B6	Germ buds
Niacin	Calf's liver, grain
Biotin	Liver, soybeans
Panthotenic acid	Liver
Folic acid	Liver, eggs
Fat-soluble vitamins	
Vitamin A	Liver
Vitamin E	Oils
Vitamin D	Fish
Vitamin K	Germ buds, Brussels sprouts, chives
Minerals and trace elements	
Iron	Meat, liver
Selenium	Meat
Magnesium	Germ buds, wheat bran
Zinc	Germ buds, animal-based food

value: wheat, corn, rice, millet, rye, oats, and barley. This kind of diet has very little in common with our evolutionary roots. 15,000 years ago, and prior to that as well, cereals were more of a secondary source of nourishment. People had a diet based on fish, meat and, depending on availability, sweet fruits, leaves, and roots. This apparently provided prehistoric peoples all of the daily amounts of micronutrients they needed over a very long time period. The switch to eating more grain which took place roughly 12,000 years ago was a move that prevented starvation since grain can be stored, yet it also reduced the amounts of micronutrients that people were getting in their daily diets. Studies of skeletons and teeth that date from around this time have revealed signs of the degenerative effects of this change for the very first time. At the same time, this was also a period when food began to be traded as a commodity between those who had rich stores of it and those who were dependent on acquiring it.

Even today grains supply 80 % of the energy and 60 % of the protein which people consume, particularly in poorer parts of the world. If 80 % of the calories one should consume come from grain, then there is only a little room left for high quality, micronutrient-rich food. Ironically, the end result is that people are 'full', yet suffer from undernourishment since their micronutrient reserves are empty. Part of this has also to do with the fact that the few micronutrients which grain does supply are poorly absorbed by the body.

Bioavailability of Iron and Zinc from Plant-Derived Food

How nutritious food is provided that it is at all, essentially depends on whether or not the micronutrients it contains can be absorbed by the intestines. The best example to illustrate this fact is pro-vitamin A found in carrots. If a carrot is eaten raw, the body is less able to absorb the β-carotene, which then results in a very low amount being absorbed due to the cellulose capsules which surround it. The β-carotene only becomes bioavailable once the carrot has been cooked or pressed to extract the juice.

The same situation applies to a variety of other micronutrients, particularly the ones which are vital to the body. Various types of grain and beans contain rather high concentrations of iron and zinc compared to other plant-based foodstuffs. Studies have shown, however, that iron absorption from soybeans, black beans, and peas is very low. Only about 0.5–4 % of the iron contained in them is able to be absorbed by the body. The figures for zinc are slightly higher. Here the absorption rate from grain is between 10–20 % (Gibson 1994). As a result, the staple foods eaten by children, especially in developing countries, provide hardly any of these two micronutrients which the body can absorb in adequate amounts.

Iron coming from plant-based food is particularly tricky to absorb. Such iron is nonheme, meaning that it is not attached to hemoglobin, and it is 10–20 times more difficult for the body to absorb than heme–iron from animal-based products.

An important factor in the poor absorption rate of the both elements is phytic acid, which is found in grain and binds itself to both minerals in the intestines. Tests conducted with a type of enzyme known as phytase, which neutralizes phytic

acid or reduces its level of activity, showed that it can actually be used to increase bioavailability (Ael-M et al. 2011; Sandberg 1991). Phenolate compounds which bind with iron and are found in millet inhibit the absorption of plant-based iron. Studies using various models have concluded that the bioavailability of iron from millet and grain lies somewhere between 3–15 % (Lestienne et al. 2005).

Studies that examined the iron content of food eaten by children in Uganda showed that fish and meat could very well be utilized as good sources (Tidemann-Andersen and Acham 2011), with concentrations varying between 1–12 mg/100 g for iron and 0.5–2 mg/100 g from zinc. Sorghum, a type of millet used to make bread, may contain up to 70 mg of iron per 100 g, depending upon the variety. Yet despite this high concentration of zinc, the authors of the study come to the conclusion that the primarily vegan diet of most Ugandans makes it very difficult for them to meet the RDA for iron and impossible to meet that of zinc.

Millet is an important staple food for many African populations. The most common variety is pearl millet, also known as finger millet in East and South Africa. Pearl millet contains a high concentration of iron (100 mg/100 g) and an adequate concentration of zinc (2 mg/100 g). In comparison, wheat has more zinc (3.5 mg/100 g), but contains very little iron (4 mg/100 g). Studies conducted in different African countries showed that, despite the high concentration it contains, millet is a poor source of iron. In Burkina Faso, millet supplies 20 % of the average person's daily calories (30 g), however nearly 80 % of children and 50 % of women are anemic (Micronutrient Initiative and UNICEF 2004).

Ultimately, food with the highest concentrations of iron and zinc are poorly suited to fulfilling people's RDA from these micronutrients. Only by including foods that contain iron in a bioavailable form, as well as preformed vitamin A into one's diet can a person improve their level of nutrition. An essential component of this is diet diversity. Combining food from different food groups is the key to preventing hidden hunger and chronic malnutrition. Some examples will illustrate the difficulty faced by many of maintaining a healthy diet by means of nutritious foods. Below is an overview of the typical daily diet of children in two different African countries (see Table 3.2). One can quickly see that these diets are a far cry from being able to provide children with the three essential micronutrients (vitamin A, zinc, and iron).

The overview in Table 3.2 depicts the diet of a child between the ages of two and five, which was determined by means of a questionnaire regarding types of food and the respective amounts over the course of one day, i.e., 24 h recall (Gegios et al. 2010). On average, 89 % of all children in Kenya and 31 % of children in Nigeria obtained 25 % of their daily calories from cassava. In purely arithmetic terms, 59 % of Kenyan children received enough vitamin A, 31 % enough zinc, and 22 % a sufficient amount of iron. In Nigeria, 17 % of children met the recommended daily allowance of vitamin A, 41 % got enough zinc, and 57 % enough iron. These figures are misleading. The problem of poor bioavailability discussed earlier means that the minerals contained in the grain-based foodstuffs which make up the largest part of these children's diets remain mostly unabsorbed. With the exception of sweet potatoes and a small variety of fruits,

Table 3.2 Daily diet of children in Nigeria and Kenya

Food	Nigeria % of energy	Kenya % of energy	Vitamin A (μg/kcal)	Zinc (μg/kcal)	Iron (μg/kcal)
Cassava	15	59	0	0.2	1.6
Corn	22	7	0	0.2	3.3
Rice	14	1	0	3.3	11.4
Sorghum	1	10	0.1	0.2	30
Wheat	8	1	0.2	1.8	3.2
Animal-based food	3	7	1.1	6.8	7.7
Legumes	9	3	0	9.4	22.3
Fruit	4	3	1.4	1.8	2.7
Green leafy vegetables	10	4	2.0	4.3	15.3
Yams	11	0	0	0.1	6.4
Bananas	2	1	0.2	1.7	3.3
Sweet potatoes	0	3	32.0	2.6	5.3

there are no foods which contain more than a negligible amount of pro-vitamin A. Only a small percentage of what the children eat comes from animals. We can hardly expect that the small quantities of sweet potatoes that are eaten in Kenya, not to be mentioned in Nigeria, supply children with a sufficient amount of vitamin A.

Nearly 40 % of children in Kenya and 50 % in Nigeria are affected by stunting. If one takes a look at the overview above, which represents the typical diet of people in most African countries, it is not surprising that half of the children are chronically malnourished. Data collected in five different countries in Asia and Africa indicate that this is no exception, but rather the rule regarding the state of food security among poorer population groups (Arimond et al. 2010).

In a more elaborately designed study in which interviews were conducted repeatedly (24 h recall), the diets of women in their child-bearing years were recorded, from which their respective micronutrient intake was then calculated. Table 3.3 shows the amount consumed as a percentage of the WHO's RDA. The WHO's recommendations are based upon the absolute minimum amount needed to prevent a deficiency, whereas the European suggestions reflect an optimal amount for maintaining a healthy population.

Table 3.3 clearly illustrates that nursing mothers (L) in particular are, to a large extent, not receiving enough micronutrients for themselves and their offspring. Women who are neither pregnant nor nursing (N) are lacking most of all folic acid, vitamin B2, vitamin B12, iron, and niacin. The WAP value shows that between 46–76 % of women in these countries are simply not getting enough of micronutrients they need. This is especially true for regions where the daily energy intake (E) is low, but also for countries such as Bangladesh (D), whose people get

Table 3.3 Place of residence and daily caloric intake including percentage of RDA for nursing mothers (L) and women who are not pregnant and not nursing (N)

Place of residence and daily caloric intake												
		A		B		C		D		E		
		City		City		Rural area		Rural area		City/slum		
kcal		2,078		2,024		2,086		2,083		1,211		
		1,692–2,791		1,613–2,513		1,620–2,547		1,761–2,445		875–1,664		
Percentage of women with an adequate supply of micronutrients												
Country	Th	B2	Nia	B6	Fol	B12	VC	VA	Ca	Fe	Zn	MAP
A	49	16	19	70	15	6	70	73	30	15	70	0.39
B	59	28	31	67	0	17	88	50	27	54	96	0.47
C/L	35	6	23	47	12	20	78	67	17	7	65	0.34
C/N	68	45	49	90	45	26	90	86	18	1	76	0.54
D/L	0	2	21	28	0	18	23	38	26	26	94	0.25
D/N	9	15	30	82	2	20	52	53	21	10	92	0.35
E/L	3	3	39	13	29	71	7	12	17	28	38	0.24
E/N	12	11	60	45	47	78	13	38	15	12	48	0.34

The number of women is given in brackets. (A) Burkina Faso (N178), (B) Mali (N102), (C) Mozambique (L306/N103), (D) Bangladesh (L113/N299), (E) Philippines (L247/N1798)
Abbreviations Th: Thiamine, Nia: Niacin, Fol: Folic acid, MAP: Mean Probability of Adequacy

enough energy each day (2,086 kcal/person) according to the FAO. When a woman in one of these regions is pregnant, a balanced diet is a serious burden for mother and child.

According to the FAO and the WHO, most women are well fed with 1,800 kcal a day, excluding the Philippines. This dangerous misconception stems are mainly from the fact that the top priority, and rightly so, is to stop undernourishment. Starchy grain-based foodstuffs build the backbone of this initiative. If we use the amount of bioavailable micronutrients in different foods as a basis for assessment, the picture would look quite different and undernourishment would quickly become obvious.

Fourth Pillar: Food Prices

The fourth pillar of food security is the most sensitive one and exerts a direct influence on each of the three other pillars. For families that already spend 80 % of their disposable income on food, there is not much a buffer zone when prices begin to fluctuate.

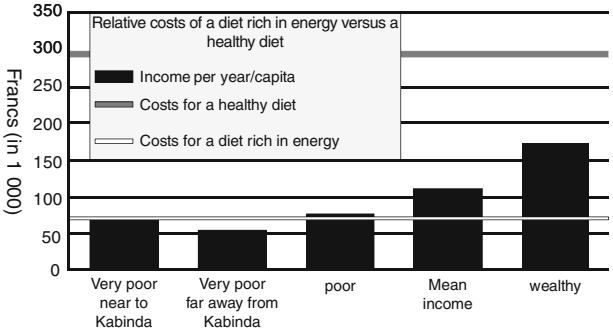

Fig. 3.1 Annual income, price of a diet containing enough calories and price of a balanced healthy diet (Save the Children 2010)

A healthy diet, meaning one which includes all of the essential components, is also impossible to achieve for those families with a healthier budget in poor countries. This is evident from Fig. 3.1, which shows the results of a study conducted in the Congo. Even those families who have a higher income would have to spend twice as much as they currently do in order to achieve a healthy diet. The poor, however not the very poor, are supplied with enough calories, at least in arithmetic terms. Hence, they are 'full' by means of fully inadequate food in nutritional terms.

Data compiled by the organization Save the Children (2010) illustrates the whole dilemma. Families with low income are still in a position to consume the recommended amount of calories and appear to be full, but in reality they are chronically undernourished. It is again the children who suffer from this situation most of all. In the DR Congo, nearly 80 % of their energy (1,651 kcal/person per day in 2007) comes from cassava and corn. Meat provides only 1 % (16 kcal) and oil 7 % (FAOSTAT.fao.org 2007). Since 1992, the number of calories consumed daily has dropped from 2,200 kcal/person to 1,650 kcal/person. As a result, every fourth child dies before the age of five.

Studies conducted in Kenya, Egypt, and Mexico clearly show that the vegetarian diets which prevail here lead to stunting and mental disorders among children (Dagnelie et al. 1991; Gibson 1994). In contrast, children whose diets included animal-based products showed a clearly healthier physical and psychological development (Allen et al. 1992). Adding even small portions of meat to a child's diet has been proven to have a direct influence on his or her intake of micronutrients and, consequently, his or her development (Murphy and Allen 2003). Diet diversity on a daily basis is of vital importance for fulfilling a child's nutritional needs. This variety in a child's diet ultimately depends upon which foods the family can actually afford to buy, an aspect which unites all four pillars of food security.

The Difference Is in the Mix

The more varied one's diet is, the healthier it is. That is what we understand in Europe by the term 'balanced diet'. Europeans hardly need to wonder whether or not they are getting enough micronutrients. Despite widespread skepticism, the industrialization of farming has had no impact on the essential micronutrients in our food for the past 50 years. We can select from a wide assortment of food which is so expansive that some cannot see the forest for the trees. Being spoilt for choice, or perhaps for personal or philosophical reasons, some people opt for diets which are quite lopsided, such as fast food, macrobiotics, and blood type diet.

Such imbalanced diets all have one thing in common: They are unhealthy in the long run. At least we have the freedom to choose how we wish to nourish ourselves. By means of education and knowledge of nutrition, we may choose to steer a particular nutritional course. The ability to plot their own dietary course is a luxury which poor populations do not have. Often the appropriate knowledge is missing, not to mention money, in order to select a diet which is not only filling, but is also healthy.

The price of food, especially staple foods, determines whether and for how long a child goes hungry with adverse effects. Dieticians in Europe are racking their brains to discover which of the so-called phytochemicals (bioactive compounds of which there are literally thousands and which have yet to proven as necessary for the body as micronutrients) or which herbs can serve to improve our health. The latest trend is called 'caloric restriction'. The underlying rationale is that what works for worms, spiders and laboratory animals can push the life expectancy of humans up over 100, as well. In light of the fact that the "age limit" for children living in developing countries is five, with such techniques as caloric restriction also playing a part, it would seem that our efforts to raise our life expectancy instead of trying to provide these children with an adequate diet is, to put it mildly, a decadent form of cynicism.

In Germany, there are more than 250,000 food products on offer. Children in developing countries often have no more than 15 to choose from. While we attempt to avoid the illnesses we cause ourselves due to our poor diets and lack of exercise by preaching such remedies as the '5 a day' concept or 'low carb diets', children living in poverty-stricken areas do not even enjoy what could be remotely referred to as a healthy diet. For them, this is a life and death issue! Only after a wider assortment of food becomes available can the basic nutritional needs of these children be met.

On the basis of the so-called Diet Diversity Score (DDS), it is possible to see the connection between food expenditure, diet diversity, and undernourishment/stunting. The DDS comprises up to nine food groups and also single foodstuffs, such as meat, fish, milk, eggs, vegetables, fruit, grains, cereal products, and oils, and it establishes a ratio of amount consumed to total calories or to the costs. The DDS can vary from country to country, depending upon whether a particular food is locally available or not. From this maximum number of nine essential foodstuffs,

the families are asked what they eat. A selection of five or less can easily contain 100 % of the energy and protein a person needs, as many studies have shown, but not supply all of the necessary micronutrients. As mentioned earlier, these include in particular vitamin A and vitamin E, but also folic acid, zinc, iron, as well as calcium and a range of other vitamins.

Limited dietary diversity usually means that one's diet comes mainly from grain-based food and cereal products and does not include animal-based food, as is often the case with families who have a lower income. A family's rise in income allows for more of an investment in food, especially in a variety of different foods, including meat, fish etc. So with prosperity comes more diet diversity. Only after six different types of food are consumed in sufficient portions on a regular basis (DDS 6 and higher) can children develop in step with other children in the same age group. If this score is not reached, height and weight will fall below the norm (see Fig. 3.2).

Normal body weight (WAZ) and growth (WAZ) can only be achieved if children take their food from at least six different sources. Since both indicators are simultaneously affected by undernourishment, the height-weight ratio remains constant and thus gives a distorted picture of the child's diet. Since up to 80 % of the calories these children consume come from cereals, there is very little room to add other foods to the diet without going over the limit for calories. This is precisely the reason why hidden hunger is, in fact, so hidden. The children are getting enough energy, but from only one or two types of food. The value of DDS as an indicator for a child's diet and, as well as a guideline for proper nutrition in poorer countries can be seen in the studies conducted by Mary Arimond and her staff (Arimond et al. 2010). The poor diets of the groups in Table 3.3 can be

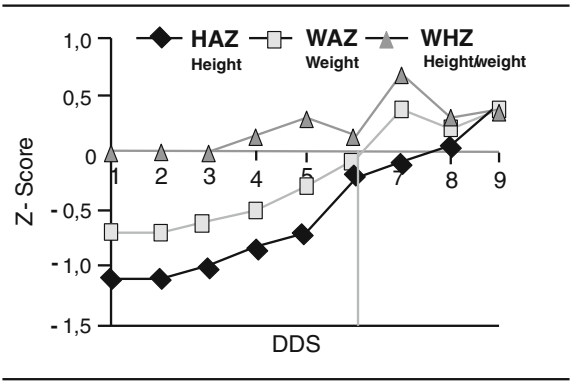

Fig. 3.2 Diet Diversity Score (DDS) and childhood development. The higher the diet diversity (DDS > 6), the more normal a child's physical development will progress. Weight-Age-Z (WAZ), Height-Age-Z (HAZ) and Weight-Height-Z (WHZ) are all calculations used to assess physical growth by benchmarking children against others who have a balanced diet in the same age group (Steyn et al. 2006)

Table 3.4 Relationship between weekly expenditure for different foodstuffs and the risk of night blindness between the lowest (quintile 1) and the highest amount of consumption (quintile 5) among non-pregnant women (Jakarta, Indonesia)

Food	Quintile	Risk	p-Value
Vegetable-based	1	1.00	–
	5	0.47	<0.0001
Animal-based	1	1.00	–
	5	0.47	0.002
Eggs	1	1.00	–
	5	0.62	0.004
Non grain-based	1	1.00	–
	5	0.36	<0.0001
Grain-based	1	1.00	–
	5	2.80	<0.0001

improved from a 70 % to a mere 20 % inadequacy by increasing the diet diversity from 3 to 6 (with 15 g per food type).

An example of the adverse effects of low diet diversity is the onset of night blindness which is suffered by young women who have a vitamin A deficiency (see Table 3.4).

A diet based primarily on cereals (quintile 1) carries with it a three-fold higher risk of developing night blindness. However, a daily diet which contains ample portions of meat and plant-based products or eggs (quintile 5) helps to reduce the risk by more than 50 % (West and Mehra 2010). A clearly higher rate of night blindness exists among Asian families, who spend more money on rice than on fruits, vegetables, or animal-based products (Campbell et al. 2009).

By eating more grain-based products, the amount of vitamin A the body receives decreases. Women in their childbearing years who are affected by this will begin to show the clinical symptoms of a severe vitamin A deficiency. This is the beginning of a vicious circle. A vitamin A deficiency arises which is passed on to the newborn child, who, in turn, will suffer health disorders and have a lower life expectancy. If the mother also suffers from an iron deficiency, which is highly probable with such a diet, she is also at risk. This fact is attested to by the high number of deaths resulting from iron deficiency among mothers (Save the Children 2012).

The findings of a study exploring the relationship between DDS and one's personal situation in South Africa illustrate this fact, as well (Labadarios et al. 2011). In the study, 3,287 adults of different age groups and income brackets were interviewed. A DDS of < 4 was found to be insufficient for ensuring an adequate intake of micronutrients. Dark skin and a low standard of living were the typical characteristics of 70 % of the people who had a DDS under 4. A score of under 4

means that, in particular, vegetables containing pro-vitamin A are missing (less than 15 % of the interviews mentioned such vegetables), as well as dairy products and eggs. The poorest group had a DDS of below 3! Their main sources of calories came from cereals and roots. Since the DDS is a method for determining food security in individual households as a whole, it is safe to assume that the children living in these households have more or less the same poor dietary patterns.

Hidden hunger and chronic malnutrition are two terms for the same phenomenon, which causes widespread illness and death, especially among children. It is so easily overlooked unless there are pictures of absolute starvation, but also due to the fact that the statistics speak of an adequate supply of nourishment. Yet the malnutrition which these children suffer from leads to frequent cases of illness and, ultimately, an early death. Granted, success has indeed been achieved on numerous fronts: hygiene, medical care, and vaccines. Yet this must not tempt us to ignore the fact that malnourished children find themselves in a life-threatening situation. Deaths caused by the most common illnesses (diarrhea, malaria, measles, respiratory infection) are seldom attributed to the real underlying cause: chronic malnutrition.

Conclusion

Diet diversity is the safest method for ensuring that one's diet is healthy and nutritious. Yet diet diversity depends upon certain factors, for instance that different foods are available and also affordable. Poverty limits the variety of food people are able to obtain. It is this lack of diversity which is responsible for malnutrition and all of its harmful consequences.

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Trapped on the Hunger Carousel: Generation After Generation

4

I would like to invite you, the reader, to take a ride on a carousel. Not just any carousel, but a very special one: the hunger carousel. The floor on which you will be standing is poverty. The hub on which it turns is the lack of adequate nutrition, health care, and hygiene. It receives its power from a number of sources. Poverty, the actual motor, is fuelled by international commerce and its restrictions on poorer countries, in addition to our demand in Europe and elsewhere for cheap goods and biofuels, as well as by price speculation, a lack of proper education and sub-standard health care. The carousel turns relentlessly while leaving a trail of death and destruction: mothers, infants, and children are all flung off to meet their death. Those who survive the horrible ride suffer health problems from the very outset. Before we voluntarily get onboard, let us first take a closer look at what happens to those who did not choose to get on the carousel themselves. We see first of all, persons who are clearly starving and it is only for that reason that we perceive them. These are the ones who are put in the spotlight by the media whenever a hunger crisis strikes, incidentally one which had been seen coming a hundred miles off. When the food supplies sent by international organizations have arrived, then it is "mission accomplished". And the merry-go-round keeps spinning relentlessly and everybody onboard lives hungrily ever after (see Fig. 4.1).

The majority of passengers onboard the carousel are women and children under the age of five. Day by day, 220,000 children are born all over the world and 10 % of these will not live to see their fifth birthday. From the moment they first see the light of day onward, the future of these children is anything but rosy.

There is no music played on the hunger carousel and no possibility to hop off. Those who get on keep silent and hungry, passing along malnutrition to the next generation. We usually see women holding wailing children on their laps and gazing out into the distance. They know that they will never be able to get off the carousel as long as poverty and everything which caused it continues to fuel the motor. They are too weakened and oppressed to voice any protest. Their cries would only fall on deaf ears anyway. The idea that 130 children die from the effects of malnutrition every 20 minutes is something we prefer not to focus too

H. K. Biesalski, *Hidden Hunger*, DOI: 10.1007/978-3-642-33950-9_4,

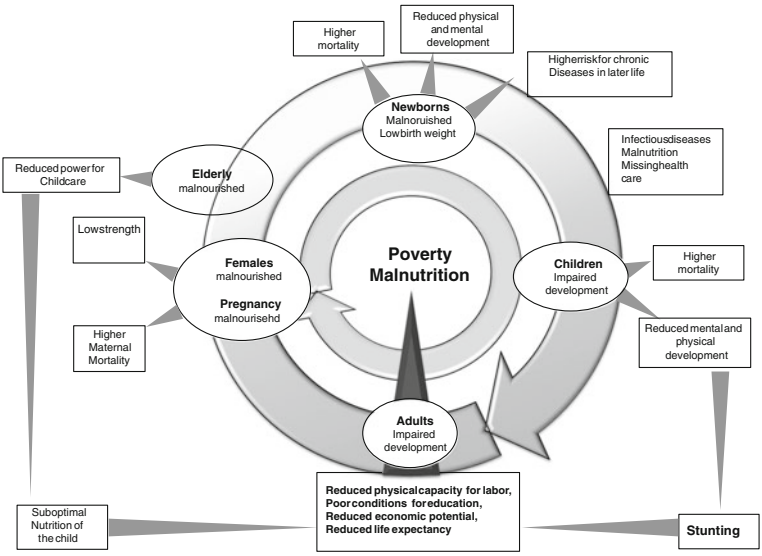

Fig. 4.1 The vicious circle, the hunger carousel, shows the people onboard and the propelling factors (modified from: ACC/SCN 2000)

long on. Otherwise, we would get up and scream in the name of these women and children. But in the end, the 'indignants' are silenced by their full bellies.

It matters not where on the carousel one gets on. You always go back to where you started from and spin around again. And the carousel turns and turns. It continues to draw power from malnutrition, poor health care, and low levels of education. These factors not only keep the hunger carousel spinning, but they keep the passengers in their places on board.

Passengers may go through a number of different phases while onboard the hunger carousel, each having a different character yet the same underlying cause: chronic malnutrition. Since the carousel is relentlessly spinning round and round, it is not enough to merely 'treat' the symptoms which appear during one of the phases and believe the job is done. All the while, the stations are filling up with new faces. Herein lies the real tragedy.

If we take a step back and observe the hunger carousel as a whole, the lethal facets of the problem come better into view. The MDG 4, which was proclaimed in 1990, is set to be achieved in 2015. The aim was a reduction in the number of children who die before reaching by two-thirds. This equates to a yearly decrease of 4.4 %. In 1990, 12.2 million children under the age of five died. Today, the number is 7.7 million. That equates to a difference in the mortality rate of nearly −2 % and not, as planned, −4.4 %. Current developments (i.e., globalization, prices, climate change, trade restrictions, poverty levels, etc.,) hardly provide any indications that the child mortality rate will rapidly sink. In a study conducted in 2010 by Rajaratnam and colleagues, the authors conclude, albeit carefully, that the

mortality rate for children under five was no longer and in no country higher than 20 %, whereas in 1990, the rate had been higher than that in 12 African countries. How relative and unstable such figures are can be seen in Somalia, where the crisis in many areas has led to a sudden rise in the mortality rate from 15 to 25 %.

The number of fatalities each year (mothers, infants, and children under five) is 4.7 million in Sub-Saharan Africa. 265,000 women die during pregnancy (between 300 and 1,200/100,000, depending on the country). 208,000 newborn infants die in their first month and 3,192,000 children die before they reach the age of five (70–180/1,000). The 880,000 stillborn babies should be added to these figures, however, such fatalities hardly receive any attention.

To make the magnitude of this tragedy clearer, it is helpful to compare these figures with the mortality rates in Europe, which for mothers is between 3 and 10/100,000 and for children is between 2 and 6/1,000. A mother's chances of surviving childbirth in Sub-Saharan Africa are 120 times worse than for a mother in Europe, and this has been more or less the case for the past 20 years. Put another way: The risk of death during childbirth is 1:2,800 in Europe, whereby in Africa it is 1:20 (Abou-Zahr 2003).

- Every year 60 million women give birth at home without any professional assistance. That number represents slightly more than a third of all births.
- Between 400,000 and 600,000 (depending on the source) women die each year during childbirth, while another 10 % of that number die after having a botched up abortion.
- 4 million newborn infants die each year within 28 days after birth.
- 3 million children are stillborn.
- 10 million children die before they reach the age of five.
- Every single minute, 20 children under the age of five, 7 newborn infants, and 1 mother die.

More than half of these deaths could be prevented with a halfway nutritious diet for mothers and their children.

Station 1: The Undernourished Wife and Mother

Giving Life Is a Deadly Gamble

On the carousel we encounter a young woman from Africa, born into a family of farmers who have managed to survive on the tiny harvests from their small plot of land in good times. In tough times, however, they have had to rely on food aid and sometimes go without eating completely. The young woman could have also come from Asia. The story is the same.

We arrive at the tiny island, one of the many which surround Zanzibar and are only accessible by means of the small fishing boats like the one we are currently on. The island is covered in a blanket of lush forest, with small beach areas along the shore. The beaches are deserted- not a soul, just sand and stone. As we make our way inland, a small trail leads us up a hill and onto a wide, sandy path. Along the path there are a few scattered huts, a well, a building which we later find out is a community center, a school, and a small medical facility. Continuing along the path, which cuts through the thick forest, we come to more huts looking as if they had dropped out of the sky and landed randomly among the trees. Then we encounter five boys along the side on the path who greet us with laughter. Their laughs have a slight air of ridicule as they point with their fingers to our bellies and our sunglasses. All five of the boys are small in stature. They are thin, yet not visibly undernourished, except for one who is wearing a T-shirt, upon which the words "Keep smiling" are stretched across his belly. It is not a belly which comes from prosperity and eating well, but a bloated belly, the result of a protein deficiency and undernourishment. From the sky the first heavy raindrops start to trickle down. Then, just as suddenly, a tropical downpour covers the land. We find refuge under the roof of one of the huts. In a matter of seconds we are invited by the owner to come inside. In the semi-darkness of the hut's interior, the young girl who invited us in disappears behind a curtain covering the entrance to an adjacent room. The floor is made of pressed clay and is spic and span. The walls are bare, except for a few colorful feathers. We cannot see what is going on in the adjacent room until the girl appears again carrying a tray with tea accompanied by a very young child about 2 years old. Judging from her size and behaviour, the girl cannot be more than 12 or 13 years old. We tell our interpreter to ask the girl if the little one is her sister and, how old she is. The question is greeted with a flood of words and loud laughter. Via our interpreter, she tells us that she is 19 years old and that the child, already her second one, is three. Her son Doimon will soon be starting school. From time to time a laugh escapes from her mouth. Then with an elegant bow, she disappears once more behind the curtain.

We would later learn that girls are usually wed when they turn 13 or 14. Normally their first child soon follows. Very many women die during childbirth and medical care is essentially non-existent. Newborn infants are usually breastfed for a long time. Because mother's milk in these regions has low concentrations of micronutrients, the infants are already undernourished. Everywhere you look you can see mothers working, holding one child by the hand while another child suckles at their breast. Toddlers get manioc pudding or cassava to eat. If they are not satisfied, they receive breast milk from their mothers. The prospects of having a normal development are slim, the mortality rate is high and so is the number of children to be fed.

In the meanwhile, the rain has stopped and a light haze rises from the damp earth. We leave the hut barefooted since our shoes would only get stuck in the wet clay and make our way back to the boot. On the way we pass young men who are building ships. Three of the five men give us a wave. In a clearing in the forest along the path, a group of young girls are standing around a well. Small children are bustling about whilst others lie nestled in wraps or suckle at their mother's breast. It is a happy, Arcadian picture. The sun's rays break up the clouds and shine golden light down on the idyllic scene. Yet it is all just a wonderful illusion.

The MDG 5 aims to reduce the maternal mortality rate (MMR) by 75 % by the year 2015!

Let us rejoin our young African passenger on her involuntary ride on the carousel. She is married at an early age, gets pregnant soon afterward, and has no possibility to make up the nutrients she had hitherto been lacking. Her pregnancy will suck everything out of her. The new life inside her wants whatever it can get (i.e. whatever is left). Nature's safety mechanism ensures that life can survive even

when reserves are low. So now there are two people riding the carousel instead of just one. The invisible passenger rides along inside its mother and already carries with it a legacy of poverty and malnourishment. The unborn child is already the 'spitting image' of its mother: malnourished, underweight, and without a chance of getting off of the hunger carousel alive.

Every minute a woman dies giving birth or shortly thereafter. 99 % of these mothers, live in developing countries, where the maternal mortality rate is roughly 200–500 times higher than in developed countries (WHO 2004; Fig. 4.2). UNICEF's recently-published figures (UNICEF 2012a) indicate a further decline in maternal mortality, particularly in Asia. According to the report, most fatalities could have been prevented. The sad reality remains that a mother's risk of dying during or shortly after childbirth in Sub-Saharan Africa is 1:39, in comparison to 1: 4,700 in rich countries. Improvements in sanitary conditions, and prenatal and postnatal care have undoubtedly played a part in reducing the mortality rate. Yet the main cause of death, maternal malnutrition, still persists.

As long as the majority of babies (60–80 % depending on the country) are delivered at home without proper medical care, these horrifying figures are unlikely to change. Aid organizations and government agencies are actively involved in trying to improve the situation. However, this is still a far cry from achieving the MDG 5. Motherly deaths, both during or shortly after childbirth, only evoke reactions on a local level, if at all.

The *Süddeutsche Zeitung* (Judith Raupp) ran a headline on March 8, 2010 which read "Pregnant, dead, ignored" (*Schwanger, tot, unbeachtet*). The article describes these women's unimaginable suffering. Every year, hundreds of thousands of expectant mothers die in developing countries. The causes are no mystery, the consequences are guaranteed.

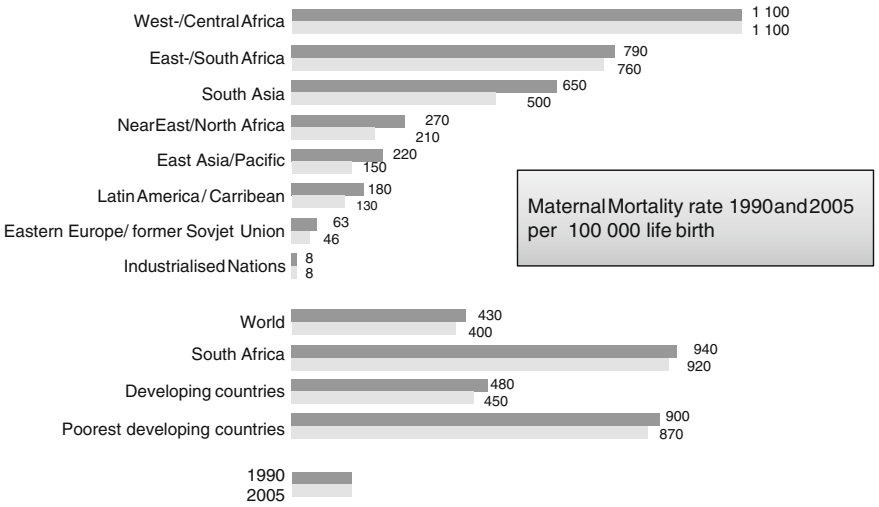

Fig. 4.2 Maternal mortality rate in 1990 (*dark gray*) and 2005 (*light gray*) (UNICEF 2009)

> Some of these women are still children themselves when they become mothers. But often pregnancy is the same as a death sentence. 536,000 women, many of them teenagers, die every year during pregnancy or while giving birth, nearly all of them in developing countries. "In the Congo alone, it is as if an airplane full of pregnant women would crash every 4th day", says Lyn Lusi, founder of the Heal Africa hospital in Goma. But because women dying in the African bush are not nearly as spectacular a story as a plane crash, the world hardly takes any notice.
>
> Women living in the poorest countries in the world are 300 times more likely to die during pregnancy or childbirth than women in industrialized countries, according to the UNICEF anual report *The State of the World's Children 2009*. The organization also believes that in no other area of health care is the difference in treatment as great as between expectant mothers in rich countries and those in developing regions.
>
> That is why 530,000 women die from complications during pregnancy or childbirth each year, 70,000 of which are girls between the ages of 15–19. 99 % of these deaths, happen in developing countries, two-thirds of these, in turn, in ten countries.
>
> These women die painful deaths caused by hemorrhaging, infection, blood poisoning and complications, or they are the victims of a shoddy attempt to abort the fetus. Critically high blood pressure (eclampsia), iron deficiency, HIV infection, early pregnancy, successive pregnancies with a relatively short time period, and malnutrition are all common high risk factors. Even if the women survive, millions of them are left with lifelong discomfort and medical conditions, which also pose a risk should they become pregnant again. (*Süddeutsche Zeitung*, 8 March 2010)

This chapter was in reaction to the publication of a study which examined the maternal mortality rate in 181 countries from 1980 to 2008 (Hogan et al. 2010).

Lancet, a foremost scientific journal, released a study showing a decline in the number of fatalities from 526,000 in 1980 to 343,000 in 2008. Nevertheless, there are still many countries which have not experienced such a decline, but some, such as Zimbabwe (+5.5 %), have even seen an increase in the MMR. The reduction in the MMR indicates that there are initiatives which are successfully combatting this problem, yet there are still countries which have been left behind. More than 50 % of maternal deaths happen in six countries: India, Nigeria, Pakistan, Afghanistan, Ethiopia, and DR Congo. A quarter of the women are between 15- and 20-years old (UNICEF 2010).

In Southeast Asia and Sub-Saharan Africa, 50 % of girls are betrothed before their 18th birthday, some even before reaching puberty. This has primarily to do with poverty and/or tradition. By marrying, they cease to be a burden to their families. Pregnancy marks the end of their physical development and it carries with it the risk of premature birth or the timely birth of an underweight infant.

In India, where 40 % of all newborn infants have a low birth weight, 8 % of the women who were between the ages of 20–24 in 2006 were 16-years old at the time their first child was born (UNICEF 2010). These infants are thus pulled onto the hunger carousel.

In order to get a better picture of the scale of this tragedy, some figures are given in Table 3.5. Some countries show an increase in the maternal mortality rate, while in others a marginal decline is visible (Table 4.1) WHO (2010).

There are two reasons for the decline in the MMR between 1980 and 2008. First, improvements in medical care, and second, a decline in the fertility rate

Table 4.1 MMR per 100,000 births (excluding stillbirths) in 1980 and 2008 (WHO 2010)

Malawi	743	1,140
Chad	891	1,065
Bangladesh	1,329	338
Pakistan	746	376
Haiti	1,122	582
Barbados	99	78
Cyprus	148	41
North America	12	17
Germany	20	7

(FRT). The FRT was at 3.7 % in 1980 and sunk to 3.26 % in 1990 and even further to 2.56 % in 2008. There is a direct relationship between the FRT and the MMR: the lower the FRT, the lower the MMR. This puts the decline in the MMR in perspective. It is not as significant as it may appear at first glance. The rise in personal income, particularly in Asia and Latin America, has played a part in improving the situation, since people can afford to buy a wider variety of foods and enjoy a healthier diet plus have access to better health care. The figures in Table 3.5 unfortunately give a distorted picture of the scale of the problem, as only fatalities are included which occurred under medical supervision or were actually reported. There are very few studies which focus specifically on this topic. A study conducted in India, for example, revealed that only a third of all fatalities were reported within a district (Bhatia 1993), and in one region of the country only a mere 31 % of deaths in clinics were registered. 64 % were apparently, not recorded in any way (Turman et al. 1995).

Figure 4.3 clearly illustrates that, even according to the most favorable statistics, achieving the MDG 5 is merely an illusion. The economic crises of 2008 and 2011 have led to a return to the same maternal mortality rate that existed in 1990. Although the MMR as a whole has dropped by 41 % in Sub-Saharan Africa since 1990 according to the United Nations Population Fund (UNFPA), it is still the highest in the world. This is largely thanks to vaccines, improvements in hygiene, and professional assistance during childbirth. Chronic malnutrition is still an issue, however, and continues to be the number one cause of maternal deaths.

The recent famine in Somalia shows just how precarious the situation is. This was a famine which UNICEF had warned about long in advance. The MMR in Somalia is 1,044/100,000, higher than the numbers in Fig. 4.3 suggest. As such, Somalia has one of the highest maternal mortality rates in the world. Hemorrhaging, long and difficult births, infection and eclampsia accompanied by edema, headache, and cramps all play a deadly and predominant role in this tragedy. The situation is further exacerbated by frequent cases of anemia and ailments caused by circumcision. The absence of prenatal care and classes provided by qualified

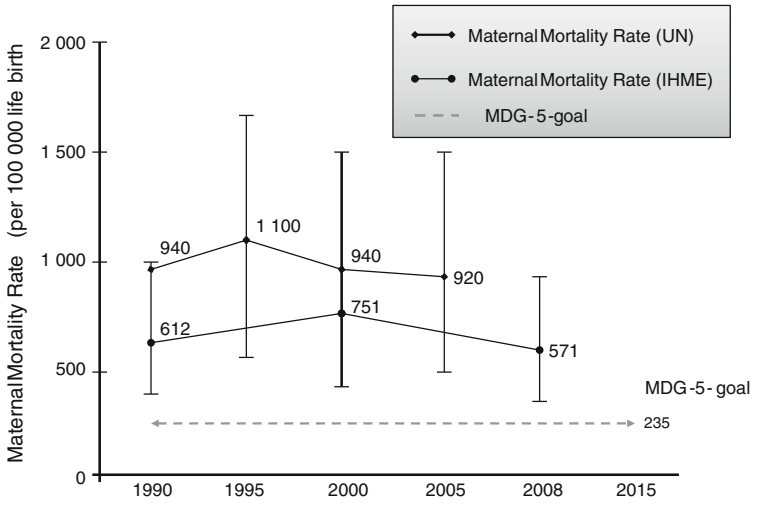

Fig. 4.3 Reality in Africa. Here the MMR has hardly declined since 1990. The values vary widely depending upon whether the means of calculation follow the UN/WHO or Hogan (IHME). Regardless of which model is applied, it is clear to see that the MDG 5 (reducing the MMR by 75 % by 2015) will not become reality and that there has been no significant decline in the MMR since 1990 (Kinney et al. 2010)

professionals combined with a shortage of emergency services complete the tragic scenario. Africa is home to 11 % of the world's population, and it is here that half of all women and infants die during childbirth or shortly afterward. The continent is also home to nearly 70 % of all HIV patients and 90 % of all malaria casualties.

The maternal mortality rate is 100–500 times higher in developing countries than in rich ones. This fact apparently does not receive much attention, and hence the initiatives which are undertaken by national governments, such as Bangladesh, to alleviate the problem are not found to be newsworthy. In Bangladesh, the MMR in 2001 was 320/100,000. By 2010, the rate had sunk by 40–190/100,000. In 2001, 90 % of babies were delivered at home and without any professional support, whereas today 76 % of births take place at home. Although this is still a high percentage, the difference has had a direct impact on lowering the MMR. This success was achieved through widespread educational campaigns throughout the country (BMMS 2011).

In contrast, the MMR in India experienced only a marginal drop from 254 to 212/100,000 in the years 2004–2009. In a January 2012 edition of the *Times of India,* there was a quote by the Secretary-General of The Federation of Obstetric and Gynaecological Societies of India, Dr. P. K. Shah:

> It is shameful that India, one of the fastest growing economies, is amongst the five countries with worst maternal mortality rate at 250–300 per lakh (100,000). The situation is unlikely to improve unless measures are taken on a war footing. This requires a planned strategy by the union government.

What Do Mothers Die from?

When she was 14, Ruande Kumirai was married. She soon became pregnant and now the 15 year old girl is expecting her first baby. The village midwife who helped deliver her sister's baby, too arrives as her contractions start. She brings incense and a small contraption made of leather. It is supposed to widen the birth canal and speed up the delivery. Ruande's contractions have been going on for the past 12 h. She is crying, yet she knows that for the other women who are standing in front of the hut and singing, the situation was exactly the same.

The 20th h of contractions and painful labor begins. In the meanwhile, Ruande's husband has arrived. He is not able to provide any help, yet he tries to convince the village elder to allow Ruanda to be taken to the health center, which is a 2 h journey from the village. After 2 h of consultations, he receives permission to take her to the medical facility. So her places her on the cart which he normally uses to distribute manure around the fields, hooks it up to his old bicycle and, in the fading twilight, drives his wife, who is still moaning, to the health center. It is dark when they arrive. He receives reassuring words that in the morning, the friendly doctor from the north will be there to help her. Everything, he is told, is going to be fine.

The next large hospital where a caesarean section can be performed is a day's journey. They do not have enough money to hire a car or a taxi. The nurse tells them that it is nothing unusual for the contractions to go on for so long. The next morning, the baby is dead. The mother suffered severe hemorrhaging and has a fever. Inevitably, septicemia sets in and Ruande can only be rescued if her uterus, which is oozing with pus, is removed. Days later, Ruande and her husband return home where the future looks bleak.

Ruande survived, unlike many other women in the same situation who die from septicemia, or blood poisoning. Death is mainly caused by hemorrhaging (28 %), postnatal septicemia (15 %), poor hygiene and/or high blood pressure during pregnancy (14 %), unsafe abortions (13 %), as well as from the effects of a long, drawn-out or 'impossible' birth. More than half of the fatalities occur within 24 h after the women first go into labor. Malnutrition is often a deciding factor, such as in cases where the mother is anemic or suffers hemorrhaging, or a contributing one, for instance when a vitamin deficiency causes immunological disorders.

The reasons for the high MMR are poverty, chronic malnutrition leading to poor health, and the double strain of being a mother and working simultaneously. Again we have the merry-go-round situation: poverty, malnutrition, health disorders and frailty, reduced levels of productivity and education, poverty, and so on.

In Many Languages, Poverty Is Female

Poverty is a state of being in which a person's resources (material, social and cultural) are limited to an extent which prevents them from having a lifestyle which is tolerable, acceptable and in general typical for others in their respective countries

According to the World Bank's definition, poverty means having <$2 per day to spend, whereas living in extreme poverty means having only half that amount. Neither amount is obviously enough to pay for a varied diet or medical care, which is not free to the general public in most cases. A billion people earn <$1 a day, and 2.5–3 billion people <$2.

Poverty is a basic problem for women, particularly in developing countries, but not only there as can be seen from recent developments in Germany. Usually, it is single mothers who are the ones most strongly affected. Elena Bütow, in her book on the subject (2010), says that poverty is a female problem and gives a number of explanations for this:

- Women have less financial resources to start off with.
- There are difficulties involved in combining work and family life.
- Being solely responsible for the children's welfare, among other things, is a tremendous strain.
- Women do not have enough free time, for instance to spend with their children.

It is no wonder that single mothers are in a significantly poorer state of health married women, as can be seen from the prevalence of 44 different illnesses, according to a health report published by the German government (Helfferich 2003).

This in turn has a negative impact on single mothers' ability to be productive and thus perpetuates the circle of poverty. Poverty has many children. Take for example poor living standards, miserable hygienic conditions, exclusion from a normal social life, and obstacles to preventive health measures and medical treatment. Everything relating to education and health care is simply out of the question when poverty runs the show. If poverty is the director, then hunger is the accountant.

Europeans are well-to-do and can therefore afford to have a privileged lifestyle. What poverty really means is something we do not know. We can barely fathom a situation in which we would have <$1 a day to spend on the things we need. And yet this is not a situation which affects only a very few people worldwide, as can be seen in Table 4.2.

Poverty does not reveal itself to us when we see women in colorful robes pounding manioc, which the media sometimes present. It has far more to do with depression and a bleak future, living on the fringes of society, which itself is poor, yet there are some members who are able to afford a small plot of land to farm and provide for their daily needs. A simple indicator for measuring poverty is the roof of one's hut. There is a small group of materials which are used: tarpaulin, cardboard, leaves, and metal. The more stable the roof is, the higher the family's income is. However, for some families, poverty means not having a hut or even a roof over one's head. Poverty means going through each day wondering where the next morsel of food is going to come from. Poverty means having to walk for hours just to get food aid for the children. Poverty means living without those basic amenities which we all take for granted: a toilet, clean water, a bed, cutlery, and protection from vermin. Last but not least, poverty means having to watch your children die from illness and starvation. It is a life of nothingness, with nothing to help you survive.

Table 4.2 Worldwide distribution of poverty

Region	% in poverty (<$1.25/day)	Population (mil.)	No. of people with <$1.00/day (mil.)
East Asia and Pacific	16.8	1.884	316
Latin America and the Caribbean	8.2	550	45
South Asia	40.4	1.476	596
Sub-Saharan Africa	50.9	763	388
All developing countries	28.8	4,673	1,345
Europe and Central Asia	0.04	473	17
Middle East and North Africa	0.04	305	11
Total		5,451	1,372

Source World Hunger and Poverty Facts 2011; www.worldhunger.org

If the mother dies during child birth, it usually means that all hope for the rest of family to rise out of their state of poverty dies with her.

Studies of maternal mortality in Sub-Saharan Africa have shown that there is a direct correlation between it and the GDP of a country, the average life expectancy, the amount of money spent on medical bills, and the percentage of births which are assisted by a professional. These factors, in turn, are directly related to personal income, and thus to the ability to afford proper health care and a balanced diet.

Maternal maternity is often a question of whether or not the family can afford to get professional support for the mother during labor and the income levels of the population as a whole (see Table 4.3). Although support, such as a midwife, could certainly prevent many of these deaths, poverty remains the biggest factor behind why complications occur during childbirth which claims the lives of both mother and child. 'Acute' cases can hardly be prevented right now since the necessary infrastructure is lacking. What must be undertaken, however, are measures to provide medical care for pregnant women, such as is the standard in Europe. Such care does exist even in poorer countries, yet the facilities are often too far away to be feasibly reached or are prohibitively expensive for the vast majority of people.

Despite improvements in its economy, Nigeria's high MMR is due to poverty. The GDP has been continuously on the rise since 2001. A moderate military council took over power in 2008 and has since then introduced some reforms. Nevertheless, the percentage of people living in absolute poverty, i.e., having <$1 per day, is still extremely high (71 %), while the number of people with <$2 per day is a staggering 92 %. In effect, Nigeria is one of the five poorest countries in the world. Life expectancy in the country is 44 years, the lowest end of the scale, while maternal mortality tops the scale with 700–1,500/100,000 births.

According to a survey conducted in Nigeria (National Population Commission Nigeria 2003, 2008), 30 % of women did not have the financial means to hire a midwife, 24 % had no possibility to travel to the nearest facility to receive natal care,

Table 4.3 Maternal mortality and income

Indicator	Honduras	Guatemala	Indonesia	India	Nigeria
MMR/100,000 births (excl. stillbirths)	108	153	307	540	704
% of women who delivered at a special facility	62	42	40	35	33
% of women who received professional support	56	41	66	42	35
Main causes of death	Hemorrhaging high blood pressure infection	Hemorrhaging infection high blood pressure	n. a.	Hemorrhaging anemia infection	Hemorrhaging infection abortion
GDP purchasing power in US$	2,800	5,200	3,700	3,400	1,000

Source Shiffman 2007

14 % did not know who they should turn to for help, and 10 % said that they were turned away from the hospital. These figures are typical for other regions besides Africa. 66 % of babies are delivered at the family's home, and a mere 23 % of women are given postnatal care by a competent professional. Often, clinics and maternity wards in the country are quite poorly equipped. According to a ranking list of the quality of health care systems, Nigeria is number 187 from a total of 191 from those which were assessed. In a nutshell, mothers die because they are poor.

That is the summary of the link between income and mortality, which incidentally also holds true in highly developed economies, according to data collected in the United States. The number of poor people in the USA, particularly women living in absolute poverty, has risen significantly in the course of the past few years. Every seventh woman finds herself in a state of poverty, whereas every fifteenth woman lives in absolute poverty (National Women's Law Center 2011). In 1990, the number of women who died during childbirth (excluding stillbirths) was 12/100,000. In 2008, it had doubled to 24/100,000. However, maternal mortality worldwide has decreased by 34 % (WHO 2010). In populations which have generally low levels of education and income, the MMR is 28.4/1,000 births (excluding stillbirths), as opposed to 8.5–10.5/100,000 in richer countries (National Center of Health Statistics 2009). The reason for this is the lack of money to pay for prenatal care, resulting in a risk of complications which is three to four times higher (Bingham et al. 2011). The fight against poverty must also be a top priority in industrialized nations. Hunger carousels are spinning in the land of plenty as well. They are simply better concealed behind all of the plentifulness and difficult to imagine for those who are not onboard.

> An analysis by the socioeconomic panel of experts revealed a positive link between income and life expectancy among men and women in the latter half of their lives. If we divide up the population into four groups based upon their income, then those with the lowest income have a life expectancy which is 4–6 years less than those in the uppermost group. Even if other factors which influence maternal mortality come into play, the link to income remains unbroken. (Reil-Held 2000)

In Germany, 17 % of men and 21 % of women live in a state of poverty; in other words, their personal income lies below €940 per month (German Federal Ministry for Families, Senior Citizens, Women and Adolescents 2005). As they were not the subject of investigation, the implications of this situation for these people's diets, in particular that of children, are unknown and so will not be discussed at this point any further. Yet according to the Research Institute of Child Nutrition in Dortmund, unemployment benefits in Germany (*Hartz IV*) are not enough to provide a balanced diet for children of the recipients. The same applies to the poor in developing countries. A balanced diet costs more than on which is lacking different micronutrients (vitamin C, pro-vitamin A, vitamin D, folic acid etc.), according to two different studies: one in the United States (Aggarwal et al. 2012) and one in France (Maillot et al. 2007). High-quality food costs more not only because it has less calories, but because it also contains more micronutrients, according to the authors. The poor do not have the luxury of deciding. If they want to feel full with the little amount of money they have to spend, it means making due with low-quality food.

The 'Bermuda triangle' of poverty, malnutrition, and disease exists in every country, and depending upon income and access to food, only the scope and severity of it differs. While mothers and their children are forced to eat the cheapest food available, namely grain, in order to fill their stomachs in developing countries, the situation in countries like Germany and elsewhere in Europe and North America is supposed to be different. Yet in Germany, the cheap food items are the ones which the poorer classes put in their shopping baskets, although these are not necessarily grains and cereals, but rather low-priced, low-quality meat and sausages. What some have too few of, namely calories, others have too many of. This explains why members of poorer families are quite often overweight. What these poor diets have in common is a low density of essential micronutrients. The result is obvious: Children from poor families in Germany are twice as often overweight and three times as often obese as children from higher-income families (Kleiser et al. 2009). This also means that appearances are deceptive. Children from low-income families are often overweight, yet this does not rule out the fact that they may also be more or less malnourished.

622 overweight pregnant women living in the suburbs of New York City underwent a 2-year postnatal examination as part of a study which revealed that the women tended to be overweight in cases where food security was lacking (low diet diversity, low nutrient density), and that the probability was higher that these women would regain the weight they had had during pregnancy (Olson and Strawderman 2008).

The premise that there is enough healthy food for everyone in developing countries may be correct, yet it ignores the fact that the ability to obtain them depends upon one's income. In industrialized countries, the land of plenty, the plight of the have-nots in this context is much less obvious. Hidden hunger in prosperous countries and its adverse health effects on those who suffer from it are issues which have been, at best, only marginally researched in most developed countries, excluding the United States.

Chronic Malnutrition and Pregnancy

Chronic malnutrition is a shortage of essential substances which are beneficial to one's health and immune system. It is once again the essential nutrients connected with hidden hunger, namely vitamin A, iron, and zinc, which are lacking as a result. Malnutrition is poverty's child and, in combination with poor hygienic conditions and the absence of professional support during labor, is a primary factor in the high maternal mortality rate in developing countries.

The time a woman spends in labor is often times prolonged, depending upon the size of the mother, as well as the baby. The percentages of delayed births differ among the developing countries. According to the estimates made by the WHO, delayed or impossible birth is the cause of 22 % of maternal and neonatal deaths. Being malnourished themselves, many mothers have a pelvis which is simply too small for the size of the infant's head. They may also be scarred or have fistulas in the birth canal caused by circumcision or untreated wounds from previous births. This, in turn, leads to inflammation of the birth canal called pressure necrosis, making childbirth very difficult or even impossible (Dolea and AbouZhar 2003).

Very young mothers who were malnourished as children themselves are usually petite. In addition, an early pregnancy also further hampers a women's physical development. Malnutrition occurring in the first 2 years of a future mother's life, referred to as the 1,000 day window, have long-term effects which begin to take hold in numerous life-threatening ways. Among poor women, being petite is a determining factor in causing disorders of the intrauterine system and for infants having low birth weight. Both of these conditions are deadly for mother and child, respectively.

A meta-analysis of 25 studies conducted in 25 countries revealed that women who are between 145 and 157 cm tall, in other words petite, more frequently require assistance during childbirth than women who are taller (WHO 1995). If we add an inadequate diet lacking micronutrients to that, then the mixture turns fatal for mother and child. The additional micronutrients which the mother needs for both herself and her baby's development during pregnancy are in ever shorter supply until the reserves are finally empty. This has a weakening effect on both of them. A mother in Africa who comes from the uneducated classes will hardly know what vitamins are, not to mention that these are of vital importance during pregnancy. Yet even if she did know the meaning and the significance of vitamins, this would not be of much use to her since she does not have the money to buy vitamin-rich foods. A vitamin deficit rarely shows up unaccompanied. Granted a

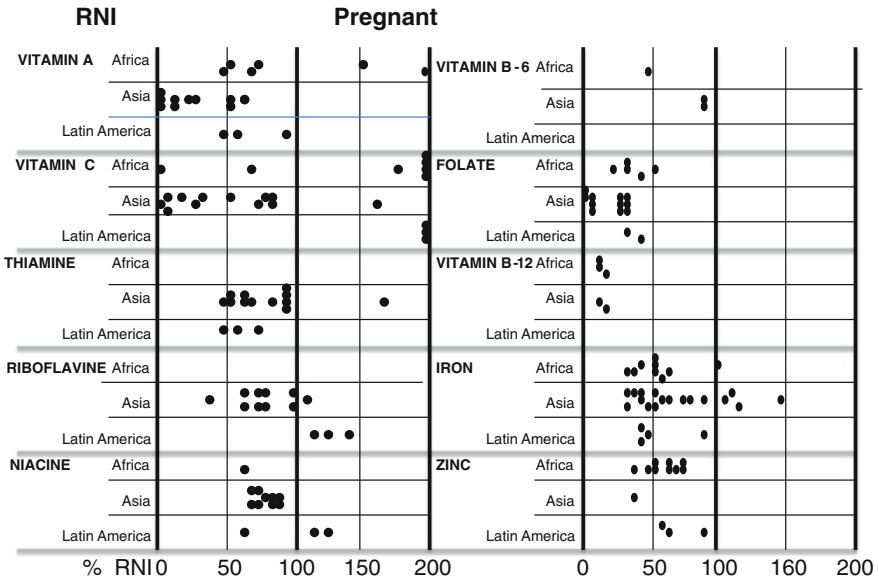

Fig. 4.4 Meta-analysis of micronutrient intake vs. the RNI (in %) for pregnant women (**a**) and women who are neither pregnant nor breast feeding (**b**) (Torheim et al. 2010). The points represent the results of one study with the percentage below (<100 %) or above (>100 %) the RNI

temporary shortage of micronutrients, say a few days, is of no real consequence to one's health, at least as far as we currently know. If the mother's diet is fundamentally insufficient, however, this can endanger both the baby's development and the mother's health condition. Not fulfilling the recommended daily allowances for multiple micronutrients is a clear indication of an imbalanced diet or malnutrition.

An evaluation of data from 1,560 studies (see Fig. 4.4 a, b) showed that in regions where people's diets did not contain enough micronutrients, the recommended nutrient intake (RNI) for most micronutrients was, for the most part, not fulfilled, particularly among pregnant women (Torheim et al. 2010). A value of 100 % of the RNI is currently presumed to be sufficient to meet the nutritional needs of 98 % of the people in a healthy population. However, it is often the case that many healthy people, not to mention pregnant women, do not meet the RNI for many vitamins. In fact, sometimes not even 50 % of the RNI are fulfilled. Pregnant women need a higher intake of micronutrients, otherwise their reserves will eventually run out. This is particularly the case with twins and triplets or when a woman has been pregnant a number of times in a relatively short time span.

Vitamin A Deficiency and Pregnancy

An inchoate vitamin A deficiency can hardly be detected by means of biochemical markers. The immune system will have already been weakened before the first clinical symptoms of a deficiency appear making way for infections of all sorts, as well as intestinal parasites. Filthy water, a lack of hygiene and, once again, poverty

are the guarantors that even a mild vitamin A deficiency can have devastating effects on pregnancy. When night blindness occurs, it is a sign that the deficiency is already in an advanced stage. Approximately, 20 million pregnant women worldwide have a vitamin A deficiency, a third of which suffer (often unknowingly) from night blindness (West 2002). Night blindness is often not viewed as a consequence of an advanced vitamin A deficiency since it is often not seen as being an illness. The maternal mortality rate could be lowered by 40 %, from 645/100,000 to 385/100,000, just by providing pregnant women with vitamin A and provitamin A (β-carotene) supplements (West et al. 1999).

A similar study which was conducted with 10,422 pregnant women in Nepal (Christian et al. 2000) showed that the risk of mortality among women with night blindness (3,601/100,000) was clearly higher than among those without night blindness (950/100,000). The mortality rate among women with night blindness who received vitamin A and provitamin A substitutions (1,163/100,000) was clearly higher than those without night blindness and who received substitutions (631/100,000). Women who suffered from night blindness were five times more likely to die from infections than those without night blindness.

The success of intervention in cases of women affected by night blindness shows that not only does a severe vitamin deficiency increase the risk of maternal mortality, but also that vitamin substitution is a helpful method of emergency intervention. This needs to be considered when examining the results of other studies which did not include women with a documented vitamin A shortage. Yet this in no ways, questions supplementation as a method for treating women without a vitamin A deficiency. The risk of infection is present long before the first symptoms of night blindness appear and poses a danger to both mother and child.

A vitamin A supplementation during pregnancy should only be accepted as a necessary last resort. Night blindness is not only the result of a vitamin A deficiency, but it is also a clinical marker for malnutrition. The decision to do without vitamin supplements should rest upon the fact of whether or not the woman's diet is adequate and contains all of the other essential micronutrients.

Anemia and Pregnancy

There are two different forms of anemia: iron deficiency anemia, which occurs in developed countries as well as developing countries, and anemia which is not (solely) caused by an iron deficiency. The latter is caused by a shortage of other micronutrients, in particular folic acid, but also vitamin A and vitamin B and is predominantly found in poorer regions.

Iron deficiency anemia often begins during childhood, worsens during adolescence, and becomes severe during pregnancy. Returning to the hunger carousel, children born with an iron deficiency are fed breast milk that has low concentrations of iron in it and so they are unable to store up any reserves. They carry along this iron deficiency throughout their childhood and different developmental stages with all of its negative implications. Anemia becomes more acute when a woman starts menstruating, and becomes increasingly severe if she marries and gets pregnant at an early age.

Major studies conducted in different countries all arrived at the conclusion that 70 % of all pregnant women and women in childbearing years have some form of anemia, more than half of these because of an iron deficiency (Kalaivani 2009). The percentages are clearly higher in developing countries. The anemia rates among expectant mothers in Africa, Europe, and North America are more than 50 , 18 , and 6 % respectively. The economic divide does play a part in developed countries, as well. Among pregnant women in the USA who have a lower income, up to 33 % were found to have anemia. There is a very conspicuous link between anemia and maternal mortality. Countries which have a high rate of anemia, such as those in Africa and Asia with more than 45 %, also have a clearly higher MMR, namely 780/100,000 and 360/100,000, respectively, excluding stillbirths. Compare this to countries where the anemia rate is lower, such as in Central Europe and the USA, where anemia is under 35 % and the MMR is 10/100,100 and 17/100,000, respectively, excluding stillbirths (Kalaivani 2009).

Similar to night blindness resulting from a vitamin A deficiency, anemia happens in stages. A visible case of anemia is a clinical indicator of the final stage (stage 3) since symptoms only appear once the iron reserves have been fully emptied (stage 1) and anemia without any signs sets in (stage 2). The needs of the fetus and the additional amount of blood in the mother's bloodstream increase the need for more iron. The results of a nationwide study in the USA show that 90 % of pregnant women do not even meet the RDA of iron for the average adult, more precisely only 14.7 mg/day as opposed to the recommended 22 mg/day. In Germany, 60 % of young women just barely fulfill the recommended amount of iron intake for women not entering pregnancy, according to a national study. If a woman becomes pregnant and does not adjust her diet accordingly, then there is a real risk of her becoming undernourished.

Regardless of whether or not it is tied to an iron deficiency, anemia is always a sign of an unbalanced diet. A shortage of zinc and copper, as well as other micronutrients, exacerbate iron deficiency anemia and make afflicted persons more susceptible to infections (Scott 2007).

The link between micronutrients and anemia becomes quite clear when one considers the success achieved in reducing anemia among pregnant women by providing them with multi-micronutrient supplements. Similar success was achieved with supplements of iron and folic acid. Despite such proof, there are still quite a few women who find themselves in the third stage of iron deficiency anemia (Shrimpton et al. 2009). In light of challenges to the value of providing nutrient supplements, the results of a recently conducted meta-analysis laid such protests to rest. The recommendation of the scientists involved stresses that a fetus is more likely to achieve the desired weight and development when pregnant women in developing countries are given multi-micronutrient supplements instead of the mixture of iron and folic acid which has hitherto been often administered (Shrimpton et al. 2009).

The daily allowance of iron for pregnant women is 20 % higher than the normal RNI since it is a vital substance which is needed for the development of the cells and tissue of the fetus. This is especially true during the second half of pregnancy,

when an adequate supply of iron cannot be guaranteed from an ordinary diet (Earl and Woticki 1993). The WHO recommends a daily amount of iron of 60 mg. This is far above the recommendations of other countries, for instance Germany (30 mg), and rightly so (WHO 2005). Young women frequently do not have enough reserves of iron to last for the entire duration of pregnancy. The issue of getting enough iron must become a high priority, therefore, especially in regions where the sources of iron are quite limited and the risk of anemia very high. It is not only the availability of iron sources which is important, but also the prices of these, as studies conducted in the USA have shown. Here, roughly 30 % of pregnant women in the lower income bracket are stricken with anemia (Adebisi and Strayhorn 2005). Regardless of income, women who believe that they must maintain a vegan diet during pregnancy have an iron deficiency. Such a diet during pregnancy is a conscious form of malnutrition which causes the developing fetus to be deprived of iron and other micronutrients.

The woman will hardly notice herself that she has anemia, as it can only really be detected by means of professional examination. Since such medical assistance and check-ups are normally not covered by their health care insurance, provided they have some, they remain in the dark and at risk. Most women assume that the fatigue they feel and the frequent infections are due to the pregnancy. A mild case of anemia will cause a pregnant woman to simply not feel as fit and, hence, not be as active as usual. As the anemia worsens, it becomes increasingly more difficult and requires more effort to perform light household tasks, such as cooking and cleaning. Ultimately, an iron deficiency will the cause the woman to give birth prematurely and the baby to be underweight. Thus, iron deficiency anemia in the third trimester of pregnancy is a risk factor for premature birth and low birth weight (Levy et al. 2005). What this ultimately means is that the lives of both the mother and the child are in jeopardy!

Women with anemia often experience symptoms, such as hemorrhaging, sepsis, and high blood pressure, which lead to death either during childbirth or shortly thereafter. The number of maternal deaths which can be traced back to anemia is estimated at 20 % (Registrar General of India 2008). The more serious the anemia is, measured on the basis of hemoglobin, the less likely the mother is to survive the birth.

Studies which examined maternal mortality in Sudan revealed the four main causes of death to be anemia (20 %), hemorrhaging (16 %), delayed birth (14 %), and sepsis (11 %) (Mohammed et al. 2011).

Anemia is often a sign of chronic malnutrition. A study conducted with 418 women between the ages of 15 and 35 from rural regions in India showed that 77 % of the women had a type of anemia, while 28 % had iron deficiency anemia (Rao et al. 2010). Iron deficiency anemia was most prevalent among women who had a low body weight (<40 kg), were short (<145 cm), and had married relatively early (<19 years of age). 63 % of the women worked in the fields and received very low wages.

An analysis of their eating habits clearly revealed just why so many of these women were chronically malnourished. This analysis also provides insight into the

diets of the poor rural inhabitants. A mere 10 % had access to food containing an absorbable form of heme–iron, and only once a week or every 14 days at that. The main source of iron was millet, which is poorly absorbed by the body. Rice was too expensive and is therefore only eaten by 30 % of the women on a daily basis. Green vegetables are reported to be eaten less than once every 2 weeks by 53 % of the women interviewed, even though these are generally cheaper than rice. Milk, which is clearly costlier, was not part of the diets of 65 % of the women, while those who did mention it as a foodstuff only took a small bit in their tea. Fruits were only eaten less than twice a week by 47 % of the interviewees. 50 % of the women reported that they did not grow their own vegetables. Only 10 % of the women who did growth their own produce used it to feed their own family. Hence, 90 % sold either all (26 %) or a part of what they produced.

Here is an overview of these women's typical diet:

- vegetables 1–2 per week;
- fruit 1–2 per week;
- no meat;
- small servings of milk;
- millet on a daily basis.

Millet is commonly grown in the family's own garden, which lacks any form of irrigation. The women give various reasons why they eat vegetables so seldom and in small portions (<50 g). They mentioned difficulties in preparing the vegetables, the fact that they do not have a garden of their own, the family does not like eating vegetables, they spoil quickly (since they do not have a refrigerator), and vegetables do not fill them like other foods do. Through the sale of home-grown produce, the family's low income can be raised slightly and perhaps allow them to pay for medical treatment or schooling for the children. The health and well-being of the family fall along the wayside.

Is it any wonder then that these women weigh <40 kg and are <145 cm tall? The diet they regularly consume has far less micronutrients than the average healthy person needs to stay healthy. The prevalence of anemia and the high maternal and infant mortality rates both point to a general deficiency which urgently needs to be addressed.

Conclusion

A fundamental difficulty in evaluating whether or not an expectant mother is getting enough micronutrients is actually measuring the amounts of vitamins and trace elements which are in her body. In cases where a deficiency is suspected by not confirmed, supplements can be provided, which may in the end be superfluous, yet are not meant to substitute a balanced diet. More specifically, taking certain micronutrients can give women a false sense of security since other micronutrients, which they would get by means of a balanced diet, are lacking. A classic example of this situation was demonstrated in studies which showed that only seldom did expectant mothers in developing countries suffer from a shortage of one single micronutrient. It was also discovered that multiple deficiencies prevailed among

women whose income was quite low and, who had experienced multiple births in a relatively short time period. This can ultimately cause developmental disorders to the fetus and thus negatively impact the health of the child in a number of ways. UNICEF, the WHO and the UN therefore recommend that pregnant women take supplements of folic acid (60 mg) and iron (400 μg). Following the example set by Canada, a multi-micronutrient preparation is being recommended in the meanwhile. The administering of such preparations has caused newborns to be heavier at birth, as well as to have a larger torso and head (Roberfroid et al. 2012)

Women who are petite (<157 cm) should be monitored closely during pregnancy. Women who are under 150 cm tall are five times likelier to experience difficulties when the baby's head travels through the birth canal than are women who are taller than 160 cm. In such cases, nutritional intervention or supplementation should be undertaken to ensure ample birth weight, yet it must be done cautiously or only in cases where a cesarian section is possible. If the mother herself is not yet full grown, there is a higher risk of premature birth since her reserves of micronutrients, which both mother and child need, will be drained much more quickly.

Station 2: Infant Mortality

Similar to the reasons for the high maternal mortality rate, the underlying factors here are chronic malnutrition with regard to mother and child, as well as insufficient health care.

We are still at the beginning of our ride on the carousel, but we have already lost a few passengers. The empty spaces are quickly filled by a new group of young mothers, who were drawn onto the carousel against their will. In fact, they were born onto it and many of them will soon leave it. We cannot wave goodbye since we do not realize what is really going on around us.

Johanna is holding her baby in her arms. Her girlfriend, who had holding the child until now, is standing beside her and crying. Johanna was barely conscious when the child first saw the light of day as she was lost in the agony of the arduous birth. In the meanwhile, pieces of the placenta and the puddles of blood have been mopped up from the floor. Her hair is wet and sticky, her eyes peer out through small slits. The infant she holds is warm and tender, its arms folded inward, its legs hanging loosely. Johanna waits for its first cries… and waits…. The baby's tiny head has gone from blue to pale white and Johanna now knows that this child of hers, this little boy, will remain nameless. Sooner or later somebody will come and take the child from her arms and bring it away. The women will whisper among each other and keep out of contact.

Johanna is one of 7,500 mothers worldwide, who hold lifeless newborns in their arms, although there are thought to be just as many unreported cases.

A stillborn child is similar to a doll: soft, pale, motionless, smiling or expressionless, and completely lifeless, yet physically speaking a child—one that was carried around in its mother's womb for a long time and destined to have a life. The mother holds it in her arms like she used to hold the dolls made from roots

wrapped in a towel. She talks to it the way she talked to the doll and gives the answers back to it as she did back then, when it was all a fantasy. Now it is a reality. The wonderful illusions have all evaporated.

Johanna cannot be furious, scream out, and blame somebody for her tragedy because she does not know the perpetrators who took the life of her child. She does not see the faces of those who caused her poverty and the death of her first child when it was only 2 years old. The wrongdoers hide behind their silence and their ignorance and unawareness. Johanna will be as still as the child she is now holding and the next one she will be holding when the carousel ride continues.

Stillbirths–approximately 30 % of children are stillborn.

Infant mortality—approximately 50 % of children die within the first 24 h.

Death cannot always be avoided. Some may call it fate. We can speak of inevitability when everything which could have prevented death from happening was undertaken. On the other hand, it is certainly not a matter of fate when certain criteria for promoting life, such as food security and health care, are missing.

Dealing emotionally with the death of an infant

What you choose to do after your newborn infant has died is a very personal matter. There is no right or wrong. Maybe you disagree with your partner or need time to work things out. The hospital should respect your wishes regardless of what you decide to do.

The heartbreakingly painful moment when parents have to say goodbye is sometimes the only chance they have to hold the baby in their arms. Some parents choose to give the baby a bath and dress it in some baby clothes. Other parents take pictures and like to keep a memory of their child. It is important to simply do whatever it takes to find consolation. (Babycenter 2010)

Studies have shown that it helps many parents when they can see and hold their stillborn child. This is especially the case if the baby was lying in an incubator after it was born.

Parents are given good advice to help them through the death of their newborn child and support in finding answers to the questions of why their child was taken from them. Mothers are relieved of the burden of thinking that it was their fault that the baby died and that they could have somehow prevented it.

Losing a child is and will always be a highly traumatic experience for a mother. The assumption that the pain lessens the more often you experience it is a form of denial.

Mothers living in city slums and even more so in huts in rural Africa and Asia do not get such words of consolation. Here, mothers are left alone with their lifeless child and are oftentimes stigmatized. They will hardly ever know the reasons why their child died and certainly not that this could have been prevented and how.

The renowned journal *Lancet* (Froen et al. 2011) ran a series of articles concerning stillbirth. Here is a summary of a few of the important aspects which were mentioned:

- At a time when great progress is being made around the world regarding mothers' health, their natural right to a living child is not to be found on any health agenda.
- Mothers who lost a child often suffer stigmatization or social marginalization in societies which view the situation as being her fault, an indicator of the presence of evil spirits or fate.

- There are many in the health care system, albeit a minority, who believe that the issue of preventing stillbirths does not have the same priority level as preventing maternal and child mortality.
- Stillborn children are not perceived by society and have no lobby to promote their interests.

At a fertility rate of 5.1 in Africa and an average neonatal mortality rate of up to 165/1,000, the probability that a mother in Africa will lose her new newborn baby is incomparably higher than in Germany, where the fertility rate is 1.45 and neonatal mortality rate is 6/1,000. Put another way: The probability that all siblings born to African mothers will survive is low.

79 million dead babies

The mortality rate of newborn babies is only gradually decreasing.

Despite progress which has been made in preventing it, millions of newborns die every year. This is according to a comprehensive study conducted by Mikkel Oestergaard and his team from the WHO, which the journal PLOS Medicine has now published online. Unlike earlier investigations, researchers are not focusing merely on child mortality up to the age of five in general, but instead on the first 4 weeks after birth, presumably the most perilous time in a person's life.

The collection and extrapolation of the data from 193 countries revealed that neonatal mortality declined from 4.6 million to 3.3 million cases from 1990 to 2009. However, neonatal mortality rose in eight countries, five of them in Africa, during the same period. This is also a problem which is faced by emerging markets, such as India. Throughout the period of observation, 4 % of newborn babies died there. In 2009 alone, the figure was nearly 920,000. In total, 79 million babies around the world lost their lives during this 20-year period.

These numbers are even more horrifying, say the authors, when one considers that the number of deaths was reduced by a third thanks to better hygienic conditions during delivery, breastfeeding and the provision of a warm environment. (*Süddeutsche Zeitung*, 31 August 2011)

Newborn mortality is classified into three different groups: stillbirth (according to the WHO, birth weight under 100 g and delivery after week 28), neonatal (day 0–7), and postnatal (day 8–28). In many developing countries, fetuses which die before the 28th week are not recorded since the general opinion is that they had no real chance of survival. They are absent from any statistics and, in the best case scenario, they are counted as aborted. The fact that premature births, including those before week 28, are closely connected with the mother's diet and age, is often overlooked when the baby dies before week 28.

3.2 children are stillborn (i.e. after week 28), or they die shortly after being born. 98 % of these deaths occur in poorer countries. They only find their way into a few isolated statistics and the number of unreported cases is most certainly not small. According to the WHO's definition, a third of babies are stillborn and two-thirds are neonatal deaths caused by a variety of immediate factors. All in all, 10 million children die every year before reaching their first birthday.

Setting the 'cut-off' date at the 28th week of pregnancy, meaning that the child is not considered as such prior to that point, is highly controversial, yet statistically it inevitably leads to an underestimation of the number of stillborn children. Elizabeth McClure, a renowned expert in the field of infant mortality, rightfully

points out that half of all stillbirths happen between the 20th and 28th week of pregnancy (Goldenberg et al. 2009). Her conclusion is that the number of stillbirths would double. This remains, however, a gray area since such deaths are often technically considered to be an abortion and are therefore not figured into the statistics. If they were, the importance of preventive measures could be recognized since more research could be done into whether or not this form of mortality is preventable. It is very likely that a significant number of these early deaths are the result of malnutrition on the part of the mother and, hence, her baby, too.

A sober assessment of the entire situation is first of all needed for us to fully become aware of what is actually taking place, yet we must see each case as an individual tragedy and look at the personal circumstances which each of these children are being born into. The campaigns for the use of contraception are certainly a milestone in the race against child mortality. Yet they are of no significance whatsoever when it comes to the children who have been conceived and, whose lives are in danger. How should farmers work to feed their families when the helping hands, in this case the hands of the children, are missing? Seeing children as the wealth of a family is a highly precarious survival strategy. Only when the child mortality rate has decreased, will there be less mouths to feed and the children who survive will be able to make positive contributions to the family's financial situation and diet. It is quite simply scandalous that women are left completely alone in this plight and there is no widespread discussion, such as there is regarding other, less vital issues, such as whether or not women should (be allowed to) wear a veil in public.

At the time the MDG 4 was conceived, child mortality after the first 6 months was the foremost issue. Infant mortality was completely disregarded. While the number of children who die before the age of five is continuously decreasing, it is a different story with newborn infants. There was no visible reduction in the neonatal mortality rate from 2000 to 2008. The gap between rich and poor can be seen particularly clearly in Fig. 4.5.

Early neonatal death is death within the first 7 days
Fetal death is birth without vital signs after week 22 of pregnancy or with a body weight of under 500 g
Late fetal death (stillbirth) is birth without vital signs after week 28 of pregnancy or with a body weight of under 1,000 g
Late neonatal death is death between day 7 and 28 after birth
Low birth weight describes newborn infants with a weight of under 2,500 g caused by stunted development in the uterus: children born not prematurely (after 37–42 weeks) and with lower than normal birth weight
Premature birth is delivery before week 37 of pregnancy

Premature babies are 13 times more likely to die than children born at the appropriate time. A premature birth (i.e. delivery before the 37th week of pregnancy) is the number one factor behind neonatal mortality and is responsible for

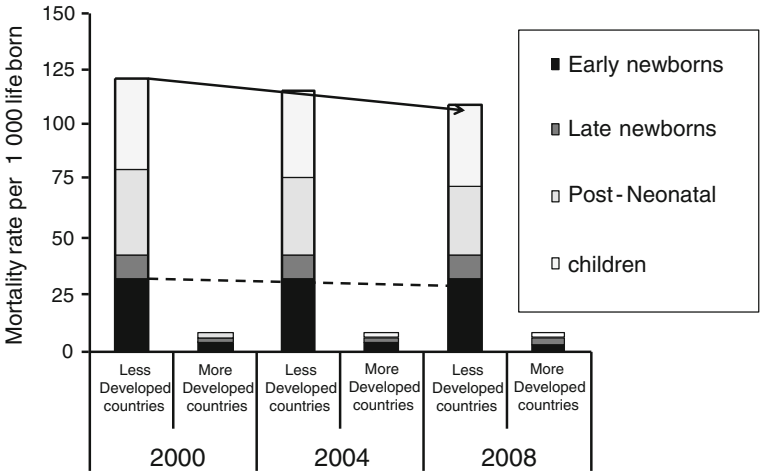

Fig. 4.5 Infant mortality in various stages and child mortality in less-developed versus highly developed countries (Lawn et al. 2009a)

27 %, or 1,080,000, of these deaths each year. Added to this are 1,000,000 stillborn children and children born before the 28th week of pregnancy or are under 1000 g. In developing countries, such children, in contrast to children in developed countries, have very slim chances of survival. If the mother gives birth at home, which is normally the case, then the birth is often not recorded and the exact number of such deaths is difficult to estimate.

Figure 4.5 clearly shows an overall decrease in child mortality, primarily among children under 5 years of age, but not among newborn infants. This overall development is what major statistical analyses make use of and refer to. On the contrary, we are currently seeing a substantial rise, according to UNICEF (UNICEF Report 2012). The percentage of neonatal deaths within the U5MR has risen from 36 to 43 %, whereas in East Asia it has risen to 57 % and in Latin America to 53 %, although child mortality in total has decreased substantially in these regions. According to the report, 30 % of all neonatal deaths occur in Asia. In Africa, the decrease in neonatal mortality has been the smallest.

Box 4.1 Sternenkinder

In Germany, stillborn children and those who die during their first 28 days are called '*Sternenkinder*', or roughly translated 'star children'.

The first 28 days in a baby's life are referred to as the newborn period. Newborns are completely dependent on their mothers, who in turn are also dependent on others, to care of them. Mothers need to be given proper food and medical attention. During the first phase, the newborn is breastfed and so the quality of the breast milk plays a big part in the child's early development. If the mother's diet during pregnancy was already inadequate, this will have a

negative impact on the newborn's early development. 38 % of all children under the age of five die during this time. So the child mortality rate during the first month is 30 times higher than at the end of the 5th year.

If a healthy child dies during the first month in Germany, or any other industrialized country, then the health care system is called into question and turned upside down in the search for (potential) inadequacies. Putting the highly-developed health care systems to the test is most certainly justified and allows for the correcting of potential problems. However, the search for answers nearly always begins with the time of birth and thereafter and ignores how mother and child are nourished during pregnancy, especially with regard to vitamin A and the development of the baby's lungs. Studies regarding the diets of pregnant women in Germany, in particular those from the lower classes, have so far not been published.

In the more affluent countries, 40,000–50,000 children die during their first month every year. This makes up 1 % of such deaths worldwide. This means that 99 % of children who die during their first month are from poor countries, two-thirds of which in only ten countries, particularly in India and Africa (2.7 mil.). Of the 130 million children who are born each year, 4 million of them never live past their first month. These 4 million children are hardly noticed, their deaths are not recorded and the cause of their deaths not investigated. From these 4 million deaths, 38 % happen during the first month. 25.50 % of neonatal deaths happen within the baby's first 24 h and up to 25 % within the baby's first 7 days (Lawn et al. 2005). Depending on the country, between 40–60 % of neonatal deaths happen when the baby is born at home.

While looking at the figures, which of course are somewhat flexible, we must always be aware of the fact that they represent only those cases which were reported or documented by the hospital. Joy E. Lawn, a British pediatrician working in South Africa, is one of the most experienced scientists in the field of neonatal mortality, more specifically probing the underlying causes of it. She gives a clear explanation for why it is so difficult to obtain exact figures for the child mortality rate. She explains that in most cases of neonatal death, neither the birth nor the death is registered anywhere. The celebration and fanfare which greet a birth in rich countries is in stark contrast to the concern for the lives of both mother and child, who remain hidden at home without any support, when a child is born in many poor countries. Children often remain nameless up until week six, this being a clear indicator of the fatalism and passive acceptance of the high neonatal mortality rate within the society (Black et al. 2008). In an interview with the WHO, Lawn explained that it was only after the startling reports on neonatal mortality were published in *Lancet* (2005) that people became aware of the real problem. Since the MDG 4 put protecting only the lives of children between 6 months and 6 years in the foreground, no millennium goal focusing on combatting neonatal mortality currently exists.

Table 4.4 Causes of death among newborn infants (Bang et al. 2002; Lawn et al. 2006; 2009b)

Cause	Percentage (%)	Absolute (2008*)
Premature birth	28	144,000
Infections (sepsis/ pneumonia)	26	108,000
Oxygen deficiency/asphyxia	23	904,000
Tetanus	7	165,000
Diarrhea	3	75,000
Birth defects	7	265,000
Unknown	6	

What Do Newborn Infants Die from?

Nearly all newborn deaths can be linked, either directly or indirectly, to the mother's malnutrition, a legacy which is inherited by the baby, as well as to a lack of proper medical care and hygiene (see Table 4.4). Deaths are sometimes due to the shortage of a particular micronutrient, for instance if the baby catches pneumonia or has diarrhea because of a lack of vitamin A and zinc. It has been medically proven that providing micronutrient supplements to pregnant women suffering from a deficiency, such as vitamin A, reduces the infant mortality rate. What is more, by placing the mother under medical supervision during her pregnancy, as well as during childbirth, the number of stillbirths and neonatal deaths were also reduced, regardless of dietary issues.

Countries where the mortality rate is low to moderate (<5–30) generally have a sound food supply. The higher the mortality rate is, the poorer the food supply. Malnourished children often die of asphyxia (intrapartum, neonatal) or as the result of postnatal complications (sepsis, pneumonia). There is also a conspicuously high number of children who die of tetanus, which can be prevented with appropriate vaccines (Lawn et al. 2009a, b). It should not be forgotten that children whose mothers suffer from a micronutrient deficiency are particularly at risk. Better medical care for expectant mothers is extremely important, but that is by far not the whole picture.

75 % of infant deaths are caused by asphyxia, low birth weight, premature birth, and all of the negative consequences of the latter two.

Sepsis and Pneumonia

Sepsis and pneumonia are caused by a lack of proper medical care and hygiene, but also by the fact that the malnourished baby's immune system is weakened. The number of children who die of sepsis and pneumonia stands in direct correlation with the mortality rate as a whole. There has also been an increase in the number of infant deaths caused by infection. What this ultimately means is that a high mortality rate within a population is due to factors which could have actually been

prevented. Preventing and treating such infections by means of medical care would undoubtedly do their part in helping. Yet, both are not adequately available in developing countries.

Oxygen Deficiency (Asphyxia)

Intervention studies in China and elsewhere in Asia revealed that when mothers took micronutrient supplements, the baby's birth weight was higher and the risk of premature birth lower. In total, neonatal mortality dropped by 54 %. At the same time, however, the risk of neonatal death by asphyxiation was higher among the group which received supplements compared with the group which did not (Zeng et al. 2008). An explanation for the increase in deaths by asphyxiation is quite possibly the fact that the baby's size had increased, as well as the length of the pregnancy.

A delayed birth is dangerous for both mother and child. The baby can die of asphyxiation during or shortly after birth (during which roughly a third of cases occur), or it may suffer severe and permanent brain damage.

One of the main reasons behind complications during birth is the ratio of the size of the baby's head to the width of the birth canal. A disproportionate ratio has been noticed to prevail among women who are malnourished (Dolea and Abou-Zahr 2003). A new look at the intervention studies (Christian et al. 2003) has uncovered elucidating clues as to why asphyxiation occurs during birth, but which also illustrate the entire dilemma of the hunger carousel (Lee et al. 2009). Pregnant women who took micronutrient supplements gave birth to children with normal birth weight and at the appropriate time much more frequently than women who did not take any supplements or only folic acid and iron. A similar conclusion was arrived at by a study conducted in China whereby children only showed appropriate birth weight if their mothers had received multi-micronutrient supplements during pregnancy, as opposed to simply iron and folic acid (Zeng et al. 2008). Thus the probability is higher that the baby's head will be too large to pass through the uterus, especially if the mother was malnourished as a child or showed signs of stunting. Two comprehensive meta-analyses confirmed the link between maternal stunting and difficult birth (Dujardin et al. 1996; Kelly et al. 1996).

Premature Birth and Low Birth Weight

According to the WHO's report (Liu et al. 2012), one child in ten is born prematurely, equating to 15 million premature babies each year, whereby 5 million of these are born in countries where there are hospitals with the medical equipment, etc., to deal with this adequately. That explains why 90 % of premature babies survive in rich countries, whereas 90 % of premature babies born in poorer countries die. 50 % of all premature births happen in only seven countries. The USA is among the ten countries which report 66 % of all premature births worldwide. Among the 11 countries with the highest rate of premature birth, i.e. above 15 %, nine are in Africa. 1 million of these premature children die. Those that survive often have some degree of disorder which affects their development and their quality of life. These include visual and hearing impairment and physical

Table 4.5 Neonatal mortality per 1,000 live births in different countries with varying income levels (Lawn et al. 2010)

Gestation period in weeks	Ilesa (Nigeria) 1996–2000	Pelotas (Brazil) 2004	Scotland 1985–1994
34–36	48	15	11
32–33	156	61	33
<32	587	370	194
All <37	179	66	41

and mental disorders. Particularly in developing countries, this puts an additional strain upon the mother. Second only to pneumonia, premature birth is the leading cause of death among children under the age of five.

Premature birth and low birth weight are typical signs of poverty and the accompanying chronic malnutrition. Children who die from asphyxia, sepsis, or pneumonia were in most cases born prematurely, however they may have been born at the appropriate time, but with a low birth weight. Often the two cases are not properly differentiated. For persons without a medical background, these may just be sundry terms and statistics. What they really mean, however, can only be learned by experiencing the tragedy first-hand. It is quite impossible to imagine what it means to a mother to see her newborn infant burning up with fever or its skin not turn a warm rosy pink, but instead stay blue as it gasps hopelessly for air.

In developing countries, the vast majority the infants with low birth weight (roughly 90 %) are born after the 37th week of pregnancy. The biggest risk factor for a premature birth or low birth weight is the mother's chronic malnutrition during pregnancy. Children who are born prematurely run a higher risk of experiencing postnatal complications because of their mother's malnutrition. As discussed previously, the hunger carousel goes on and on.

Premature birth often occurs in developing countries and is a determining factor in whether or not the baby will survive. The worse the general state of nutrition and the higher the level of poverty in a population, the greater the number of children who die from having been born prematurely (see Table 4.5).

A child that is born into a poorer family prior to week 32 hardly has any chance of survival in a country such as Nigeria. If the medical infrastructure needed to care for premature babies is lacking, or if these cannot be paid for by the mother, then the child stands even less of a chance of pulling through. For births occurring before week 30 the chances are close to 0. In industrialized countries by contrast, babies born after week 25 have a relatively good chance of surviving. At least everything is undertaken with the help of the latest medical technology to see the baby through. What can be done to help premature babies survive is another topic altogether, and one that unfortunately does not apply to developing countries anyway. The focus here is why the number of premature births is higher in developing countries than in rich ones (see Table 4.6).

Table 4.6 Occurrence of premature births (<week 37) (WHO 2005)

Region	Premature births (1,000)	Rate (%)
Worldwide	12,870	9.6
Developed countries	1,014	7.5
Less-developed countries	7,685	8.8
Under-developed countries	4,171	12.5

The data in Table 4.6 has been updated since its publication. An increase in premature births has been observed worldwide, which is restricted to developing countries. India tops the list with the most deaths caused by premature birth, followed by Nigeria, Pakistan, and China. Germany is at number 84 among the 184 countries. Premature birth and the mother's diet go hand in hand. Malnutrition continues to be the biggest risk factor. This is also evident when one looks at different countries' GDP. The lower the GDP, the less possibility women have to have a balanced diet. The difference does not seem to be so great when one looks at the percentages, but if one looks at the children's chances of survival, there is a world of difference.

Chronic Malnutrition

Low birth weight resulting from malnutrition is a primary risk factor regarding neonatal and postnatal mortality, regardless of when the baby was born. 20 million children (15 % of all births annually) are underweight when they are born, whereby 96 % of these are born in developing countries, 70 % of these, in turn, in Asia (United Nations Children's Fund 2004). Having low birth weight, in other words being under 2,500 g at birth, carries with it a number of negative consequences, including a high risk of neonatal death, illness and complications which could be fatal during childhood. Babies which are between 2,000 and 2,499 g when they are born have a four times higher risk of dying in the first few months of their lives compared with children over 2,500 g (Ashworth 1998; Muthayya 2009). Malnutrition plays a big negative role in embryonic and fetal development and, therefore, it directly influences both the length of gestation, causing premature birth, as well as the infant's birth weight, causing it to be too low. According to the Barker Hypothesis (see Box 4.1), low birth weight has adverse effects on the rest of the child's life.

Box 4.2 The Barker Hypothesis

This theory regarding childhood development is as controversial as it is significant. It is named after David J.P. Barker, the researcher who formulated it. In a nutshell, the theory states that numerous diseases which occur during adulthood have their roots, in this case two seemingly opposing ones, in early childhood.

1. *Poverty and malnutrition* Malnourished mothers give birth to underweight babies.
2. *Prosperity and super-nutrition* Underweight newborns are given an energy-rich diet.

According to Barker, both conditions lead to an attempt to adapt to the deficiency by means of securing an abundance. This adaptation process can result in functional alterations of the child's various organs due to so-called plasticity, in other words, the ability of organs to adapt to certain conditions. The malnourished fetus adapts itself to its state accordingly and thus prepares itself for what is to come after birth. As a result, its organs modify their functionality to handle the shortage. This process is referred to as intrauterine programming.

If contrary to expectations, the newborn receives an abundance of energy causing it to gain weight rapidly, this can be conducive to complications and obesity during adulthood. A number of studies conducted in Europe have arrived at the conclusion that there is a connection between poor parents and children with heart disease, diabetes, hypertension, and lipometabolic disorders (Brooks-Gunn 1997; Steptoe and Marmot 2004).

If, on the other hand, the child stays malnourished, then the already weakened organism suffers additional debilitation leading to complications during childhood. The question about why children become afflicted with the above-mentioned diseases is hardly ever asked. The simultaneous occurrence of obesity and stunting among children in large, poor families in South America might prove the validity of the Barker Hypothesis since the mother's malnutrition is already programmed into the embryo, which tries to compensate for it on an epigenetic level. It can also be the case, however, that the calorie-rich and micronutrient-lacking diet of the child, as is often the case with poor families, is the sole cause of the child's obesity (Fernald and Neufeld 2007). Nonetheless the latter is, in any case, not an uncommon phenomenon in developing countries.

Premature birth as a typical result of malnutrition can be seen from the results of studies which were conducted after severe food shortages, such as in China, the Ukraine, and St. Petersburg (at the time Leningrad). The studies showed that during the crisis the number of premature babies and those with low birth weight had clearly risen. The same situation applies to countries in which poverty is on the rise. In the USA, premature births are up 20 % versus 20 years ago. Most strongly affected by this development are members of the African-American community, many of whom belong to the poorer classes (Martin et al. 2010).

Malnutrition can be caused by a shortage of nutritional resources or by a voluntary abstinence from certain foods. Whatever the case, a shortage of micronutrients inevitably leads to developmental disorders concerning the fetus and health complications during childhood. Pregnant women in developing

countries are particularly at risk, especially if they are very young since they themselves require enough nutrients for their development.

Studies examining malnutrition and its effects among expectant mothers in developing countries are rare. Yet those which have been undertaken all point is in the same direction. Doyle and colleagues (Doyle et al. 2001) were able to show that pregnant women with an intake of under 1,800 kcal per day were four times more likely to give birth to an underweight baby than women whose intake was above 2,000 kcal per day. It is interesting to note that the former group of women was also found to have a shortage of iron and folic acid. This discovery was confirmed in a more recent study. Nearly all of the 165 women whose children were underweight at birth did not meet the recommended intake for pregnant women for iron, folic acid, and vitamin B2 (Rees et al. 2005). An iron and/or folic acid deficiency is not an issue which is confined to developing countries, but rather it is an increasing problem in industrialized countries, as well, regardless of social class. This has often to do with the vegan diets or lopsided eating habits.

One should think that an expectant mother who is petite and does not gain much weight during her pregnancy would make getting enough macronutrients, in other words energy, in her diet the top priority. However, the results of studies during which the number of calories was increased during pregnancy did not confirm this. In fact, a meta-analysis has shown that the effect of the mother's caloric intake on the weight of the baby is rather slight (Grantham-McGregor 1998).

A study of 602 newborns in India, whereby 169 were underweight, showed that it was not only the caloric intake which was a determining factor in the infant's birth weight, but also whether or not the mother ate adequate amounts of green vegetables, fruits, and dairy products (Rao et al. 2001). The mothers from rural areas were petite (1.51 $\pm$ 5.1 cm), weighed little on average (41.7 $\pm$ 5.1 kg) and did not consume many calories or protein during the 18th and 28th week of pregnancy. It seemed at the time likely that the infants' low birth weight in 28 % of the births was caused by the mothers' low calorie and protein consumption. This, however, could not be confirmed. As it turned out, the quality of their diets was much more of an influential factor. The fetuses gained an average of 19 g when the mothers ate more vegetables and 7 g when they ate more fruits or drank more milk. Biochemically, there is a higher concentration of folic acid in red blood cells, which are vital for transporting nutrients to the cells, when a baby's birth weight is higher, in addition to higher concentrations of vitamin C in the blood. Green vegetables are a relatively good source of folic acid, yet the bioavailability is lower than folic acid from eggs or meat.

Poverty and the accompanying 'poor' diet are the factors which push the mortality rate for the first 28 days upwards. The fact that this problem is not only encountered in poor countries was shown in a study conducted in Canada (Luo et al. 2004). Child mortality among the 20 % poorest families in comparison to the richest in the nation remained consistently and clearly disparate over a 20-year period. Making the mortality rate among the richest in the country the average would reduce the mortality rate as a whole by 20 % in 20 African countries, by 28 % in Bangladesh, 41 % in India, and 43 % in Nepal.

A starting demonstration was recently given of how important a balanced diet is for an unborn child's development (Karim et al. 2011). Expectant mothers who took micronutrient supplements or took part in the national diet program were four times likelier to have a child with normal birth weight than pregnant women from a reference region. This was particularly the case among women with lower incomes. It can be concluded that the results of the study were less related to calorie intake (this was in most cases clearly under the recommended amounts among all participants) than to the poor quality of the mothers' diets and this is what essentially leads to low birth weight.

An increased intake of micronutrients not only leads an infant to have a higher birth weight, but it also promotes the baby's development during its first 2 years, such as reducing the risk of stunting, as studies done in Vietnam also show (Huy and Le Hop 2009).

Vitamin A Deficiency and Neonatal Mortality

If the fetus does not receive sufficient nutrients for its development, this can impact the maturing of the lungs, which can cause complications for the child further down the road. Since the forming of the so-called surfactant (a complex network made of proteins and other compounds which prevents the pulmonary vesicles in the lungs from collapsing) depends on a rich supply of vitamin A, this explains why among other things many infants die of asphyxiation in regions where hidden hunger is widespread. The mixed results achieved by giving vitamin A supplements to newborns with regard to the neonatal mortality rate may have to do with the fact that such measures to improve the functioning of the lungs simply come too late (Gogia 2009). Such suspicions are supported by studies in which premature babies with immature lungs were given vitamin A supplements and a clear reduction was achieved in the mortality rate, as well as the infants' need for oxygen during the first month (Darlow and Graham 2007).

Looking over a longer period of 6 months after birth, the mortality rate decreased by 20 % by giving the infants vitamin A supplements (Sachdev 2008). Especially in cases involving a serious vitamin A deficiency, for instance when the mother shows clinical symptoms such as night blindness, giving the mother supplements during pregnancy led to a reduction in the number of newborn deaths (Christian et al. 2001). These results have been confirmed by a comprehensive meta-analysis of regions where a vitamin A deficiency is widespread and, where a reduction in neonatal mortality by means of supplements was observed (Rotondi and Khobzi 2010). In regions where up to 35 % of women suffered from a vitamin A deficiency, such as in Indonesia, the mortality rate dropped by 63 %.

International organizations, such as the WHO and UNICEF, recommend taking vitamin A supplements. However, it would certainly be more effective to ensure that expectant mothers are getting enough vitamin A by means of dietary improvements. Under the current circumstances, however, this is an illusion.

Iron Deficiency and Neonatal Mortality

In some countries, as many as 50 % of expectant mothers are believed to suffer from iron deficiency anemia. IDA often results in premature birth and low birth weight, both of which endanger the lives of newborn infants (Scholl and Reilly 2000). Iron is needed to transport oxygen to the red blood cells. If not enough of it is available in the blood, the organs will not get enough oxygen. A link between newborns suffering from asphyxia and mothers with anemia was recently described by Akhter and colleagues (Akhter et al. 2010). Anemic mothers were found to have smaller placentas, a shorter gestation period, and their newborns often suffered from asphyxia. Asphyxia is most certainly not linked to iron deficiency alone, but also to other factors such as the ones previously mentioned (e.g., other deficiencies and difficult birth).

A rigorously monitored and comprehensive study of more than 31,000 expectant mothers showed a clear reduction in the neonatal mortality rate when the mothers received either a combination of folic acid and iron (IFA), or a multi-micronutrient supplement (MMN). The mortality rate among the MMN group was 18 % lower than the IFA group. This means 35 deaths per 1,000 births compared with 43. The reduction in mortality within the MMN group was especially visible when the mothers were anemic or malnourished. Of the 11,101 babies from the MMN group which were weighed within the first hour after birth, 14 % showed less signs of being underweight, whereby 33 % showed less signs if the mother was anemic when she joined the study. This study is a classic example of how food quality and neonatal mortality go hand in hand. MMN do not contain any calories, so a low energy intake remains constant. Only the quality of the woman's diet improves (temporarily) by means of the MMN. The reduction in mortality depends on the dosage. Taking more than four tablets reduced the rate by 24 %, whereas <4 contributed to a 5 % decrease. This clearly shows that the severity of the micronutrient deficiency has a direct influence on whether or not a newborn baby (Shankar et al. 2008).

Iodine Deficiency and Neonatal Mortality

The neonatal mortality rate is also affected by the amount of iodine which pregnant women intake. There have been, however, no such systematic studies to confirm this to date. Supplements containing iodine have shown thoroughly positive results nevertheless. One such initiative involved adding iodine to water used for irrigation in a region with a high deficiency rate among the population. Within 3 years, the amount of iodine in wheat, vegetables and meat increased five-fold, and the neonatal mortality rate sank by 64 % (DeLong et al. 1997).

A Lethal Combination: Young, Female, Petite, and Pregnant

The hunger carousel can show us why the target of reducing the mortality rate, particularly in Africa, is nowhere in sight. Poverty, particularly in rural areas, a lack of education, an inadequate health care infrastructure and, last but not least,

traditions such as marrying young are still the status quo, which rests like a burden on the shoulders of the children.

The results of a study conducted in 55 countries with 1,176,530 children from low to middle-income families speak for themselves. The children's development is handicapped right from the very beginning and the probability that they will someday be able to get off the hunger carousel alive is much lower if their mothers are younger than 18 than if they are older than 20. Children whose mothers are under 18 have a 100 % higher risk of dying and a 50 % higher risk of suffering from anemia and diarrhea. The infants born to these women, who either have no nutrient reserves or need them for their own development, are often underweight or premature, particularly if the mother herself was malnourished as a child and suffered complications as a result (Finlay, Özaltin & Canning 2011).

The importance of newborn infants receiving a balanced diet for the following generation was shown by a study of 54 countries with low to moderate income levels (Özaltin et al. 2010). This telling study involved more than 2.6 million children from 1.8 million mothers. The conclusion cements the fatal link between stunting and neonatal mortality: the smaller the mother, the higher the risk of death. The probability of a child dying at some point within its first 60 months was 58 % higher if the mother was under 145 cm tall than if she was above 160 cm tall. Concerning neonatal mortality, the difference was even as much as 72 %. If expectant mothers are grouped according to their height, then we can see that the infant's chances of being unaffected by low birth weight, wasting and, in particular, stunting increase significantly with every step up the scale above 145 cm. The higher risk of death caused by having an extremely petite mother persists throughout the child's first year.

The pattern of a mother whose development was negatively affected due to adverse conditions passing on this phenotype to her offspring is a certainty before the child is born, and it takes on a bigger dimension altogether if the mother is under the age of 18 at the time of birth. The hunger carousel is a ride that these children take with their mothers before they are even born. It is unlikely that, in the course of time, they will ever manage to get off alive.

Conclusion

Premature birth and low birth weight caused by the mother's unbalanced diet are the primary reasons for the high neonatal mortality rate. The critical analysis of the data from 130 studies, according to the ethics of empirical medical science, and the information which was able to be extrapolated from this reveal that malnutrition is a substantial risk factor for early neonatal mortality and it cannot, as has been stated numerous times, be dealt with successfully by providing more energy, i.e. calories, by means of protein mixtures or grain-based foods and the like. (Yakoob et al. 2009). Certainly the lives of many newborns could be spared by providing them with care and medical attention. This fact is attested to by numerous studies which have compared the quality of medical attention with infant mortality. A startling reduction in neonatal mortality can also be achieved in poorer regions, as

studies conducted in Bangladesh illustrate. The implementation of support given by volunteer midwives at specially designed facilities in urban slums contributed to a reduction in the number of newborn deaths from 37/1,000 to 11/1,000 (Afsana and Rohde 2011). This success can undoubtedly not be replicated in every situation, however it illustrates the importance of providing support to mothers during labor, especially if the lives of the mother and child are in jeopardy due to malnutrition. The cost for such care: $13. It is without question that undernourishment also leads to a greater risk of death among newborns and a higher number of stillborn babies. Ensuring that mothers have a balanced diet must be the foundation for preventing neonatal mortality. Multi-micronutrient supplements in combination with folic acid and iron can be seen as additional means of achieving this goal. Professional associations in Canada, a country without major nutritional issues, recommend taking these for pregnant women (Wilson et al. 2007).

Station 3: The Hunger Goes on

Let us take a look around our carousel. A few newborn infants have vanished, as well as a few mothers. Alongside of us there is a group of children, all of them under 5 years old and in grave danger. What they do not suspect is that they, too, may be taken off the carousel very soon. Then we see the mothers of these children, whom they love and, who know what fate awaits their babies. The pain of seeing what happens to their little ones day after day in their fight for survival is visible on their faces and in their eyes.

The adverse effects of chronic malnutrition depend upon the age of the child, which is roughly divided into three partly overlapping stages:

- the start of pregnancy until the end of the 2nd year, the so-called 1,000-day window,
- six months until the end of the baby's 5th year,
- adolescence (year 6–16).

The time period starting from the baby's 6th month until the end of its fifth year is especially critical regarding whether or not the child will survive. It is this age group that the MDG 4 is concerned about ("reduce the under-five mortality rate by two-thirds"). If a baby dies prior to 6 months, it is considered a neonatal death, which is not addressed by the MDG 4.

The 1,000-Day Window

Children who are malnourished during their first 1,000 days will hardly be able to make up for this shortage later in their lives. An expectant mother's malnourishment will cause her baby to have low birth weight, which, in turn, leads to complications, such as developmental handicaps during the baby's first 1,000 days. It is a condition which affects between 16 and 32 % of all newborn

babies in the developing world (ACC/SCN 2000). If, however, the mother becomes malnourished after the 1,000 days have expired, this usually will not result in any developmental disorders to the baby. Yet, the rectifying of a nutrient deficiency arising from an unbalanced diet after the 1,000 days cannot compensate for damage which was already done. Stunting is the obvious sign that a child experienced developmental disorders during his or her first 2 years.

Figures in the United States illustrate that this is not merely a problem in poor countries, but rather a problem of poverty itself. Across the country, 5 % of children suffer from stunting. However, if income is taken into account, the stunting rate among children in the lowest income bracket is 13 % (Lewitt and Kerrebrock 1997). The importance of the 1,000-day window is the fact that developmental disorders which arise during this period cannot be rectified later on.

What Leads to Stunting and What Does It Entail?

Developmental disorders caused by malnutrition already begin in utero and become more pronounced in particular during the time between the 12th and 18th months of the infant's life (Matorel & Young 2012). Within an ethnic group, however not between different ethnic groups, the genetic factor is relatively small with regard to growth. Thus, stunting is not a sign of genetic influences within an ethnic group. An interesting theory was proposed by Golden (1988), who claimed that stunting was a result of the body's use of nutrients to supply the vital organs instead of using them to grow as a whole.

Infants need a lot of energy and micronutrients during the time of breast feeding. At the same time, they are also highly susceptible to infections, particularly if there are hygienic issues. Children who do not consume adequate amounts of energy and micronutrients or who often fall ill, will be less-developed than other children who are better nourished. An obvious sign that a child is affected by a developmental disorder is his or her height in comparison to other well-nourished children. A standard derivation of two or more from the norm, i.e. healthy children in the same age group, is referred to as stunting. A derivation of three or more represents a case of severe stunting.

The real cause of stunting is malnutrition. Which elements are missing from the diet that are necessary for the child to grow? Is it calories, or protein, or essential micronutrients?

The difficulty in separating a high-quantity diet from a high-quality one, i.e. energy versus nutrients, lies in the fact that an insufficient quantity always entails a shortage of essential micronutrients. This difference can be illustrated however, by examining to what extent a change in caloric consumption has on growth without modifying the quality of food. Two different baby food formulas containing the same concentrations of micronutrients, but with different amounts of calories, were given to infants aged 8–41 days and 112–167 days in an attempt to answer the question of whether this difference exists or not (Fomon et al. 1975, 1977). The

calorie rich formula led to a significant increase in weight, yet not to a difference in growth. The discussion regarding whether or not an inadequate amount of macronutrients alone causes stunting still rages on. Yet the observation that there are children who suffer from stunting but not from wasting (low body weight relative to age caused by a macronutrient deficiency) contradicts this possibility. Nevertheless, a macronutrient deficiency is a clear indicator that the person also suffers from a micronutrient deficiency. Compensating for a shortage of calories by eating for instance rice or cereals will hardly have an effect on growth. In fact, when a baby weighs more, it obscures the actual problem, and that is that stunting is caused to a much greater degree by hidden hunger.

Micronutrient Deficiency as a Leading Factor in Stunting

A topic which is currently being critically discussed among experts is the impact which vitamin A, D, K, zinc, iron, and iodine have on growth during early childhood. With regard to these micronutrients, different mechanisms are being examined for their role in the growth process.

Their effect on a child's growth can best be illustrated by studies which involved nutritional intervention using single types of micronutrients. Researchers observed that zinc contributed to promoting the child's growth, yet multi-micronutrient supplements proved to be even more effective (Branca and Ferrari 2002). One reason for this result might be that deficiencies rarely come unaccompanied, but rather in combination with other shortages. An example of this situation was impressively shown in a study involving Mexican children. According to the study, 24 % of children in Mexico are affected by stunting (Rosado 1999). 82 % of the children examined were found to be deficient of at least two of the five micronutrients in question (vitamin A, E, B12, zinc, and iron). Barring vitamin E, animal-based foods are the best sources of all of these micronutrients. Hence it follows that if zinc is lacking, then other micronutrients are also being consumed in low amounts, as studies in Asia, Africa, and Central America have also shown. Zinc supplements (10 mg/day) given to children under the age of five in Ecuador over a ten-day period resulted in visible increases in their growth rate in comparison to children who did not take zinc. During evaluations of the nutritional habits of these children it was discovered that 64 % of them suffered stunted growth. 69 % of the children aged 6–11 months were found to be deficient of vitamin A, B2, zinc, and iron (Dirren et al. 1994). So in essence, the diets of these children were lacking other micronutrients which are needed for the rapid growth occurring during this stage of a child's development.

What would it mean for the high mortality rate among children with stunting if success in promoting a child's growth can be achieved by means of supplementing a single micronutrient while others are lacking? Promoting growth with a single micronutrient is by no means the equivalent of the success which can be achieved by improving a child's diet. Studies conducted in Canada and the United States whereby healthy, well fed, yet small children were given zinc illustrate its

beneficial qualities. The zinc supplements actually had a positive impact upon these children's growth rate, even though they showed no clear signs of having a zinc deficiency. Zinc seems to possess its own growth-enhancing property which must not be related to a deficiency (Brown et al. 2002). This can perhaps be explained in part by the effect which zinc has upon growth factors, as well as upon the so-called osteocalcin, which regulate the growth of the skeleton.

The degree to which a fetal iodine deficiency causes a chain reaction of growth disorders in a child's first few years has yet to be extensively examined. Thyroid hormones stimulate the secretion and receptor interaction of growth hormones (GH) and they spur the development of important growth factors, such as insulin-like growth factors (IGF), which children suffering from an iodine deficiency have less of. Iodine supplements cause this growth factor to increase and, therefore, benefit the growth process (Zimmermann et al. 2007).

One of the primary micronutrients which is discussed within the context of stunting is zinc, which is responsible for the production of a variety of enzymes and cellular functions, which, in turn, are vital to growth and development. A weakening of the immune system and developmental disorders result when the body does not get enough zinc. The importance of zinc for development and preventing stunting was shown by an extensive comparison of 33 different studies which examined the impact of zinc supplements on a child's growth (Brown et al. 2002). A significant improvement in growth was generally observed, particularly among children under the age of four who showed signs of stunting. However, zinc had no visible effect on the children's weight. The amount of zinc a child receives during its first 2 years has a direct effect on its growth rate. How zinc affects growth exactly is still unclear. What is known, however, is that zinc reduces the risk of infection by supporting the immune system.

Comprehensive meta-analyses have concluded that individual micronutrients, such as vitamin A, or mixtures, such as folic acid and iron, have a beneficial effect upon growth. Multi-micronutrient supplements, however, were found to achieve even more positive results, as was the case with pregnant women (Ramakrishnan et al. 2011, 2012; Allen et al. 2009). The results clearly show that the diagnosis of a micronutrient deficiency is simultaneously an indicator of a shortage of other vital nutrients. Certainly the prevention of certain childhood illnesses with the help of micronutrient supplements can also help to explain why the growth of these children was not hampered (Chen et al. 2011; Chagan et al. 2009; Sazawal et al. 2007; Sharieff et al. 2006).

Station 4: Living and Dying with Chronic Malnutrition Among Children Under Age Five

At the end of the 1,000-day window, the fate of many children is decided. A child's future is largely determined during these first 1,000 days, provided it has a future at all.

In a touching essay, Emily Rapp describes her experiences with her dying toddler, who is the victim of an inherited illness with little hope of recovery:

> She knows that her child will die before the age of three or shortly thereafter. This she knows with certainty. The African mother, we shall call her Joana, is holding her hungry child lovingly in her arms in just the same manner as Emily Rapp is cradling her own child. She feels that the baby's days are drawing to a close. She would do anything, even walk over fire, for the sake of her child, as Emily Rapp describes in her essay. While Emily tries to make her child's life as worthwhile as she can in the short span of time remaining, Joana has no choice but to keep fighting for survival on the borderline to starvation. In between bouts of diarrhea, fevers, and infections, the life of the tiny baby tries to develop. Emily is conscious of the helplessness she faces. As she says, she is "free of expectations". Joana, however, hopes that her prayers will be answered. Yet, she knows from experience and from what she is now suffering that this is just a happy illusion. Emily describes at the end of her work what it means to her to have been a part of her child's life: "Being a father of a mother means loving your child today. Right now, at this moment. It is the same for all parents. No matter where. (*Die Zeit*, 8 Dec. 2011)

And the carousel turns and turns. We see the children who survived their first 6 months and can now hope for a happy, untroubled future, as it should be for all children. Most of all, they must hope to grow, develop, and keep in good health. Their hopes all depend on whether they will have something to eat and, if so, what it will be.

12 % of all children worldwide under the age of five are malnourished, causing them to suffer from physical and psychological setbacks, as well as a high risk of death. Malnutrition, according to estimates made by the WHO, is accountable for more than half of all child deaths (under age five) in developing countries.

According to Save the Children (2012), an additional 11.7 million children will be affected by stunting by the year 2025. The report goes on to say that if the trend continues, there will be 450 million stunted children worldwide. These children are the productive force of tomorrow, which is needed to drive down poverty in poorer regions and, who will hardly be in a position to do so if we keep on our current course.

> *Let us imagine, we meet a boy named Manuel riding on the hunger carousel. He has already turned the 'ripe old' age of two and is able to walk. He giggles a lot and is curious like other children his age. The legs which carry him are not as strong, however, as those of other children. He often needs to sit down because his muscles are weak. Suddenly Manuel stands up and quickly runs over to Joana, who is holding a 3-month old infant. He latches on to her leg and starts to cry. He cries because he is hungry. The parasites nesting in his intestines cause the diarrhea which robs him of his last bit of energy. Manuel is not yet able to reflect upon life and death. He is still too young to be aware of it, but his mother knows what fate awaits him.*

According to the latest tally, 8 million children under the age of five died in 2010. 5 million deaths were due to infections, indeed ones which could have been avoided, and 3 million of these children were newborn infants (Liu et al. 2012). In 2000, there were 10 million such deaths. The downward trend is partly due to an increase in vaccinations against malaria, measles and tetanus. It has little to do with nutritional issues, such as supplements. More than a third of the fatalities were

caused by chronic malnutrition and another third were due to diseases which are linked to malnutrition. A malnourished child is twice as likely to fall ill with malaria as one with an adequate diet. The mortality rate among severely malnourished children is a whopping nine times higher compared to that of well-nourished children (UNICEF 2007). These children do not so much die from starvation as from pneumonia, which occurs after months and years of nutrient shortages and, which stands less of a chance against children who receive a balanced diet. Every child who dies represents millions of others of chronically malnourished children who follow in their footsteps. The true scale of this situation is still partly obscured by the fact that the deaths of children are often not reliably documented in many countries, particularly in Africa. Thus, the sirens which would call for immediate action in the form of dietary intervention are silenced.

MDG 4: A Reason to be Optimistic or Just Deceptive Packaging?

Started in 1990, the MDG 4 aims to reduce the under-five mortality rate by two-thirds (from 10.6 % to 3.5 %) by the year 2015.

Under 5 Mortality Rate (U5MR) This is an indicator for the risk of dying for children under the age of five, or in other words, the number of children per 1,000 who died before reaching their 6th birthday. The figure best describes childhood development and the general state of health within a nation. The U5MR is less of a gauge for the sum of calories being consumed by under-5-year olds, as it is a tell-tale indicator of the effect of the children's diets and their living environment. Here is an example to better illustrate this distinction. 100 g of butter a day contain enough calories for a child to survive. Obviously, from a dietary point of view, eating only butter would hardly be beneficial or help to reduce mortality. Therefore, nutrition cannot be assessed on the basis of quantity, as expressed in kcal, alone. The U5MR provides the most accurate indication of the state of nutrition and food security in every country, as well as the health care system, care provided to expectant and nursing mothers, and sanitary conditions

So what is the status quo regarding the anticipated reduction of child mortality by two-thirds? According to calculations made in 2005, reaching that target would mean 20 million less children would die (Sachs and McArthur 2005). On the flip side, if everything goes on as before, it means that 20 million children will not survive. Since 2005, the world has seen two economic crises and this means that even the most pessimistic assessments of the current situation will probably not reflect the real truth.

Here are a few details from a recent analysis (Lozano et al. 2011): Approximately 70 % of deaths happen in 15 countries, half of these, in turn, occur in 5 countries—India, Nigeria, DR Congo, Pakistan, and China. Nigeria (11 %) and India (22 %) are

home to a third of all fatalities worldwide. Between 1960 and 2005, child mortality decreased in nearly all regions by 50 % or more. The reference parameter for the MDGs, however, is the year 1990 and since that time, the countries with the highest rate have experienced the smallest drop (Young and Jaspars 2009).

The U5MR in total has decreased by 2.2 % each year since 1990. The MDG 4 could become a reality by the year 2020 (Lozano et al. 2011), but only when there is a significant improvement in the situation in Africa. Sadly, this does not seem feasible at present. Although the number of children under five years of age who died in 2011 did actually decrease from 3.9 (from 11.6 births) to 3.5 million (from 7.2 million births), we can see that the percentage of children who died increased from 33 % to 49 %. The financial crisis of 2008 played a not too trifling role in this development (according to UNESCO, an increase in child mortality of just under half a million), and the economic crisis of 2011 has intensified the situation in Africa. This is not taken into account regarding the current predictions for the MDG 4, especially when the 23 countries of Sub-Saharan Africa will only be able, in the best case scenario, to reach the MDGs in 2040. The U5MR would need to decrease by 13.5 % annually and not by the current rate of 2.2 %. The most recent optimistic report by UNICEF (UNICEF 2012a), which speaks of a "drastic" reduction in the annual increase in U5MR from 1.8 % per year between 1990 and 2000 to 3.0 % per year between 2000 and 2011 must not belie the fact that the basic situation, the prevalence of malnourishment, particularly in Asia and Africa, has hardly changed. In the end, according to the report, the MDG4 will not be achieved. Even for the most optimistic of optimists, achieving the target is difficult to imagine.

In South Asia, where a third of all under-five deaths still occur, progress is more visible, although the impact of the financial crises has hardly been considered. Here, the U5MR has been on the decline by 2.4 % each year. In 1990, the probability that a child born in Africa would die was 1.5 times higher than in South Asia, 3.2 times higher than in Latin America and nearly 12 times higher than in developed countries. More recently, the probability that a child born in Africa in 2010 would die was 1.8 times higher than in South Asia, 5.3 times higher than in Latin America and 17.3 times higher than in developed countries.

The under-five mortality rate has indeed gone down by almost 25 %, yet the real success of this must be seen in relation to the difference between more developed and less developed countries (UNICEF 2008; Fig. 4.6). The ratio today is 1:20, a disparity which is simply not acceptable.

The probability that a child can celebrate his or her 6th birthday is drastically reduced if he or she lives in a rural area and the mother is poor and uneducated (see Fig. 4.7).

Living in a rural area, belonging to a lower-income bracket and being relatively uneducated is the all too common recipe for child mortality in developing countries, and in more developed economies, as well. A child born into a poor family in a rural area has a much lower chance of survival and a lower life expectancy than a child born into a higher-income family in a city. The chances of receiving a proper education in the country are more than slim. And so the next generation of 'uneducated' mothers enters the circle of poverty, hunger, and mortality.

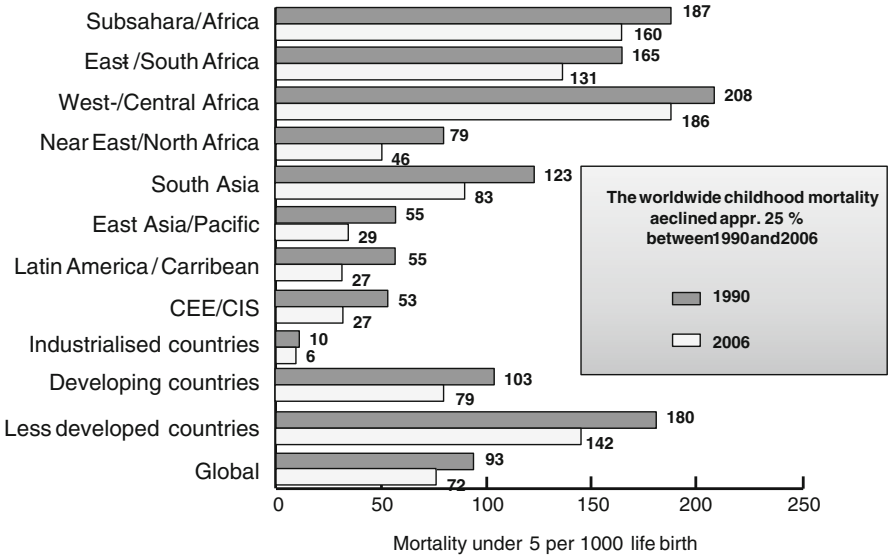

Fig. 4.6 The U5MR in various regions between 1990 and 2006 (UNICEF 2009). CEE/CIS: Central Eastern Europe/Commonwealth of Independent States

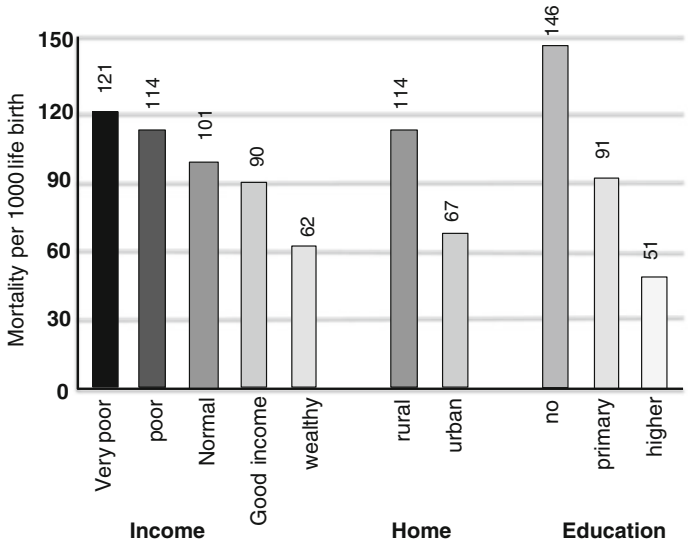

Fig. 4.7 The U5MR (1,000) in relation to income, living environment and education (UN-Report 2011)

If Manuel ever manages to get off the carousel alive, his problems will definitely not all be behind him. His risk of dying will be only half as high, but it will still be ten times higher than for children in Germany. Much better for him would be to get off the carousel with his mother, who would then move with him to the city, find work and catch up on her education. If we change the scenario from Manuel to Manuela, the chances of getting off the carousel alive become even worse. Manuela will become a young bride, a teenage mother, and she will carry her malnutrition along with her as it worsens.

What Do Children Die from?

The principal causes of death are:

- respiratory diseases, particularly pneumonia,
- chronic diarrhea,
- malaria,
- measles.

These are illnesses which are hardly relevant when it comes to the U5MR in developed countries. In developing countries, however, they entail a long period of suffering for children until their immune system finally gives out.

In 2008, 8.795 million children under the age of five died, 68 % of them (5.970 million) from infectious diseases. The principal fatalities involved newborn infants, but also older children with pneumonia, followed by diarrhea and malaria among 1-month old children and older. The cases of pneumonia and diarrhea were distributed among only a small number of countries. 52 % of fatal cases of pneumonia among under-five year olds occur in India, Nigeria, Pakistan, DR Congo, and Afghanistan. Regarding diarrhea, the same countries are home to 51 % of fatalities, with the exception of DR Congo, which is replaced by Ethiopia (Black et al. 2008). The U5MR continued to decrease until 2011 (UNICEF 2012a). In Sub-Saharan Africa, it has been 109/1,000 live births and in South Asia it has been 62/1,000 live births since 2006. In the meanwhile, the figure climbed to 6.9 million in 2011.

The regions with the highest child mortality rates are still Sub-Saharan Africa and South Asia. In 2011, 82 % of fatalities occurred in these two regions. In 1990, when 12 million children under the age of five died, the combined mortality rate in the two regions was 68 %. These figures force us to stop and think. The reduction in child mortality in North America, East Asia, Latin America and Europe is thanks to a rise in prosperity and improvements in health care. This is development which has most certainly taken place in Africa and Asia as well, albeit not to the same extent and with the same level of investment. Chronic malnutrition is thus one of the primary reasons for the much too high child mortality rate in Africa and Asia. UNICEF's report summarizes the factors behind the reduction in mortality: medical attention, development programs, improved data capturing, advances in education, child protection and respect for human rights. With regard to preventing

Table 4.7 U5MR and hidden hunger (Black et al. 2008)

	Deaths (in 1,000)	% of U5MR
Vitamin A deficiency	667,771	6.5
Zinc deficiency	453,207	4.4
Iron deficiency	20,854	0.2
Iodine deficiency	3,619	0.03

malaria through immunization and the use of mosquito nets, much has been accomplished and this has contributed to reducing child mortality. However, little has been undertaken to combat hidden hunger, which is also a primary cause of child mortality. Sustainability, such as can be achieved with the above-mentioned measures, can hardly be achieved in this situation since food security is too instable and too dependent on outside influences which are difficult to predict. Here some changes must be made so that the children who are trapped on the hunger carousel and will otherwise die from the effects of chronic malnutrition can have a future. More than 1/3 of the children died as a result of malnutrition, according to UNICEF. That equates to approximately 6,500 children per day, or 4–5 children per minute who could have been saved through intervention.

The avoid ability of death in these cases is clear by observing the causes themselves. While 4 % of deaths occur due to pneumonia and 1 % due to diarrhoea in countries where the U5MR is <10, in countries where the U5MR is >100, 18 % of deaths are caused by pneumonia and 12 % by diarrhoea. While the number of deaths caused by measles was able to be substantially reduced thanks to immunization programs, the fatalities resulting from pneumonia and diarrhoea have only decreased marginally. The reasons for this are still a lack of potable water and chronic malnutrition among the poor (UNICEF 2012a).

Should the question remain as to what role hidden hunger plays in triggering these infectious diseases, Table 4.7 shows the breakdown of the mortality rate based on certain micronutrient deficiencies.

It must be remembered that a deficiency rarely shows up unaccompanied. Thus, hidden hunger is the underlying cause of more than half of the fatalities. Infectious diseases and malnutrition, even a mild form of it, go hand in hand (see Table 4.2). On the one hand, many micronutrients are need by the immune system to perform all of its functions properly, whereas on the other hand, micronutrients also play a vital role regarding the so-called barriers, or the mucous membrane lining of the respiratory and gastrointestinal tracts, which keep out germs and parasites. Those stricken with an infectious disease often experience a loss of appetite, yet it is precisely at this time that the body requires even more micronutrients, especially if they also experience a fever. The loss of protein means that there will not be enough transport proteins available for a wide range of micronutrients. Another vicious circle develops, one in which an inadequate supply leads to a heightened need, and one which further debilitates the immune system (see Table 4.8).

Table 4.8 Nutrition and infectious disease

Nutritional component	Relationship to infectious disease
Protein	A person stricken with an infectious disease undergoes a breakdown of protein in the muscles, whereby the amino acids which are set free are then used to produce glucose in the liver. Approx. 0.5–0.8 g is lost per day and kilo of body weight (i.e., the daily requirement for adults). A protein shortage results in a curtailing of antibody production leading to a decrease in the amount of antibodies, or immunoglobulins, as well as alterations of the cell-derived mediators, which are required by the body for a number of functions.
Energy	24 kcal are needed to produce 1 g of protein. Turned around, protein which is lacking costs the body energy, namely 4–5 kcal/kg/day (Jackson et al. 1977). This is roughly 15–30 % of the energy which a one-year old child needs on a daily basis. To recombine 1 g of protein requires on average 7.5 kcal.
Vitamin A	During a fever caused by an infection, retinol-binding protein (RBP) is lost through the kidneys. As a result, vitamin A levels rapidly decrease in the bloodstream. Vitamin A is essential to the mucous membrane lining of the respirator and gastrointestinal tracts. Regarding the innate and adaptive immune systems, vitamin A nearly always works in combination with vitamin D. If one of these is lacking, it will have an adverse effect on the immune system's ability to function. Among these functions are the activation of the lymphocytes and their proliferation, the differentiation of the T helper cells, certain tissue-specific processes, the production of certain antibodies and the controlling of immune responses (Mora et al. 2008).
Iron	Infections lead to a reduction in the concentration of iron in the bloodstream. This, in turn, results in a dysfunctioning of the phagocytes and of the lymphocytes. The lower level of activity which ensues makes a person more susceptible to bacterial infections.
Zinc	A zinc deficiency has a direct impact on the development and functionality of the cells in the innate and adaptive immune systems. A lack of zinc also has a debilitating effect on mucous membrane tissue and its ability to prevent infection locally.

Vitamin A and vitamin D work synergistically to help control the immune system. Iron, iodine, and zinc also play an important role in this process. Last but not least, the so-called antioxidant micronutrients (vitamin C, E, pro-vitamin A and carotenoids, as well as selenium, copper, and manganese) are involved in the controlling of inflammation and infections. This is an area which hitherto has rarely been examined in relation to children, particularly those who are malnourished. So far only data for vitamin E is available, which shows that between 10 and 25 % of suffer from a deficiency, depending upon the country (Dror and Lindsay 2011). The most important sources of vitamin E are plant-based oils, particularly germ oil, as well as non-refined palm oil, nuts and seeds, such as sunflower seeds. 30–50 g of nuts or 15–30 g of oil would be the minimum amount which children to fulfill their recommended daily intake of vitamin E. Such foodstuffs, however, are not very common in the diets of people in developing countries.

A malnourished child who suffers from an infectious disease is by far more severely afflicted in comparison to a well-nourished child and has a slimmer chance of recovering from it. Not only are the body's own substances, of which there were less to begin with, metabolized, but there are also less nutrients to replenish these. The fact that the body needs more energy when ill and does not receive it results in a further metabolizing of bodily substances. The immune system, which has been weakened by hidden hunger, is therefore no longer able to defend the body against infections. Only when all of the necessary components for combatting an infection—protein, calories, and micronutrients—come together can a child's immune system stand any chance against infection. The bleakness of the current situation, the vicious circle of malnutrition and disease, can best be understood by taking a look at the four most common fatal illnesses: pneumonia, chronic diarrhea, malaria and measles.

As we have already seen regarding deficiencies, an illness also does not show up unaccompanied. Typical childhood symptoms of dehydration, namely coughing and perhaps fever, caused by persistent diarrhea are not uncommon. The treatment of one illness is often times hampered by the occurrence of another and so the ability to deal with one disease often depends upon how severe and persistent the other one is.

Vitamin A Deficiency as a Major Cause of Respiratory Disorders

Respiratory diseases, both infectious and bacterial, are the most common severe illnesses faced by malnourished children and are often fatal. Roughly 2 million die of respiratory disease each year. There are five primary causes of illness among children under 5 years of age.

- low birth weight
- inadequate breast feeding (<6 months of only breast milk)
- chronic undernourishment
- vitamin A deficiency
- zinc deficiency (conducive, in turn, to a vitamin A deficiency)

It is estimated that 150 million under five are stricken with pneumonia each year. Of these, 44 million cases occur in India, 18 million in China and 95 % in developing countries. 18 % of the U5MR is due to pneumonia. Prevention measures with malnourished children often prove difficult and ineffective. Vaccines against streptococcus pneumonia or measles have been partly successful in combination with dietary improvements and also with zinc and vitamin A supplements (UNICEF 2011). The rate of pneumonia is ten times higher in developing countries than in industrialized ones. The mortality rate, however, is incomparably higher. Of the 2 million deaths caused by pneumonia, 1.7 million occur in South Asia and Sub-Saharan Africa, and a mere 1,000 in all of the industrialized nations combined.

Awareness of the effects of a vitamin A deficiency on children's health has led to studies in which children were given various amounts of vitamin A at different intervals. Since it is rather difficult to classify respiratory diseases, and as they

often occur in combination with other illnesses, as mentioned previously, the target of these studies was an overall reduction in the mortality rate.

The WHO recently suggested giving vitamin A supplements to children aged 6–59 months in order to reduce the rates of illness and mortality, as the results of numerous studies indicated. A meta-analysis of 21 studies showed that early intervention involving vitamin A supplements given to children aged 6 months and older resulted in 12 % less deaths. This was particularly true in cases of diarrhea, measles, and also pneumonia (Imdad et al. 2011). However, the researchers were not able to achieve a similar reduction in the mortality rate of children younger than 6 months. This inability to reduce the mortality rate of infants younger than 6 months could be due to the fact that an expectant mother's vitamin A deficiency near the end of pregnancy inhibits the maturing process of the baby's lungs and, therefore, the supplements come too late. Nevertheless, there have been more than 30 studies conducted which confirmed that vitamin A supplements for children have a significant effect in reducing child mortality (20–30 %), as well as in significantly lowering the number of cases of diarrhea and measles (Beaton et al. 1993; Glasziou and Mackerras 1993).

A more recent meta-analysis of 43 studies involving 215,633 children (Mayo-Wilson et al. 2011) has confirmed the results obtained in the above-mentioned studies. In 17 studies, the child mortality rate dropped by 24 %, and deaths caused by diarrhea also decreased in 7 studies. The provision of supplements led to a 15 % reduction in diarrhea and a 50 % in measles cases. Not to be neglected is the placebo effect, which may have had an impact on the results. For that reason, the studies all involved the administering of placebos for the sake of comparison. The mortality rate among the placebo group was higher than that of the group which had received real supplements. To experiment with children may seem shocking to some, and rightly so. The starting point of this research, however, was the empirical observation that a vitamin A deficiency is deadly to children. It might the case that the vitamin A deficiency is only a signal for another underlying shortfall or illness and, therefore, is not directly linked to the mortality rate. The procedure used to test this in medicine involves giving one group the real substance while the other receives a placebo. In this case, the latter group leaves empty handed in the truest sense. If we rely strictly on empirical observation and omit the use of placebos, the positive effect of giving vitamin A supplements to one group and not to another on the mortality rate would perhaps be less. As a result, the financial backers and decision makers would probably opt to do away with supplements altogether.

The success which has so far been achieved by giving vitamin supplements to children suffering from malnutrition (and most likely a number of deficiencies) illustrates the potential of proper nutrition for improving children's health. At the same, it is clear just how important the food group containing the most vitamin A is for preventing illness and death among children.

Once again, since a visible vitamin A deficiency is automatically in an advanced stage, a child who is affected will have experienced a long period of susceptibility to infectious diseases. Thus the assessment of a person's intake of

Table 4.9 Risk of vitamin A deficiency in Africa (Aguayo and Baker 2005)

Region	Risk in %	Children affected (mil.)	Deficiency-related deaths	Deficiency-related deaths (%)
West and Central Africa	40.2	20.8	315,960	23.5
East and South Africa	44.8	22.4	330,295	26.9
Sub-Saharan Africa	42.4	43.2	646,255	52.1

the vitamin can be equated to the probability of someone from that region suffering from a deficiency, such as in the table below showing the situation in Africa in 2005 (Aguayo and Baker 2005; Table 4.9).

Since the introduction of vitamin A supplementation in 1997, there has been a distinct reduction in the number of childhood deaths. Since then, nearly 75 % of children under five have taken part in one of the many comprehensive initiatives (UNICEF 2007). It is important to be reminded of the fact, however, that the diets of these children are not only lacking enough vitamin A, but also all of the other micronutrients for which vitamin is merely the most conspicuous representative in this food group. This must be taken into consideration when vitamin A, zinc, and iron supplements are used to counter illnesses and combat mortality. It must also be added that the number of malnourished and stunted children cannot be sustainably diminished by means of nutrient supplements.

Attempts to prevent respiratory disease through vitamin A supplements have not been completely successful, whereas zinc supplements appear to be more effective in preventing such illnesses. In a comprehensive meta-analysis, zinc supplements were found to reduce the fatal cases of pneumonia by 15–19 %, while reducing the morbidity rate by 18 % (Yakoob et al. 2011).

Zinc Deficiency and Diarrhea

When children become affected by diarrhea, it means that their bodies are not able to absorb nutrients and that they also lose a large amount of water in a brief time period. As a result of this loss of fluids and electrolytes, they become languid and unresponsive, with heavy eyes and an air of sleepiness. It becomes more difficult for the mother in such cases to give her child liquids. If urgent measures are not undertaken to replenish the water and electrolytes which the child has lost, cramps will set in and the child will die.

A direct link exists between a child's diet and his or her anthropometric status and diarrhea. Children with stunting or wasting have a much higher risk of falling ill, are also more susceptible to longer and more severe cases of diarrhea and, thus, are more likely to die as a result (Rice et al. 2000). Diarrhea resulting from bacterial or viral infections, such as ADRV, *E. coli*, and *Cryptosporidium,* remains the number one killer of children under 5 years of age. The bacteria and viruses are transmitted when proper hygiene and/or clean water are lacking, or when food

becomes contaminated. Very young children carry an extremely high risk of becoming infected, especially if they are malnourished. Certain risks can also be significantly reduced by means of exclusive breast feeding for a minimum of 6 months. Children who do not receive breast milk are 11 times more likely to suffer from diarrhoea and are also 14 times more likely to die during their first 6 months than those who do (UNICEF 2012b). In most developing countries, the number of children who are breastfed for the first 6 months is still only 30–35 %, whereby these figures have hardly changed since 1990 (UNICEF 2012a). The mortality rate among small children is very high because they dehydrate much more quickly than adults.

Dehydration is not the only effect of chronic diarrhea. The body is also less able to absorb protein and fat, as well as fat-soluble micronutrients. This only worsens the preexisting state of malnutrition. In turn, malnutrition causes diarrhea to persist over a longer time period, making intervention in the form of food or supplements futile, provided this is even an option. Often, however, it is not. A third of all children who suffer from diarrhea do not receive enough sustenance or any at all, whereas three-quarters of afflicted children do not receive additional liquids (UNICEF/WHO 2011). The standard form of therapy, which is recommended by the WHO as an urgent treatment measure, is the administering of an oral rehydration solution (ORS) containing mineral salts together with zinc capsules. As a result, the number of deaths from diarrhea decreased from 4.8 million in 1980 to 1.8 million in 2002. This solution, however, is still not administered in many regions. A mere 38 % of children suffering from diarrhea have access to it (Bryce et al. 2006).

A critical comparison of different controlled studies regarding the prevention of diarrhea through zinc supplements revealed a reduction in the morbidity rate of 25 % for diarrhea and 40 % for pneumonia (Bhutta et al. 1999; Imdad and Bhutta 2011). Not every study involving zinc supplements has been successful and this is because a zinc deficiency is often accompanied by another shortage. Children who do not receive enough zinc often also do not get enough iron and copper (Schneider et al. 2007). If this is the case, then other micronutrients which are in the same foods as iron and zinc are also lacking.

The following approach is recommended by the WHO (2011) for preventing diarrhea:

- avoiding stunting
- vaccinations (ADRV, measles)
- proper hygiene
- vitamin A and zinc supplements

These precautionary measures are certainly the right ones for preventing diarrhea. For our passengers on the hunger carousel, however, they are mostly no options. If there is not enough nourishment, stunting occurs. If the water is not clean, diarrhea lurks. If the mother is wrongly informed or not informed at all, she will not have her child vaccinated. Lastly, there is poverty, which places a long-term improvement in the situation by means of better dietary habits out of reach for many people.

Chronic Malnutrition Weakens the Immune System with Far-Reaching Consequences

Malaria

According to the WHO, 216 million people, mostly children, fell ill with malaria, of which 781,000 died as a result. More than 90 % of the fatalities occur in Sub-Saharan Africa. 22 % of children who die before reaching the age of five were victims of malaria. Malaria is the third biggest cause of death in the world. Children who survive a bout with malaria are by no means safe from a reoccurrence of the infection, such as in the case of measles. Should fever and anemia reoccur, important bodily substances are tapped into leading to long-term handicaps in the child's physical and psychological development.

Hidden hunger is one of the reasons behind the high morbidity rate among malnourished children. Children coming from countries where there is a high rate of vitamin A deficiency, as well as zinc are much more likely to become infected with malaria than children living in countries where the deficiency rate is not very high. It is worth noting that in regions where the deficiency rate for iron, zinc and vitamin A is equally high, the morbidity rate for malaria is higher than in regions where one deficiency, for instance vitamin A, is prevalent (Caulfield et al. 2004). This explains why nearly 90 % of all malaria deaths among children under the age of five happen in Africa.

Vitamin A supplements can reduce both the risk of infection by 30 %, as well as the number of cases by 20–30 %, according to some studies (Shankar et al. 1999). Exactly how vitamin A helps to protect the body against malaria is not 100 % known, yet its beneficial effects on the immune system, the mucous membrane lining have been observed, as well its ability to reduce the risk of anemia. One possible explanation is vitamin A's effect on erythropoiesis, or the production of red blood cells by means of the hormone erythropoietin (EPO). Children with an iron and a vitamin A deficiency who are given vitamin A supplements produce more hemoglobin as a sign that their iron deficiency has been reduced (Zimmermann et al. 2006). Zimmermann ascribes the rise in hemoglobin to the discharge of iron from the body's reserves in an attempt to support the process of EPO-induced erythropoiesis.

Iron is a double-edged sword when it comes to malaria. On the one hand, anemia seems to benefit the morbidity rate because it weakens the body's immune system. On the other hand, however, a range of studies have shown that giving iron supplements to children can actually increase the morbidity rate and lead to further complications (INACG 2000). They can also increase a child's susceptibility to pneumonia and ear infections, as well as other infectious diseases. However, this only appears to happen when iron is administered parenteral, in other words injected (Oppenheimer 2001).

Various reasons are given for this fact. Iron promotes the production of blood, thus providing more red blood cells for parasites to infest. Iron supports the reproduction and development of parasites. It also inhibits the destruction of the

parasites by causing abnormalities to from among the red blood cells. Nevertheless, anemic children are more prone to infections, such as pneumonia and diarrhea. Yet a distinction needs to be made here in any case. Iron supplements seem to have a different effect if they are administered in regions with a high malaria rate or in places where the infection rate is rather low.

Hidden hunger, however, continues to be the basis for children's increased susceptibility to malarial infections and attacks. In addition to iron, vitamin A, and zinc deficiencies, shortages of other micronutrients, such as folic acid, vitamin E, and selenium make children easy targets for infectious diseases (Nussenblatt & Semba 2002).

Measles

What does it signify if one of the children onboard the hunger carousel becomes infected with measles? First of all, it means that the child had not been vaccinated against them. The severity of the infection will depend upon how seriously malnourished the child is. Symptoms include not only the common appearance of a rash, but also bleeding inside the mouth and high fever. This causes the child to lose a lot of bodily fluid and quickly fall unconscious. The child's debilitated immune system makes him or her more susceptible to further complications, such as pneumonia, which are often fatal. Diarrhea often occurs and reduces the child's chances of survival even further. Also quite peculiar are the symptoms of a serious vitamin A deficiency which suddenly appear around the eyes.

Despite worldwide immunization programs, 18 children, most of them under 5 years old, still die from measles infections every hour. That equates to 164,000 deaths each year. Up until the year 2000, the number was more than twice as high. 95 % of all fatal cases occur in countries with low income levels. The WHO's vaccination programs, according to the organization, have reached 85 % of the world's children. Yet 20 million people worldwide still become infected with measles, whereby the most fatal cases involve children younger than 5 years of age and young adults 20 years old and above.

A primary cause of death concerning measles is malnutrition, especially vitamin A deficiency. Through the simultaneous administering of vitamin A and measles shots, the number of fatalities has been reduced by 80 % (WHO 2012). This means that 12.7 million deadly cases were avoided in the years 2000–2008. In 2012, 140,000 children died from measles, 95 % of them in developing countries. Although the percentage of children being given vaccinations worldwide has risen from 74 to 85 % since 2000, it is still not enough (WHO Fact Sheet 286 04/2012).The WHO's target is a further reduction to under 80,000 measles deaths a year. A condition which must first be met, however, is that all 47 countries where measles is still an issue implement nationwide immunization campaigns. Countries such as India, Nigeria, and China have shown too much disinvolvement in such initiatives so far. In addition, more funding must be made available for vaccinations. Whereas previously $150 million a year were available for immunizations, today the budget

has been trimmed down to only $50 million. If the vaccinations are not carried out on a nationwide scale and if India does not get onboard the campaign, we can expect the number of fatalities per year to top 150,000. Then we would almost be back to the same number of deaths that occurred in 2000 (CDC 2009; Wolfson et al. 2009).

Besides not having been immunized, a vitamin A deficiency is a major cause of measles infection. An increase in vitamin A intake alone led to a reduction in measles-related deaths of 18–76 % (Imdad et al. 2011).

The reason behind the curative powers of vitamin A lies in the fact that measles cause the body to both require larger amounts of the vitamin, as well as lose binding proteins through the kidneys. The consequences of this can be fatal. The small reserves of vitamin A are quickly emptied and, if the body does not receive enough protein, it will not have enough transport proteins at its disposal. At this stage, it is too late for a vitamin A supplement. What happens next is a fateful worsening of the deficiency at an ever increasing pace. Within a matter of days after the onset of the infection, the once smiling eyes of the child start to become irreversibly cloudy. Ultimately this will turn into blindness. Since the vaccination programs are no longer carried out consistently, the accompanying vitamin A supplementation efforts will also fall along the wayside.

The importance of immunization, in addition to a balanced diet, was illustrated by a study conducted during the famine in Ethiopia in 2000, which affected 10 million people (Salama et al. 2001). The test group included 595 households comprising 4,032 people. During the observation period (12/1999–07/2000), 293 people died, 159 of which were children under the age of five. 116 children, representing 73 % of the fatalities, died of infection—either from measles, diarrhea or malaria. Measles alone was responsible for 47 % of deaths among the under-five-year-olds. Among the victims were 72 children between the ages of 5and 14, 42 of whom (58 %) died from measles (16.7 %), diarrhea or malaria. Most deaths (77 %) had occurred before humanitarian aid arrived (April 2000). According to the projections based on the number of inhabitants in the region (Gode: 330,000), the lives of nearly 20,000 people, including almost 11,000 children under the age of five, were lost in total. Many of these deaths could have been prevented. A further projection of the fatalities including the other five regions affected (with 1.5 million inhabitants) brings the total number of deaths in the famine to 98,000. Once again, many of these fatalities could have been avoided.

In addition to nationwide vaccination programs to prevent measles, vitamin A supplements (2 × 200,000 IE) have been shown to have a positive effect in reducing the mortality rate in regions where vitamin A deficiency is widespread. A meta-analysis even revealed an 82 % reduction in measles-related deaths by means of vitamin A supplements (Mayo-Wilson et al. 2011). It is not a lack of vitamin A alone, however, which minimizes these children's chances of survival, but rather a combination of deficiencies (zinc leading to diarrhea etc.,) which proves to be a deadly mixture.

Long-Term Effects of Hunger

Children who make it through the first 5 years of their lives are certainly not out of the thicket by any means since questions pertaining to their development are still wide open. They carry with them the detrimental legacy of their first 1,000 days. It has often been observed that there is a close link between the size of a child and the health of that person later as an adolescent and as an adult. Stunting which occurs during the first 2 years can no longer be rectified and it will have a negative impact on the child's development later on (Golden 1994). The negative effects of malnutrition during a child's first 1,000 days are far-reaching, influencing not only his or her physical, but also psychological and social development (Ruel 2010). Children who are affected will have difficulties at school, ranging from a higher rate of absenteeism to a lesser ability to absorb the material. When they finally reach adulthood, they will earn on average 20 % less than someone in a similar position who is not stunted (Deaton 2006).

The link between one's health and one's stature can be traced back to a person's so-called cumulative net nutrition, in other words the difference between how much one consumes and how much of that is used up additionally by illness or physical labor, during the growth stage (Bogin 2001). This ties in once again to the relationship between the availability of food, food quality and morbidity during childhood. It is a generally acknowledged fact in developed countries that stature, morbidity, and mortality are interrelated (Bozzoli et al. 2009).

No Choices, No Chances! A Brief Retrospect

Throughout the course of the past few 1000 years, life for our ancestors was brief and full of hardships. Food, of which there was often a shortage, was seldom wholesome and was frequently the same. The average life expectancy in Central Europe was 32–40 years, resulting from major hunger crises which hit the poorer classes the hardest, and also unbalanced diets and the limited availability of locally-produced foodstuffs. In France, the average caloric intake at the beginning of the eighteenth century was 1,700 kcal a day, the same amount of energy that was available to the average Rwandan in 1965. Records from the early part of the ninteenth century clearly reveal a simultaneous decrease in stature and in life expectancy, both of which resulted from chronic malnutrition (Fogel 2010). At that time, chronic malnutrition essentially arose from a lack of food or energy, in other words, from undernourishment. The calories which people consumed were often not nearly enough for the work they had to do. People's productivity sank as food became less nutritious and simply less, eventually resulting in poverty for many of them. Robert W. Fogel believes that the low life expectancy was more the result of chronic malnutrition than of the hunger crises. Improvements in the quality and the assortment of food led to the rise in life expectancy in the late ninteeth and twentieth centuries, which, in turn, resulted in more productivity and an economic boom, according to Fogel.

The link between size and mortality can be observed today in developed countries such as Norway and the United States. For persons under 160 cm, mortality increases by up to 2.5 times (142 cm) (Waaler 1984). This is regardless of body weight. Thus, small men with the same BMI as taller men have a lower life expectancy. The fact remains that chronic malnutrition during childhood plays a predominant role here since it favors illness, which increases the need for micronutrients, which then accelerates the deficiencies even more. An example of this was poignantly described by Fogel, who received the Nobel Prize for his work in 1993. He describes how small men were less often recruited into the United States Army than taller men since they had a higher probability of becoming chronically ill. Small men suffered three times more often from circulation problems and periodontitis, as well as being more susceptible to hernias and illnesses related to poor nutrition. They were also more often affected by developmental handicaps. The US Army's recruitment records from 1985 to 1988 show that men who were shorter than 160 cm were up to 2.5 times more likely to be in poor health (Fogel et al. 1993). In his work, Fogel explains the relationship between stunting and mortality which was observed over an extensive time period and he explains how an insufficient diet, especially during childhood and adolescence, leads to illness and death. By malnutrition, Fogel understands a diet which is insufficient from both a quantitative and a qualitative point of view, yet he does not go into detail regarding the latter. Stunting is in his view an indicator of poor health and a shorter life expectancy.

The dietary failures of the first few years of a child's life express themselves in the form of shortness compared with other, better-nourished children of the same age. A study conducted with 283,050 6-year olds in the German state of Brandenburg by the sociologist Jörg Baten and the physician Andreas Böhm, whereby data pertaining to the children's size and social status was available, showed that children from lower-income families were significantly smaller than those from high-income families (Baten and Böhm 2010). The authors come to the conclusion that stunting is the result of a lack of attention on the part of the parents. The issue of what role diet could have played in the first few years of these children's lives was unfortunately not touched upon. This was due in part to the fact that not enough data was available. The role of nutrition in height is illustrated also by the fact that children who have three or more siblings are often shorter. Children from families with two children were 0.5 cm shorter, whereas children from families with four or more children were even 1.8 cm shorter. Children whose mothers had <10 years of schooling were 0.8–0.9 cm shorter than children from better-educated families. These observations have been confirmed by studies in Great Britain and the United States, in which children coming from lower-income families with many children had a higher tendency to suffer from malnutrition and stunting (Hunger in America 2011).

The authors conclude that a lack of attention on the part of the parents is the main cause of the children's predicament. This is certainly a relevant factor for their development. In fact, a lack of involvement by parents who are less educated

and less prosperous also means that they do not take an active interest in their children's diets to make sure that these are adequate and well-balanced.

Limited Productivity

Above and beyond the obvious health effects, hidden hunger also drastically limits productivity. It is estimated that the health issues caused by widespread iron deficiency in South Asia cost the region roughly $5–$6 billion every year (Ross and Horton 1998). This, in turn, accelerates poverty and worsens malnutrition. Studies relating to increasing productivity in China concluded that reducing stunting would raise the GDP by $100–$140 billion, and a reduction in iron deficiency anemia would lead to an increase of $350 billion.

The easiest way to manage one's physical resources is to become less active. Malnourished and undernourished children have more of a tendency to remain sitting or lying down than healthy children do. The 'saved' amount of energy corresponds to the quantity needed for growth (Grantham-McGregor et al. 1990). Malnourished children do not explore their environment with quite the same curiosity and jungle gym enthusiasm as healthy children typically do. The images of children lying on the ground or cowering and, who stare at us with alert but hopelessly sad eyes represent attempts by these children to conserve what energy they still have left. This 'metabolic adaptation' is a typical indicator of hunger. The muscles of children who are inactive will weaken sustainably and this will exert a long-term impact on their ability to be productive. Muscles can only develop when they are exercised, put under strain and supplied with enough protein. The adverse of effects of malnutrition are enhanced by the increasing inability of the muscles to obtain energy in the form of glucose caused by the loss of muscle tissue. Studies conducted with mildly malnourished children (slight cases of anemia and stunting) in Mexico revealed clear constraints on the children's physical activities in comparison to healthy children in the same age group (Aburto et al. 2009).

Education

In addition to reducing the rate of stunting and the risk of mortality, micronutrient supplements also exert a positive influence on children's mental development. This has been confirmed by comprehensive follow-up studies to the ones conducted by INCAP and CRSP (see Box 7.2). Limited cognitive abilities were observed to be linked to physical handicaps caused by stunting among school children, as well as adults.

The key micronutrients affecting cognitive development are iodine and iron. Children whose mothers had an iodine deficiency during pregnancy are born with a more or less serious mental handicap, depending on the degree of the deficiency, or they do not develop mentally as rapidly as children who have an adequate iodine supply and are the same age do. Meta-analyses which have compared the IQs of children with and without an iodine deficiency have come to the conclusion that a child with an adequate supply of iodine will, on average, have an IQ which is 13.5 points higher than one with an iodine deficiency (Bleichrodt and Born 1994).

Table 4.10 Effects of iodine enrichment in a region where iodine deficiency is prevalent (Ma et al. 1994)

	Before 1978	After 1986
Cases of goiter	80 %	4.5 %
Cases of cretinism	14 %	0
School ranking (out of 14 in the district)	14	3
Absenteeism at school	>50 %	2 %
Value of local produce (yuan)	19,000	180,000
Per capita income (yuan)	43	550

Another meta-analysis which compared the results of 37 studies in China noted a negative difference of 13 points among children with an iodine deficiency versus those without. Children in these regions, whose mothers who were given supplements containing iodine before or during pregnancy, remained unaffected by an IQ deficit for their first 3.5 years (Qian and Wang 2005).

Another study conducted in China provides a compelling description of the beneficial effects achieved by increasing one local population's intake of iodine (Ma and Lu 1994). The township of Jixian was referred to as 'idiotville' due to the fact that among its population of 1,243, 850 had goiter and 115 were so-called 'cretins'. Since nobody wanted to marry anyone from this town its productivity low and it remained very poor. A general mood of hopelessness filled the air. Some believed that the town's plight had to do with a cliff in the shape of a monkey which was located nearby. The destruction of the cliff did not result in redemption for the town, however. Finally, the first startling success in changing the situation was achieved when salt and water became enriched with iodine in the town in 1978 (see Table 4.10).

Not only iodine, but also iron has a profound influence on children's intellectual development. A chronic iron deficiency leads to a higher risk of infection, in addition to having a negative impact on a child's overall cognitive abilities, especially during the first 2 years. In various batteries of tests, different cognitive, affective and motor skills have been observed to be influenced. This is evident from the affected person's inability to grasp abstract material and to retain information in the memory. At the same time, children who suffer from early iron deficiency anemia seem to be more often depressed and fearful. They tend to have more difficulties at school and, therefore, require more help with learning. Studies with anemic children who were younger than two from 1981 to 1983 revealed that these children showed cognitive deficits 19 years later as young adults compared with children who were well-nourished at the time (Lukowski et al. 2010). They were clearly handicapped when it came to self-control, flexibility, and memory. The underlying cause of these handicaps is the negative effect which an iron deficiency has upon the dopaminergic system in the hippocampus during childhood (Lozoff 2011). What that ultimately means is that an early childhood iron

deficiency negatively impacts a child's future professional development and thus reduces his or her chances of moving up and out of poverty. Iron deficiency does not only affect lower-income families, yet it is precisely these families which suffer more clearly from its long-term effects than families which are more financially secure (Lozoff et al. 2006). Cognitive deficits, which are exacerbated by iron deficiency, apparently cannot be overcome if the affected person comes from a family with a lower economic and social standing.

Sally Grantham-McGregor (1990) pooled together a number of different studies which explored the impact of malnutrition on cognitive development of by comparing the abilities of stunted children with those of normally developed children. She arrived at a sobering conclusion. Roughly 200 million children worldwide are affected by a cognitive disability caused by malnutrition and will move more slowly forward in their working lives later on as a result. Their marks at school will tend to be one to two grades lower than those of their classmates without stunting. In Ecuador, the vocabularies of five-year olds from poorer families are 40 % smaller those from families with more money. She also mentions various studies which speak of difficulties with abstract thinking, as well as a lower IQ. This, according to the author, is already preparing these children for a long imprisonment in their state of poverty, as well as for the passing along of malnutrition and all of its negative consequences to the following generation.

Conclusion

Hidden hunger represents not only a problem for a child's physical, but also for its mental development. The slowed development undergone during adolescence reduces a person's possibilities, thus making it impossible to break the vicious circle of poverty and malnutrition, even if dietary improvements are made later on. Only after a number of activities to end poverty are concertedly undertaken will it be possible for an entire generation of people to break the circle and start on the path to positive physical and mental development, albeit very slowly at first. First, however, the world community must recognize the current dilemma while the global economy looks for ways to better deal with it.

The unfortunate link between poverty and developmental disorders is self-propagating and keeps those who are affected poor (see Fig. 4.8). It makes dietary intervention possible in a relatively small number of cases and it is extremely difficult to guarantee long-term success. Stunting, as can be seen in Fig. 4.8, is the phenotype of poverty with all of its negative consequences. These adverse effects either cause individuals to return to their former state of poverty or they make it extremely difficult, if not impossible to ever leave it in the first place.

Stunted children, especially girls, will find it nearly impossible to ever get off the hunger carousel alive since their futures have already been determined. Referring back to many of the studies mentioned previously, the following can be said about stunting:

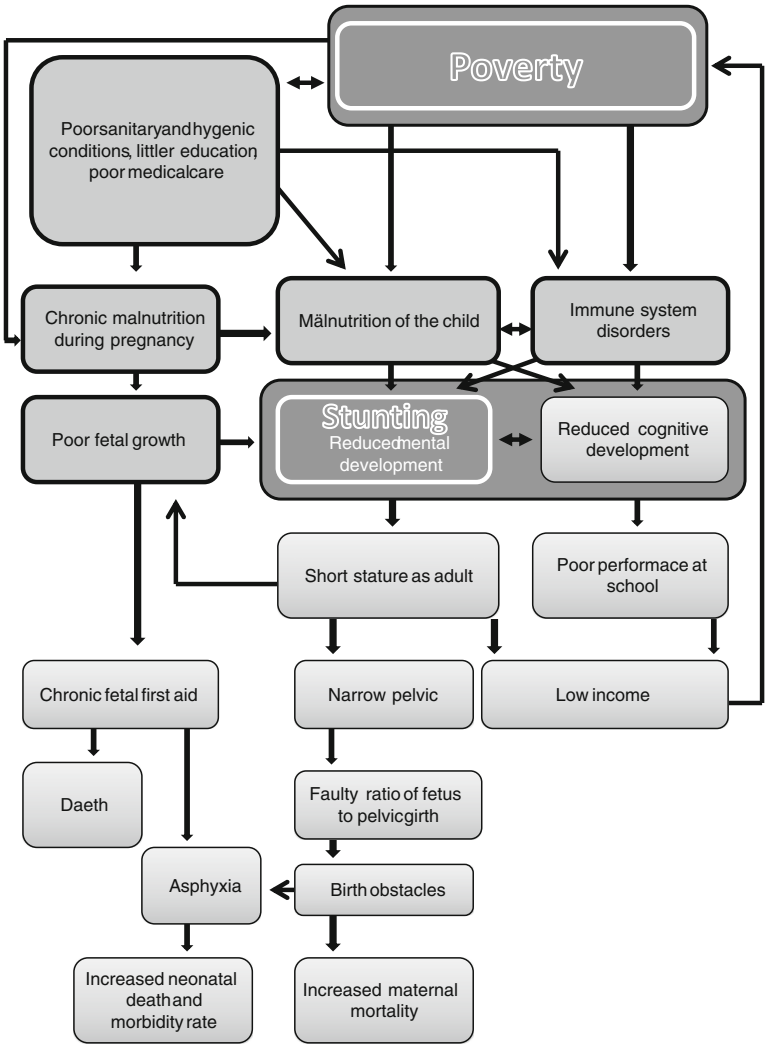

Fig. 4.8 Stunting as a result of poverty and the ensuing consequences (Dewoy and Begum 2011)

- Children whose mothers are petite are born smaller and remain smaller in stature their entire lives. As the height of a mother increases, so too does the height to which a child will grow as an adult. The ratio in centimeters is 1:0.5.
- Stunted children have learning disabilities which affect their academic performance and their marks.
- Stunted children are also less productive and earn less when they become adults.
- As adults, they are more often afflicted with psychological problems and are more frequently ill.

Stunting thus sows the seeds of physical and mental disabilities, resulting not only in constraints which limit one's performance, but which also entail further health complications and lower socio-economic standing. By taking the personal loss caused by stunting and magnifying it to a much larger degree, the economic setback faced by countries which have a high percentage of children with stunting becomes obvious.

Up to 2011, the prevalence of stunting among children sank significantly from 40 to 26 %. However, that still means that 165 million children worldwide suffer irreversible mental and physical disabilities! In Asia, the stunting rate has fallen from 61 to 39 % and in Sub-Saharan Africa it has decreased from 47 to 40 % (UNICEF 2012a). Thus, stunting occurs most often in the two regions where malnutrition mars children's hopes for the future. The figures also indicate that the "optimistic" interpretation of the decline in child mortality must be put into perspective. When there are still so many stunted children, then these are the children who will be the first fatalities when food prices suddenly rise or a drought occurs. They live on the edge of survival and their futures hang on factors which they themselves do not decide upon, but rather which are determined by policy makers and companies.

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Quality Comes with a Price Tag: The Deadly Triangle of Economics, Hunger, and Child Development

5

What power source keeps the hunger carousel turning? What force regulates its speed and the number of passengers who are sitting onboard and get carried off? The answer is largely food prices. These are subject to a number of factors which can send them climbing, such as the demand for biofuels, climate change, and price speculation.

Price and Food Selection

The income gap can be seen most distinctly when it comes to buying food. There are those who can afford to buy meat and vegetables while others have to make due with only cereals. While in Europe people 'suffer' from fluctuations in the price of gas or heating oil, poorer populations suffer from slight changes in the prices of staple foods, particularly cereals. As the percentage of well-to-do persons in a population increases, so does the amount of meat that is consumed. This requires more animal feed and so a rising demand results in a higher price for grain. Whoever lifts one foot off the hunger carousel runs the risk of falling down before they can get off. A rise in food prices may force a family to go back to eating strictly cereals. In richer countries, where a smaller percentage of family's disposable incomes is spent on food, this can be more easily compensated for by making a few adjustments. Yet in rich countries it is also the case that food which contains more micronutrients is more expensive than food which contains less micronutrients and is generally fattier (Aggarwal et al. 2012).

Provided there is enough money in a poorer household to purchase food to satisfy the daily requirement of calories, for instance 50 % from cereals and the other 50 % from say oil, fish, vegetables, and perhaps a bit of meat from time to time, this does not necessarily mean that the family has a balanced diet as understood by us in the developed world. It does, however, provide at least an important foundation for their children's development. A rise in the price of

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Table 5.1 Breakdown of calories consumed daily in Sri Lanka in 2009

Food	kcal/day
Cereals	1,368.45
Sugar	255.75
Oil and fat	362.93
Fruit, vegetables, nuts, and powdered milk	276.42

cereals does not mean that the family buys less of it, but rather that grain-based foodstuffs make up a larger portion of the family's diet. Money can be saved by buying less of the more expensive non-grain-based foods.

Here is an example to illustrate this. In Sri Lanka, the average person consumed roughly 2,450 kcal a day from 2005 to 2009. This correlates to the amount of calories which, according to the WHO, a person requires to stay healthy and be able to do physical work. The recommendations for a healthy diet as persons in the developed world understand the term emphasize eating primarily plant-based foods, in other words less meat, but instead more vegetables and cereals. Vegetarian cuisine is typical for many Asian countries where the maternal and child mortality rates are very high. One cannot help but wonder if there exists a connection here. And why are so many people in Sri Lanka malnourished when they seem to enjoy a healthy diet? A convincing answer is provided by the food balance sheet (FBS) in Table 5.1.

In total, 2264 kcal are consumed daily. In order to reach the daily energy amount of 2,450 kcal, only 186 kcal remain for those sources of food which supply the most micronutrients, such as fish, meat, and eggs. Sri Lanka is a perfect example of a country whose population gets its energy primarily from cereals. Cereals, however, are not a particularly good source of micronutrients. When prices go up, the amount of oil, fat and, most especially, fruit, vegetables, and meat consumed goes down. Families want their stomachs to be full and so mothers have no alternative but to buy more expensive rice or, when rice itself becomes too expensive as was the case in Indonesia in 2011, to switch to millet.

Conclusion

Stabile, low prices for staple foods could ensure at least a small variety in people's diets and could make it possible to plan the daily food budget in poorer populations. This, in turn, would contribute to preventing short- and long-term health complications among children. That is why the fourth pillar, price stability, is the actual basis for what is understood by food security.

Price Fluctuations

Prices can be affected by factors over a short or longer time period. Sudden jumps in prices, or price shocks, can mean serious limitations in an already restricted diet for poorer families. A determining factor is the price of that food item prior to the jump. If the price of the item is already rather high, then even a mild shock can have devastating results. The increases in already high food prices in 2007/2008 resulted in 170 million new cases of hunger worldwide, according to estimates made by the FAO. In recent years, each price shock has resulted in mid- to long-term price increases (see Fig. 5.1). Hence, even mildly negative shocks will have disastrous consequences for many people. More and more individuals will inevitably experience a social decline from which there is no return.

Numerous factors underlie price fluctuations—from developments in international markets to changes happening in local ones, as well as a range of other influences, such as elasticity, demand, the behavior of better-earning consumers, and much more which cannot be elaborated on at this point. Inflation reduces the buying power of families, lessens social security, and plunges those who had so far managed to keep their heads above water into absolute poverty. Price fluctuations have a dual effect, whereby each unfortunately strengthens the other. Social decline goes hand in hand with a loss of food security. A loss of food security, in turn, leads to chronic malnutrition which, as discussed previously, results in a loss of productivity and income. Ultimately the circle keeps not only the entire family, but their offspring in poverty over generations.

It is primarily the poor who are hardest hit by price fluctuations and price shocks affecting grain-based products, their staple foods. Something which plays a big part in triggering deviations in grain prices is the price of crude oil, which is needed for the production (e.g. fertilizing) and transportation of food products. This relationship is further intensified by the production of biofuels since now a choice needs to be made between food and power. Biofuels are in competition with food products for land and, more importantly, water reserves. Due to the fact that biofuels are strongly subsidized, they can easily cause prices to fluctuate and remain higher. The subsidy policies for biofuels in the United States and Europe

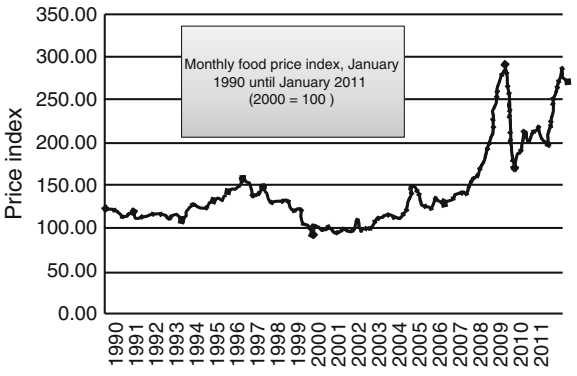

Fig. 5.1 Development of food prices from January 1990 to January 2011. Peaks during the financial crises of 2008 and 2011 are clearly visible (World Bank 2011)

are essentially responsible for the general rise in food prices worldwide, particularly cereals, in 2007/2008.

It should be clear by now to the bystanders who are watching the hunger carousel that an insufficient diet has grave consequences for people of all age groups. The passengers onboard the carousel are there against their will and, since they will continue to be malnourished and impoverished, they will have no opportunity to ever get off anytime in the grim-looking future. What force keeps the hunger carousel in motion? What power prevents those who are onboard from ever being able to get off again alive?

There are some conditions which must be met first before an individual can be liberated from the hunger carousel (see Box 5.1). Food must be: available, accessible, nutritious, stable in price (see the four pillars of food security, Chap. 3).

Box 5.1 Conditions for the stability of the four pillars of food security

Availability of food

- Possibilities to deliver to the local markets (transport and costs);
- Lifting of trade barriers (customs);
- Affordability of seeds and fertilizers for self-supporting producers;
- Land ownership;
- Mobility.

Access to (available) food

- Sufficient financial means;
- Knowledge of food quality;
- Stabile food prices, especially regarding staple foods.

Quality (nutritiousness) of food

- Sufficient financial means;
- Knowledge of diet diversity;
- Stabile food prices, especially regarding staple foods.

Price stability

- Political will

All four pillars are subject to forces, which the poor farmer is powerless to influence and which can cause a shake-up:

- Price fluctuations;
- Land distribution;
- Climate changes.

The conditions listed in Box 5.1 (there are certainly others) can only be enduringly fulfilled by combatting poverty. Poverty is a particular problem for rural farming families, who typically own less than one hectare on which to grow their own food and that to be sold. And even these small plots are not safe.

A farmer's land is always under the threat of being sold off by a corrupt government or it must be sold in order for the farmer to pay off money the farmer borrowed to make it through hard times, such as a dry spell and/or a loss of crops or to supposedly optimize harvests. If their operating costs go up, farmers must make

an important decision: live hungrily ever after or sell the land? Both paths, however, lead only to poverty and malnutrition. The farmers and their families hang like string puppets controlled by price trends and, hence, availability of food. They receive emergency relief in the form of grain, vitamin supplements or vitamin-enhanced food from non-profit organizations in times of extreme hardship. Yet that does mean that the prospects of their getting off the hunger carousel are any better.

Poverty: No Money, No Food

Poverty and malnutrition go hand in hand. Poverty underlies a person's inability to secure a nutritious diet. Nearly a third of humanity lives in poverty. 70 % are women and 99 % live in developing countries.

> *The reason why many people choose a diet based on quantity is the subjective feeling of fullness which it gives them. The reason why others choose a diet based on quality is because they are aware of its importance and have the financial means to obtain it. Without money, information is rather useless when it comes to feeding the family. Then it simply comes down to feeling full by whatever dietary means possible. Poverty is the foundation for malnutrition!*

Sir Partha Sarathi Dasgupta, a renowned economist at Cambridge University, described poverty in Africa in a lecture given at the World Bank. He writes that, in the world of the poor, there is no such thing as food security or wealth, but rather stunting, wasting, and illiteracy. The poor have no possibility to receive credit, build up food reserves in case up crop losses or other emergencies. They have no control over their own lives, are cut off from the rest of the world, live in unsanitary surroundings, are powerless, and have no advocates to speak up for them. What is more, their natural resources are increasingly disappearing and the birth rate among them is high (Dasgupta 2004). This is the world of the very poorest, where less than $1.25 a day is all that stands between them and death. This world, located predominantly in Asia and Africa, is inhabited by 1.3 billion people. There is also an increasing number of poor people living in developed countries, such as the United States and in Europe. The exact figures, however, are difficult to estimate. Granted that there most certainly is a divide between what is happening in developed versus less developed countries; nevertheless, the common denominator, according to Dasgupta, is continuity. Entire lineages have been living in absolute poverty and it is very difficult, if not impossible, to escape from poverty and the hunger carousel. The reason lies in the fatal link between economics and food quality.

70 % of poor people live in rural areas. These people are primarily farmers. Poverty prevents them from purchasing necessary farming equipment, fertilizer, or adequate amounts of seeds. As a result, the harvests shrink and the quality of the produce plummets as the soil quality decreases with use (Sanchez et al. 2005). Poverty and poor nutrition lead to a higher child mortality rate, which results in a higher birth rate and, ultimately, the persistence of poverty.

If the market price for cereals rises, this inevitably leads to a reduction in the quality of the foods which the poor are still able to purchase. Based upon the fact that 20 % of the world's population has less than $1 a day to spend on necessities, and that 50–80 % of that money is spent on food, it is not difficult to imagine what such a diet must look like. Here is a comparison to help put this in perspective: In Germany, the average family spends 13 % of its disposable income on food!

Price Development of Staple Foods

Fluctuations in the price of grain are reflected in variations in the maternal and child mortality rates, as well as in the number of disabled children. There are 'avoidable' causes for these fluctuations, such as profit-oriented market trading, the production of biofuels, unfair trade policies, and subsidization. It is possible to drive and keep the prices of important staple foods down by means of a fair form of market regulation. To accomplish this, however, political will is required.

The development of prices, according to the FAO's food price index (FFPI) wherein they are regularly recorded, shows two essential characteristics. Prices of essential staple foods are twice as high as they were in 2000. Prices rose dramatically during the financial crises of 2008 and 2011 and afterwards did not decrease again to the levels prior to the crises. Food and cereal prices have risen by 100 % since 2005 (World Bank 2012).

We are currently on track to overtake the inflation rates for staple foods from 2006 to 2008. Figure 5.1 does not show the entire impact of the financial crisis of 2011. Recent studies reveal, however, that staple food prices have not decreased significantly (World Bank 2012).

The FFPI is a numerical index for the prices of staple foods in international markets. In 2011, the FFPI was higher than in 2010 and the highest level since 1980 (FFPI 2011/2012). The price for grain reached a 40-year peak in 2011, 35 % higher than it had been in 2010.

If we look at the details up close, focusing on the effect which these price fluctuations have on poorer regions, it becomes obvious that we are dealing with catastrophes—ones which poor families are powerless to stop.

According to the Global Food Price Monitor (December 2011), increases in the price of grain in several African countries were the result of poor harvests and higher fuel prices. In 2011, the price of corn in the city of Nairobi was 75 % higher than in the previous year. In Kampala, the price of corn was 26 % higher at the end of 2011, and in Ethiopia, the price of corn in November 2011 was 147 % higher than it had been in November 2010. In a few African countries, prices have gone down thanks to good harvests. Yet prices are still higher than they had been in 2009.

Looking at the detailed analysis, it is clear that the prices of grain and oil were the most heavily affected by the financial crises (see Fig. 5.2).

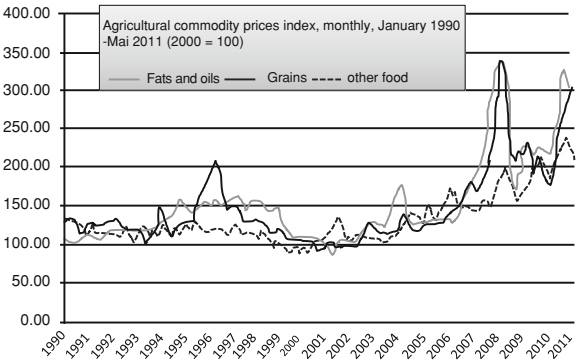

Fig. 5.2 The price of produce from January 1990 to January 2011. Prices will not have significantly decreased by the end of 2012. The staple foods of the poor, cereals and fatty foods, have become particularly expensive (World Bank 2011)

When a portion of rice suddenly doubles in price, those who are affected by it have no choice but to go hungry or to shop for even cheaper, i.e., poorer quality products. From September 2011 to December 2011, the price of rice increased by 25–90 %, the price of wheat by 15–90 %, the price of corn by 10–120 %, and the price of millet by 20–60 %, depending on the country (World Bank 2012). Alternatively, the poor must do without other items for which there is not much money anyway (see Fig. 5.3).

Figure 5.3 illustrates that such a family budget, which does not apply to the very poor, does not leave much leeway for sudden expenditures. The bigger the slice for food is, the smaller the slice for non-food-related costs. The percentage spent on food varies in Sri Lanka between 50 and 70 % depending on the province, whereby 30–50 % is spent on staple foods (mostly rice). The percentage of

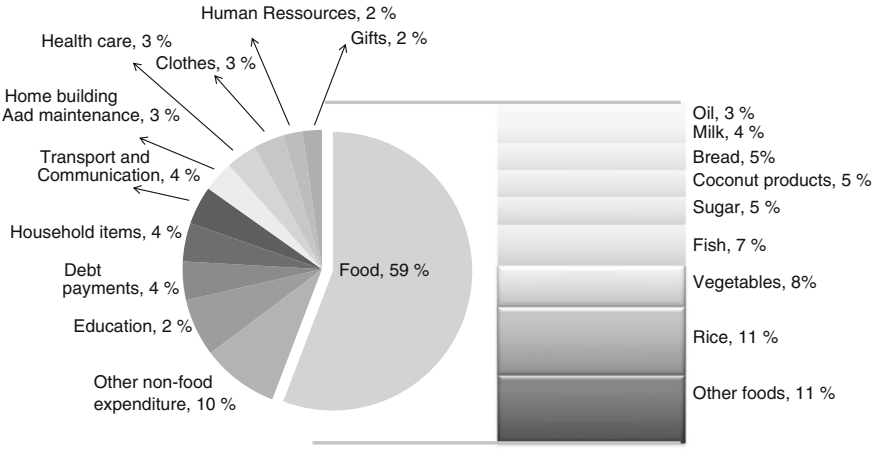

Fig. 5.3 Allocation of household income for food and non-food items in Sri Lanka (Petersson et al. 2011)

households which spends between 65 and 100 % of their income on food varies between 20 (in wealthier regions) and 65 %.

Here is what the World Bank has to say:

The sharp rise in cereal prices, which has nothing to do with the season, is alarming. Action must be taken immediately in order to avoid hunger crises in Burkina Faso, Chad, Mali, Mauretania, and Niger. It can be safely assumed that because of the sharp rise in prices in 2011, an additional 500,000 children have died (Save the Children 2011).

In addition, a further 1 million children will now be affected by malnutrition. This is due to the fact that poor families need to compensate for these price surges by tightening their belts so that, in the end, all they will be able to buy for a long time is rice or corn.

Price trends are easy to depict in tables and charts—neutral and apparently of no real consequence. The price of food is a two-sided coin. On the one side, there are the world's poor, who need to buy food in order to simply survive. On the other side, there are the rich, who utilize rises in the price of food to make a profit and live in the lap of luxury.

The former are in the majority with over a billion people, while the latter are merely a few hundred. While the poor do not have enough means to secure an adequate diet, the rich take advantage of the poor's predicament in order to maximize profits. Those whose lives depend on being able to purchase enough food have nothing to say in the marketplace. Traders of food products are not at all interested in the complex crises which have made purchasing food an even trickier task. For them, it is a matter of cold calculation and profit maximization.

When the prices of staple foods rise, hunger increases, especially hidden hunger. This situation does not only apply to developing countries!

Reasons for Price Increases

There are various other less questionable reasons for hikes in food prices in addition to gambling on the commodities markets. The FAO lists the following causes:

- dry periods in the important exporting countries;
- political support for biofuels (in the form of subsidies) leading to an increased demand for corn and vegetable oil;
- changing currency rates (e.g. weakening of the dollar);
- economic growth leading to a rise in energy and fertilizer prices, as well as a higher demand for meat (as society grows wealthier), which increases the demand for animal feed;
- higher transport costs resulting from higher fuel costs;
- smaller harvests, particularly rice and wheat;
- price speculation.

Last but not least, the trade policies of certain countries involving export restrictions and hoarding lead producers to wait for the best time to sell. This has an impact on the markets and on consumers, who rush to obtain the necessary foodstuffs. Consumer behavior in rich countries often does not take into account under what conditions food products are produced.

Speculative market trading only adds fuel to the fire:

> On the Chicago Board of Trade (CBOT) contract market, wheelers and dealers bet on pork bellies, frozen orange juice, and wheat. Small-time private investors can also trade in options and futures contracts for certain produce goods.
> Wheat trading is particularly lucrative at the moment due to the floods in eastern Australia, which turned up to 40 % of the harvest into animal feed at best. Normally about 10 % of wheat is sorted out as waste. This year, Australia is likely to be the fourth biggest exporter of wheat with 14.3 million tons. Last year, the country exported 16.9 million tons. The governments of Algeria and Indonesia are currently stockpiling wheat in order to build up reserves, thus removing large quantities from the market.
> China imports 60 % of all soybeans traded worldwide and it also has a major influence on the price of corn. Corn imports from the USA are expected to rise from 1.5 million tons to 7 million tons. The boom in the biofuels sector is also driving the price of corn up. In 2005, only 12 % of US corn was pumped into fuel tanks. Last year, that number rose to nearly 40 %. According to the FAO, worldwide bioethanol production could reach 125 billion liters by 2017, a doubling of the amount produced in 2007 (*WirtschaftsWoche* 2011).

Commodities in general are a lucrative investment, but most especially wheat. If investors traded responsibly, keeping an eye on the impact of prices on countries affected by shortages and economic woes, then this would not be an issue. In reality, however, things look much different.

> **Rice at an All-time High**
> The crisis of rising food prices around the world continues: The price of rice has hit an all-time high. The chief economist of the United Nations Conference on Trade and Development (UNCTAD), Heiner Flassbeck, sees price speculation on the commodities markets as being primarily responsible for the sudden jump. "Speculative trading must be happening on a massive scale. Nothing else could push the price of rice up so high in such a short time", Flassbeck told the *Frankfurter Rundschau*.
> The price of rice reached an all-time high on Thursday. In Thailand, one ton cost more than $1,000. Hence, the price of this staple food in the biggest rice-exporting country in the world has more than tripled since the beginning of the year. (www.n24.de/wirtschaft&Börse)

The prices for staple foods and cereals around the world have in fact dropped since 2008, yet they have been continually rising since 2009 and are expected to reach or even exceed the peak of 2008 (see Table 5.2).

It is difficult to imagine what it must mean for a family which needed to spend 70 % of its income on food prior to the crisis of 2008 when the price of rice suddenly triples. Particularly troubling is the fact that the price has remained well above the average price in 2006. The same applies to the price of fat and oil. Ultimately, the existence of many needy persons has been wiped out. The World Bank's most recent report covering February to December 2011 indicated a further rise of 12 % in the price of rice (Food Price Watch 2012). During the same time

Table 5.2 Food price index of the FAO and World Bank 2011

	1990–2006 average	2008 monthly high	2009 yearly average	2010 yearly average	2011 01–03 average
Food	124	292 (June)	205	224	284
Cereals	126	340 (April)	214	215	289
Rice	129	448 (April)	274	241	229
Wheat	130	305 (June)	196	196	281
Corn	122	324 (June)	187	209	319
Oil and fat	127	341 (June)	216	244	321
Sugar	120	165 (Feb)	222	260	348

period, the prices for wheat, corn, millet, and rice in Burkina Faso, Ethiopia, Niger, Uganda, Rwanda, Kenya, South Africa, Mexico, and Malawi were 20–120 % above the already steep prices of the previous year. In other African countries, however, the prices of these staple foods dropped by as much as 40 %. Once again, it was the poorest countries which got hit the hardest.

If we compare the price of corn with the value of all funds listed on the stock exchange from 2006 to 2011, we can observe an all-time peak of roughly six billion dollars for the latter in 2008, a year of severe food shortages. Thereafter the price of funds fell temporarily (International Grain Council 2011). When prices are up, commodities trading, particularly with food products, seems to be quite lucrative, as the figures from the second food crisis in 2011 illustrate. The value of all listed funds at that time was more than $9 billion. The price of corn at the height of the crisis in June 2008 was $287/megaton. In April 2011, it had risen to $318/mt and in June 2012 it was at around $281/mt. The drought in the USA, as well as the fact that 40 % of corn harvests are used for biofuel production, has caused prices to rise once again to $314/mt. Compared to the prices before the crisis and the relatively stable period between October 2008 and October 2010 ($150/mt), the situation can hardly be referred to as a price shock. Rather it seems to be an on-going, albeit perhaps not necessarily permanent, price increase, which is taking the lives of many mothers and children. The forecast of the international grain council (IGC) will certainly be well-received by investors: Increasing prosperity will keep the demand for cereals high, particularly as animal feed and also for industrial purposes. In other words, the wealthier class, especially in China, India and Latin America, will want to have more meat on the table. In addition to that, the increase in demand for biofuels will also do its part in keeping prices high. The IGC goes on to say that diet diversity, in particularly the consumption of more meat and meat-based products, will result in a gradual decrease in cereals as a source of food. Investors will most certainly be attracted to the stabile corn prices, which promise long-term healthy returns.

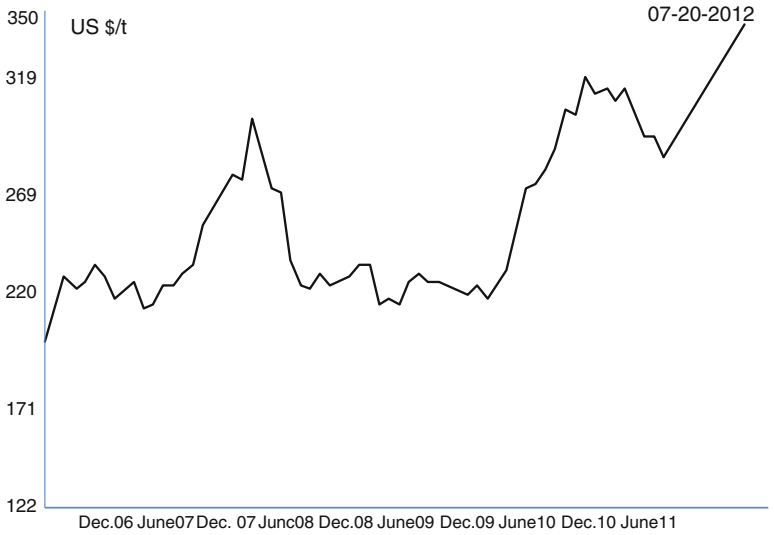

Fig. 5.4 The price of corn until July 2012 (www.mongabay.com)

The chart for corn (see Fig. 5.4) is similar to that of other staple foods, such as rice and wheat. Here we can see a parallel trend with sudden increases of 100 % or more within a month's time. These trends also go hand in hand with fluctuations in the prices of energy and biofuels. In the end, it makes no difference whatsoever who or what drives the prices up since it is the poor who pay the price with their health.

As part of a study into rising food prices, UNICEF has focused on the effects of price speculation (see Box 5.2).

Box 5.2 Dealing in food (and lives)

During the past five years, money has been pouring into the commodities markets. Between 2005 and 2010, the number of options and futures traded on the commodities markets nearly quadrupled. 66 million deals were closed at the end of 2010, not counting OTC sales of food, which only make up a small but growing percentage of the total. Non-regulated OTC activities are exploded during the same time period, reaching a nominal value of $12 billion excluding gold contracts in 2008 (Bank for International Settlements 2010). More liquidity in the financial markets contributed to the sudden jump in prices as major investors, who were not so much interested in the ethics of agriculture as in making money quickly, starting taking an interest in commodities futures, thus generating a bubble.

The principle behind futures contract is to hedge against rising prices and protect the producer and the consumer of the goods. However, a mere 2 % of futures actually involve goods changing hands, whereby the remaining 98 % are traded by investors before they expire in the hopes of making a quick profit.

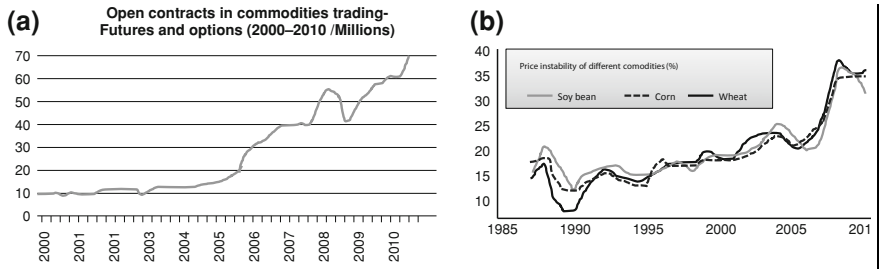

Fig. 5.5 **a** Expired futures for wheat and the price of wheat **b** Expected price instability of wheat (Ortiz et al. 2011)

This type of trading can send the prices of futures contracts skyrocketing or tumbling, and give false indications about what to expect regarding the prices of actual food products. Amidst all of this speculation, it becomes difficult to keep the prices of food stable. In addition, due to the financial burdens laid on food producers, processing industries and vendors by these fluctuations, the prices at the market can suddenly jump. Viewing price speculation as a type of exploitation which takes the lives of millions of people, the UN and the G20 countries have demanded better regulation to make the financial markets more transparent and effective in an attempt to better handle dramatic price fluctuations on the commodities markets (see Fig. 5.5).

The latest FAO Food Price Index from May 3, 2012 shows a minor decrease in cereal prices of 2.5 % and a slight increase of 2.2 % in the price of fats and oils. These deviations may seem marginal, but considering that prices have already been at peak levels since the financial crisis of 2008, any increase whatsoever is certainly not inconsequential. The severity of the hike in prices ranged from 40 % in Belarus to 12 % in Thailand. Price developments on an international level herald what will be seen happening locally. Within a matter of weeks, global price increases, caused in part by international crises, price speculation and political decisions make their way to the local markets. These minimal drops in prices have long since been overhauled by further increases. In July 2012, the price of wheat increased by 25 % and has remained at this high level. Similarly, there have been increases in the prices of many staple foods and livestock feed crops. The rise in the price of soybeans, which occurred between June and August 2012, resulted in a temporary rise in the price of meat. In the end, the poor are driven further into poverty and malnutrition due to these price developments.

Effects of Price Shocks

Rising food prices, no matter what the underlying cause, result in malnutrition and fatalities, particularly among children under the age of five. What such price hikes actually mean, such as the rise in the price of rice by 141 % since January 2008, is

explained by Josette Sheran, the former Executive Director of the World Food Programme:

> For the middle classes, it means cutting out medical care. For those on $2 a day, it means cutting out meat and taking the children out of school. For those on $1 a day, it means cutting out meat and vegetables and eating only cereals. And for those on 50 cents a day, it means total disaster. The poorest are selling their animals, tools, the tin roof over their heads—making recovery, when it comes, much harder. (*The Economist* 17 April 2008).

The increase in prices over the course of the past few years has plunged millions of people into poverty and extinguished any hope which those people who already live in it had of escaping from it. The impact of the rise in food prices will soon be very visible. What we have already seen is a doubling of the number of chronically malnourished and severely undernourished children all over the world (Compton et al. 2010). In Ethiopia, a massive famine resulted in a rise in severe malnutrition and child mortality in 2003. It was comparable in scope to what happened after the price shocks. From August 2007 and February 2008, the percentage of malnourished persons, which had been between 2–5 % depending on the district, rose to 10–20 %. At the same time, the child mortality rate in these districts increased by as much as 15-fold (ACF 2009). Unlike 2003, there was no officially announced hunger crisis in Ethiopia in 2007/2008 and the nationwide child mortality rate decreased slightly (2007: 118/1,000; 2008: 112/1,000), however, these dry figures are apparently not a result of the price shocks. Local, smaller scale crises are often overlooked precisely because they are local and do not develop into massive nationwide famines.

For those who are affected, sudden jumps in price, commonly known as price shocks, have the worst impact. It is difficult to judge what influence price speculation has exactly, but in the end it really does not matter for the victims. First and foremost, price shocks (often triggered by speculation) harm individuals. Nationwide relief programs cannot always provide adequate response to the needs of the victims. Local price hikes, quite devastatingly, tend to be clearly higher in poorer countries (>20 %) than those which occur in more prosperous countries, as was illustrated by an analysis of 27 low-income and 32 middle-income nations (Ortiz et al. 2011).

If we look at Turkey, a country with middle to high income, the price shocks of 2008 resulted in 73 % of households buying cheaper groceries and 53 % buying less food in general (TEPAV, UNICEF, and World Bank 2009). In the Philippines, a country with low but still middle income, 83 % of households bought less food, 55 % did without health care, and 40 % had to borrow money (Reyes et al. 2010).

An effect of such a development is that women work more, nourish themselves less, and wind up being the victims of price shocks together with their children. Tiwari and Zaman (2010) came to the conclusion that the price shock of 2008 resulted in an increase in undernourishment of 16 % by conservative estimates. That equates to 63 million people. The basis of the calculation is a daily caloric intake of 1,810 kcal per person and an average price increase of 35 %. It was clear to the authors of the study that looking solely at the amount of energy consumed does not wholly cover the

actual problem and that the price increases were much higher in certain regions. Nevertheless, watertight figures must be collected in order to demonstrate the impact of such price shocks. How many more millions of children will suffer and die from undernourishment and how many more mothers will give birth to chronically undernourished children due to their own inadequate diets cannot be expressed in terms of numbers. Yet it is presumably far above the estimated 64 million.

The next price shock came in 2011, bringing prices to an all-time high. By May 2012, the price of corn had risen by 82 % in Malawi, 80 % in Ethiopia, and 71 % in Mexico (World Bank 2012). These price increases will certainly be expected to have a massive impact on food security since the shock came at a time of already high prices. In mathematical terms, the number of new cases of hunger is estimated at 1.3 billion (Brinkman et al. 2010).

The consequences of this for countries such as Mexico, where programs to reduce malnutrition are being implemented and it will be difficult for the organizers to carry on in light of permanently inflated prices.

Even much worse than this since the effects often cannot be undone are the attempts of the victims living in poor countries to manage these price shocks. Their efforts to survive lead them to sell their last possessions, their farming equipment, and the last bit of land they still own. Often they are forced to borrow money in order to buy food. The products they purchase are able to still their hunger pangs, but are not able to feed the hidden hunger which they suffer from. The end result of this dilemma is that the afflicted lose all hope of ever escaping from the crisis and returning to a normal life—one in which they can at least adequately feed their families. They lose everything and are left with nothing. They will have to depend upon food aid indefinitely.

As if that was all not enough, unemployment increases in such crises and has already hit 30 % among young persons in certain regions, or salaries drop dramatically since employers, wholesalers, retailers, and consumers also need to tighten their belts. A particularly grim example of this loss of income is provided by data from a survey of rubbish collectors in Latin America (Mendoza 2010). In Santiago de Chile, the price paid for used paper sank by 60 %, for plastic by 40 %, for iron by 70 %, and for other materials by 30 %. What these plummeting prices mean for poor families is easy to comprehend.

As ironic as it may seem, price increases may also benefit the population. The net income of people who buy food in developing countries is often higher than that of people who produce and sell it. So the latter group naturally profits from a (temporary) rise in prices, provided that their produces are not displaced by ridiculously cheap imports. Another condition is that the prices of fuel (based on oil) and fertilizer remain relatively stable. Due to the fact that the prices of grain and energy run parallel to each other, this is usually not the case and minimizes the rise in income.

A 10 % increase in the price of corn in Malawi results in a reduction in real income of 1.3 % among the very poorest classes and 0.6 % among the poor. However, the richest individuals end up earning 0.5 % more (FAO 2008). The changes affecting the former group may appear marginal, they are however catastrophic.

This simplified depiction is not valid for the 20 % of the population who are the very poorest since they usually do not produce their own food, or if they do, then only in very small quantities. They simply do not have the means to acquire seeds, fertilizer, land, and workers.

Even a minimal rise in prices has resulted in a growth of the poorest class in seven out of nine countries (Ivanic and Martin 2008). The authors of the study analyzed 60,000 households and assessed the effects which a 10 % increase in the price of staple foods would have upon them. They discovered that the result would be an average increase in poverty of 0.6 %, with the exception of Vietnam and Peru, which showed no change. When they replaced the figures with those from the dramatic increase from 2005 to 2007, an increase in poverty of between 3 and 3.6 % was the result. Surprisingly, the increase in poverty in rural areas was lower than in cities. Most heavily impacted by the inflation was the price of wheat, followed by rice, dairy products, and corn. In some countries, the changes were quite drastic. In Nicaragua, the urban poor increased by 10.7 %, while size of the rural poor grew by 7.8 %. This study also confirms that the poor who purchase food are more heavily affected by inflation than the poor who produce it. Buyers hardly have any chance of becoming even partly self-sufficient when it comes to produce. The chances are even less when they live in the cities, and this explains why the negative effects are stronger there. The number of people earning just $1 a day increases by 4.5 % or 105 million as a result of the price increases. With regard to the Millennium Development Goals, the setback is seven years according to the authors. A recent world bank report (Ivanic et al. 2011) concluded: "Global food prices have increased substantially since 2010 resulting in an increase of the average poverty change of 1.1 % points in low income countries and 0.7 % points in middle income countries with a net increase of 44 million people falling below the $1.25 per day extreme poverty line".

98 % of farmers in Rwanda grow beans. Beans are a good source of protein and energy. Nevertheless, these farmers are unable to make a living from farming beans and to feed their families. Most of them have to purchase additional beans. Even in years when harvests are good, 25 % of them are lost because they cannot be stored and are eaten by pests (Devereux et al. 2008). This is simply one example of a situation which repeats itself again and again with different produce. Perhaps we should try putting ourselves in these people's shoes for just a moment, for example, after we have gone to the local food discounter and filled the refrigerator with food. How would we feel if 25 % of that food was instantly spoiled? How long would we tolerate that?

A recently published study from Namibia illustrates the disastrous effects of price shocks (Levine 2012). From April 2006 to September 2008, inflation for food prices jumped from 4.9 to 18.8 %. During the same time period, the inflation rate for energy and thus for food transport went from 7.5 to 18.1 %. Prices for oil and fat rose by 30 %, fruits and vegetables by 18 %, milk, cheese, and eggs by 25 %, and bread and cereals by 23 %. What were the effects of this? As expected, the poorest members of society were the hardest hit. Most of the products consumed on a daily basis must be paid for in cash, also in rural areas, leaving little margin for price fluctuations and

resulting in the amassing of debt. The overall supply of food was diminished since staples, such as oil, fat, and cereals were also much more expensive. At the same time, the last possessions which some of the poor had still had, for instance agricultural machinery, vehicles, and animals, were sold. In order to survive, the poor were forced to send their children off to work instead of off to school. They were also forced to do without any form of health care. Namibia is a country whose progress in successfully reducing infant and child mortality during the years 1990–2008 is recognized, yet in the face of such price shocks, all efforts to keep up the success are futile. The reduction in child mortality since 1970 has leveled off since 2000, whereas the maternal mortality rate has increased.

Rising prices start an upward spiral which is difficult to halt and which plunges the innocent victims caught within it deeper and deeper into debt. Studies of the so-called coping strategies (designed to counter the diminishing of food resources) by households in answer to the inflation of food prices always follow the same pattern (see Fig. 5.6). Cheaper and cheaper products are purchased, the number of daily meals is reduced, and food is bought on credit. As a result, the phantom of hunger comes creeping up again until the next jump in prices or another crisis. It is a deadly spiral, driven by hunger and accompanied by mothers' concern for their children's lives.

The impact of price shocks can only be reversed when prices drop again as quickly as they rose. Malnutrition and the loss of resources push the poor irreversibly further down into the depths of poverty. Lastly, price fluctuations have an impact on various other issues (FAO 2011). They not only affect individuals,

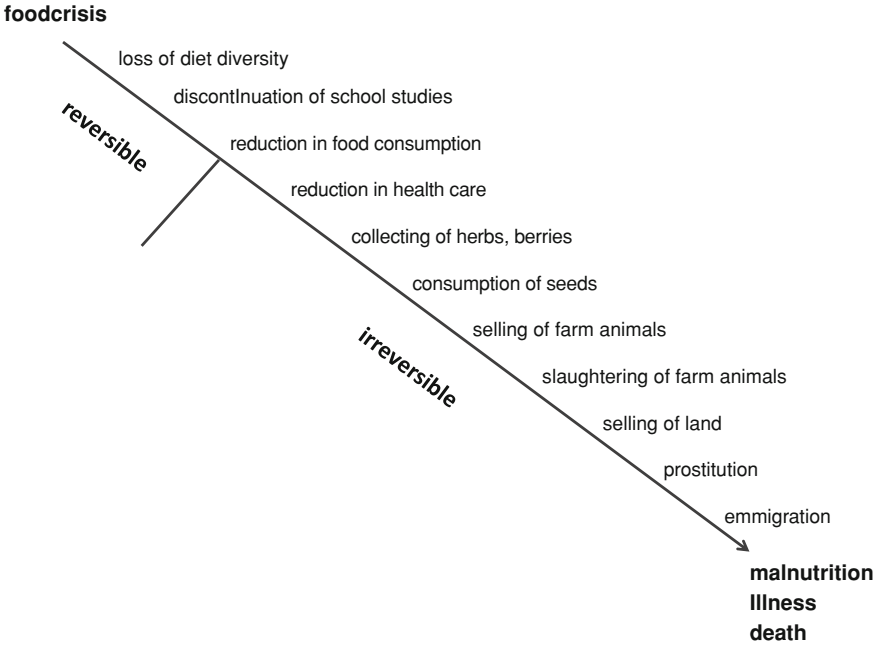

Fig. 5.6 Coping mechanism for securing food for the family (Hauenstein and Vaitla 2007)

Table 5.3 Impact of price shocks (Dessus et al. 2008)

Effect	Victim/result	Example
Poverty trap	Consumers and farmers	Temporary coping strategies (e.g., sale of possessions or dietary cutbacks)
Reductions in private investments	Farmers	Smaller harvests due to less use of fertilizer
Macroeconomic	Price fluctuations/influence on distribution of resources	Reduced economic growth
Political processes	Democratic institutions/long-term economic effects	Riots which deter overseas investors/subsidies which inhibit investments in the general welfare of the populace

but can also have a lasting effect upon the entire economy. A consequence of this is that people who were able to just barely keep their heads above water are forced onto the hunger carousel. According to conservative estimates, the inflation of 2008 has resulted in 5 % more impoverished individuals worldwide (Dessus et al. 2008; Table 5.3). How many poor persons have sunk even deeper into poverty as a result of inflation is unknown.

The World Bank calculated the consequences of the price shocks of 2011 in its report for 2012 (World Bank 2012). In a short time, 48 million people will become impoverished, on a mid-term basis 45 million will become poor despite a rise in salaries, and in the long run, 34 million will fall below the poverty line, even if nutrition improves. Since prices have hardly decreased again since the price shocks in 2011, but rather have risen in 2012, it is easy to imagine how the number of poor persons will continue to rise in the future.

According to the FAO's calculations, the price hikes of 2010 have resulted in an increase in the cost of food imports to the poorest countries of 11 % versus the previous year and of 20 % to countries affected by food shortages (FAO 2010). The bottom line is that countries are stripped of their ability to compensate for the impact of price fluctuations by means of their own resources. Inflated food prices also have a negative impact on the heath care and education systems in these countries. Each jump in prices sets a new spiral in motion, pulling the already poorest of the poor countries further down into poverty and obscuring future prospects regardless of all initiatives.

Price fluctuations, according to the FAO, even if they remain over a longer time period, lead to sudden price shocks, which affect farmers and low-income consumers, making them susceptible to long-lasting poverty. Thus, farmers go from being net sellers, who can improve their situation by selling products, to net buyers, who must buy additional food to feed the family. Peasant farmers refrain from investing in their small farms as long as prices remain unstable. In addition, peasants do not possess the resources, either land or the financial means, to increase their own production in order to feed their families.

Price hikes are a predominant force behind the development of malnutrition, particularly of pregnant women and children under the age of five. A temporary increase in prices can already change the food landscape within a matter of months, resulting in malnutrition with all of the previously described effects. These adverse effects are irreversible, even if prices do in fact return to their previous levels. And the hunger carousel turns and turns, pulling new passengers onboard as it goes along.

Poverty and Limited Selection Leading to Hidden Hunger

An estimated two-thirds of humanity suffers from hidden hunger in one form or another. In most cases, the victims are women and children in low-income families. Hidden hunger is not only a health issue, but rather an economic one, as well. It triggers immense costs, which have to be carried in part by the victims themselves. The victims themselves, the mothers and children, often cannot cover the additional costs for treating illnesses related to hidden hunger because hidden hunger has plunged them into poverty. In terms of GDP, hidden hunger causes an annual loss of 4 % or $25 billion. In India, economic growth is slowed down from the target of 6.9–2.5 % as a result of a vitamin A and iodine deficiency (Stein et al. 2007). Hidden hunger ultimately clogs the entire state system. Economic progress becomes impeded if not completely unachievable. On the flip side, a nation's level of productivity can be significantly enhanced through investments in the supply of food on offer (Fogel 2004).

The underlying causes of the spread of hidden hunger have already been mentioned: limited selection when it comes to food and a quantity-based evaluation of people's diets. This becomes evident when we observe food prices in relation to calories and nutrient density.

The price of a food product corresponds directly to the amount of energy, fat, and micronutrients which it contains. It must be mentioned that this rule does not only apply to developing countries. A diet which contains an adequate amount of micronutrients, in particular vitamin A, C, D, E, B12, pro-vitamin A, folic acid, iron, and calcium, is more expensive than one which contains less of these, according to studies conducted in the USA (Aggarwal et al. 2012). As prices increase, so too does the consumption of energy-rich and micronutrient-deficient cereals. Cheap products have a high fat content. This leads to more cases of obesity, particularly among the poorer classes and to micronutrient deficiencies, such as occurs in developing countries.

The amount of money spent on food has a direct influence on how nutritious it is. Diet diversity is a good indicator of a person's or a family's access to food. A balanced diet, in turn, has a direct impact on an individual's growth and state of health, as mentioned earlier (Hoddinott and Yohannes 2002).

The financial crisis of 2008 illustrated within a short time period the devastating effects which price increases can have. In a very comprehensive study, the effects of rising food prices on food purchases and the ensuing health implications were examined in Bangladesh (Sulaiman et al. 2009). From January 2006 to August

2008, the price of rice increased from 15.9 taka (€0.14) per kg to 30.8 taka (€0.26), or by 94 %. The price of wheat rose by 106 %, from 14.1 taka per kg to 29.1 taka per kg. As a result of this, the percentage of rice in the diet of average poor rural inhabitant increased from 45 to 51 % and in that of poor city-dwellers from 29 to 40 %. At the same time, the percentage of disposable income spent on food among poorer households rose from 49 to 69 %. In higher income households, however, the percentage remained nearly constant, with a rise from 37 to 39 %.

An increase in rice as part of people's daily diets, from 0.28 kg a day in 2006 to 0.32 kg a day in 2008, and a bigger percentage of income being spent on food can be explained by the fact that people buy more rice and less other food products in order to feel as full as they can. In extremely poor areas in Bangladesh, 51 % of income was spent on rice in 2006. By 2008, it had increased to 62 %. Unlike other regions, the actual amount of rice consumed, which is relatively large, increased only marginally, from 0.41 to 0.42 kg a day. There simply was not enough money to buy more of the more expensive rice. The cost of 100 g of rice is slightly more than €0.01.

Effects of Having a Limited Assortment of Foodstuffs

A reduction in diet diversity is the cause of health complications, not a reduction in calories. In 2008, a study was conducted in which data were collected from children who were between 1 and 59 months old in 2006 (i.e., they were between 24- and 82-months old at the time of the study) (Sulaiman et al. 2009). Their weight was measured in relation to their height. If the child's weight was two standard deviations below the norm, this was an indicator that the child suffered from wasting, or severe undernourishment. The prevalence of wasting in the 24–59-month age group increased by 5.5 % in rural areas and by 6.7 % in urban areas. Considering that stunting and wasting is extremely high among children under the age of five in Bangladesh (39.2 % and 11.4 % respectively in 2006), such an increase is much more than dramatic. Stunting and wasting do not only afflict the poorest households. Both occur in higher income families as well, albeit slightly less frequently.

The long-term consequences of even temporary increases in food prices can be explained by the fact that many households need to borrow money to buy food and pay it back when prices decrease again. The (limited) variety of foods eaten by poorer members of the population remains mostly the same while prices are at a peak and after they have decreased again.

A 'food basket' in Bangladesh will typically contain the following items:

- Beans (twice per week);
- Green leafy vegetables (twice per week);
- Yellow fruits and vegetables (once per week);
- Eggs (once per week);
- Fish (five times per week);
- Poultry (once every 2 weeks);
- Red meat (once every 4 weeks).

Depending on the variety, rice contains between 250 and 350 kcal per 100 g. People in Bangladesh eat between 0.35 kg (2006) and 0.44 kg (2008) of rice daily. If the average amount of calories needed is 2,000 kcal, then more than half of the calories are being supplied by rice. This does not leave much room for micronutrient-rich food in these people's diets. When prices increase, forcing people to increase the percentage of rice in their diets, then it is not difficult to imagine how poor the quality of these must be and what the health implications of this are. There have been only a very few studies to date which have examined the effects of rising prices on the micronutrient content of people's diets. Due to the food crisis in Indonesia in 1997/1998, the rate of anemia affecting children under five rose from 52 to 70 %, the highest morbidity rate being among children who were born during the crisis (Block et al. 2004).

A peasant worker earns on average 170 taka per day. In order to buy two kg of rice, enough for a family of five (0.4 kg per person per day), he must spend up to half of his daily wages, depending on the current price. The increase in the percentage of income spent on food to over 60 % clearly indicates how much is actually spent on food which can at least somewhat satisfy the family's nutritional requirements.

Diet Diversity and Stunting

Research conducted in Freetown, Sierra Leone which examined the effects of price increases dramatically showed just what damage even temporary price shocks are capable of doing (ACF 2009). From January to May 2008, the prices of rice and gasoline increased by 64 and 15 % respectively. In some urban districts, the jump in the price of rice was between 25 and 65 %. As a result, many people bought other food products than they had done in 2007. 75 % of people ate less food in general, 45 % refrained from eating meat, 21 % stopped buying vegetables, 18 % did not consume any milk or dairy products, 17 % did not eat any fruit, and 10 % had to forego eating fish. The issue was not availability, since all of these things were on offer at the local markets, but rather access—they had simply become prohibitively expensive. The number of chronically malnourished children increased and the negative effects that occurred during the 1,000-day window would never be reversed. Even when the rise in prices is only temporary, the negative health effects on children endure. The price of millet went up in Ghana from £23/kg to £34/kg during the so-called hunger season (May to August), when farmers need to tap into their reserves. Starting in September, the beginning of the harvest season (September–May), it dropped again to £20/kg. In the same time period, the number of malnourished children rose from 41 to 51 % and remained at 46 % during the harvest season (ACF 2009). Regardless of whether the price goes up or down in a particular season, fluctuations mean an increase in child mortality in any case.

Diet diversity has a direct impact on childhood growth and development. When prices increase, poor families in particular are forced to reduce the assortment of different foods they consume. A good example of this situation is the dramatic rise in food prices which triggered the food crisis in Indonesia in 2003 (Sari et al. 2010). As illustrated in Fig. 5.7, the figures for stunted children run parallel to the percentage of cereals in people's diets. On the flip side, stunting decreases as higher quantities

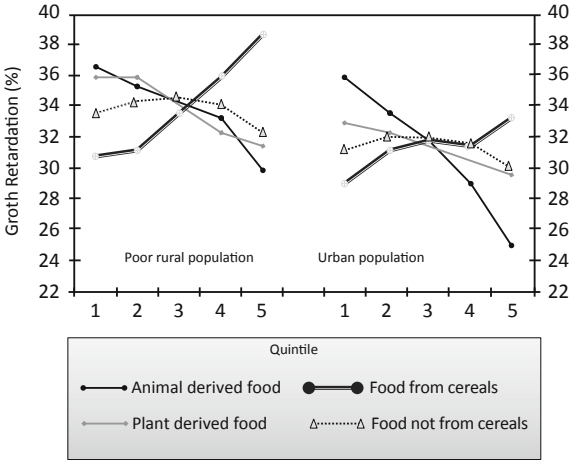

Fig. 5.7 Stunting cases (% of all children) in relation to diet diversity in quintiles (Sari et al. 2010)

of animal-based and plant-based foods are consumed. The simultaneous reduction in stunting and increase in meat consumption in urban areas is just as evident as the increase in stunting which accompanies a decrease in meat consumption in rural areas. To understand this phenomenon better, one must first be aware of the situational differences between life in the city and the country. Most people must buy their food since they do not have the possibility to produce it themselves. In rural areas, food can be produced on small peasant farms, yet is normally not enough to feed an entire family. These peasant farmers belong to the lowest social class and are usually matriarchal. The only option which most of them have to feed themselves is grain since other foodstuffs are neither affordable nor available. In the cities, the poor have access to more variety when it comes to food despite their financial constraints. As Sari et al. (2010) have indeed concluded in the study, people living in cities do spend more money on food than those who live in rural areas.

The adverse health effects of a diet based primarily on cereals with only one-fifth comprising other foods are evident from the rise in stunting by 25 %, especially in rural areas.

City dwellers spend on average 30 % more on food than their rural counterparts. This applies to families which spend less than $1.50 a day on food as well as to those which spend between $3 and $4. When food prices increase, however, the food budget is maintained by a fatal means of compensation. Less money is spent on health and education, portions are rationed more strictly, and women forego eating high-quality foods, such as dairy products, meat, and vegetables, or they do without entire meals for the sake of their children. This makes it impossible for them to get off the hunger carousel. If a woman in such a situation becomes pregnant, then her unborn infant is already a victim of inflation and will suffer health complications due to its mother's inadequate diet.

As a result of the food crisis in San Salvador from 2006 to 2008, there were numerous cases of stunting among children under three, yet no observable weight-related issues (de Brauw 2011). These findings confirm that the children received

sufficient amounts of calories, yet they did not consume enough of the nutrients necessary to promote growth. Food prices rose from March 2007 to March 2008. The price of a pound of beans climbed from $0.50 to $0.84, rice from $0.32 to $0.50, and corn from $0.16 to $0.22. This resulted in an increase in monthly household spending by 25 % (CORECA, Regional Council for Agricultural Cooperation). For poor families, in which 50 % of the budget had already been allocated for food purchases, this situation caused a severe limitation in their access to a variety of different foods. Since stunting has long-lasting effects on children, they will hardly be in a position to escape from the poverty and hunger spiral.

The fatal link between rice consumption, food prices, and undernourishment was illustrated by a study which examined roughly 82,000 children from 63,000 families in Indonesia from 1992 to 2000 (Torlesse et al. 2003; Fig. 5.8). The close relationship of household spending on rice and undernourishment says it all.

The trend shows children's absolute dependency on an adequate diet. An increase in household spending does not necessarily entail that more or better quality food is purchased. On the contrary, it means that the quality of food diminished when the price of rice experienced inflation.

Until 1992, the price of rice had been high at $0.30/kg. By the summer of 1993, it had decreased to $0.20/kg, before climbing to $0.30/kg in 1995 and nearly $0.40/kg in 1995. Household spending on rice mirrors these price hikes and inversely correlates to the amount of money spent on higher quality food items.

When the price of rice drops, the money spent on higher quality food increases. Consequently, fewer children are underweight (see Fig. 5.9). Peak prices in 2008 and 2011 combined with the consistently high levels since 2008 have most certainly resulted in an increase in the number of undernourished children. It is quite

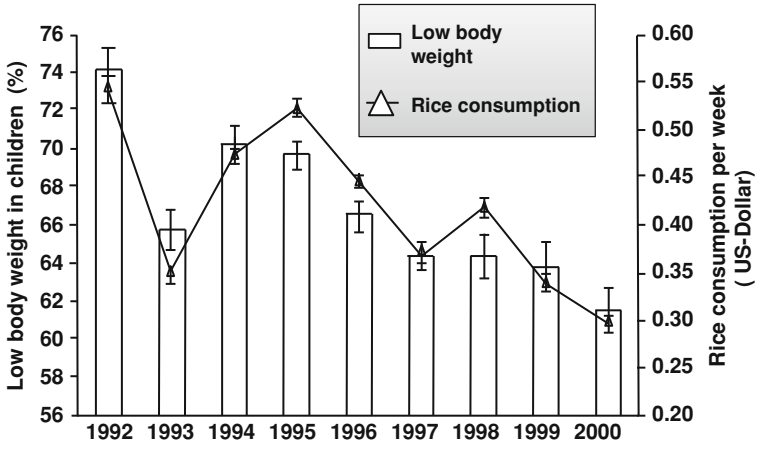

Fig. 5.8 Household spending on rice and its correlation to underweight (z-score for that age group >2 SD) among 81,337 children between 6 and 59 months in 62,959 families (Torlesse et al. 2003)

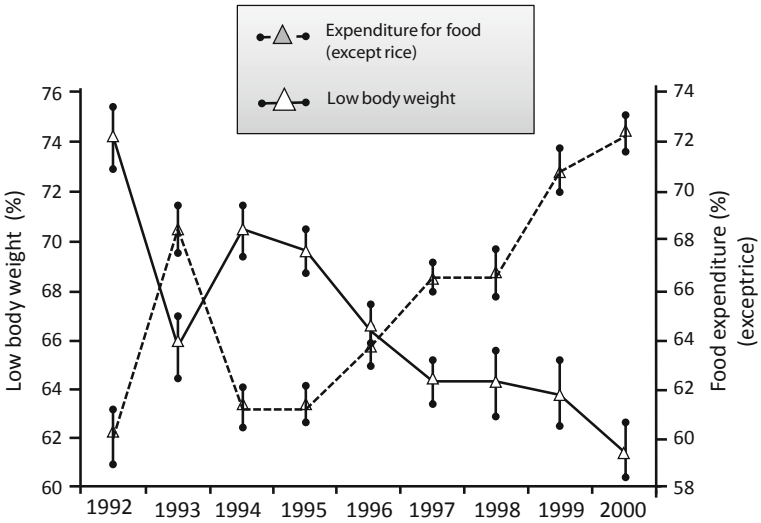

Fig. 5.9 Household spending on other food items than rice and its correlation to underweight (z-score for that age group >2 SD) among 81,337 children between 6 and 59 months in 62,959 families (Torlesse et al. 2003)

understandable that people need to satisfy their hunger even in the face of rising prices. This can best be accomplished by eating rice. When this goes up, smaller amounts of it are consumed.

In the end, fluctuations in price are reflected in the prevalence of undernourished children. Taking into account the price of rice in 2008 and the 20 % increase in the number of undernourished children in 2011, it is not only clear that the MDG 4 has drifted further out of reach, but also that there are even more children without a future. Since a child's future is determined within the first 2 years, even short phases of undernourishment have fatal consequences if they occur during this time, especially since rising prices make nutrient-rich food unaffordable. After every variety of meat has been foregone, fruit and vegetables disappear from the shopping basket, followed by sugar, oil, salt, and finally the staple foods. Thus, micronutrient deficiency silently creeps up and befalls children and young expectant mothers first.

Looking at price developments over the past few years (Brinkmann et al. 2010), the situation looks gloomy, if not completely shocking. The authors of the following study examined food price hikes and their effect on household food expenditure in Asia, Africa, and Latin America (see Table 5.4).

Even in rich countries, such as Germany and the United States, it is unimaginable what the result of a 100 % increase in staple food prices would be.

The authors (Brinkmann et al. 2010) estimate the impact of price increases based upon the above-mentioned data (see Table 5.5).

Table 5.4 Impact of rising food prices in various nations (Brinkmann et al. 2010)

Country/ time frame	Price increase	Effects
Afghanistan 01–07/2008	Wheat: +200 %	16 % more households were inadequately fed
Cambodia 04/2008	Rice: +100 % meat: +50–70 % fish, vegetables: +30 %	34 % of farmers earned more money 50 % of all households had less money to spend on food
Palestine 04/2008	Food: +15 % wheat flour: +70 %	50 % of households reduced the quality of the food they purchased (meat and milk 89 %) and 79 % reduced the quantity
Burkina Faso 06-07/2008	Food: +23 %	Household food expenditures increased within a year by 50–70 % Less meals containing less variety of foods were eaten Less money was spent on health and hygiene
Lesotho 06/2008	Vegetable oil: +100 % corn: +59 %	More money was spent on food and fuel Less meals containing less variety of foods were eaten
Ethiopia 07/2008	Wheat, teff, rice: +100 % corn: +180 % meat: +50 % vegetables: +60 % sugar: +40 % vegetable oil: +60 %	The number of urban inhabitants with insufficient food security rose from 36 to 60 % Between January and July 2008, the number of severely malnourished persons increased from 3 to 5 %
El Salvador 05/2008	Corn: +19 % millet: +31 % beans: +64 % rice: +66 %	87 % less food was consumed in poor households

The underlying cause of the reduction in food consumption by as much as 21 % is an increase in food prices by 37 % from 2006 to 2010. The rise in GDP in East Asia left the region as the only one not affected by this trend. We must bear in mind, however, that not all social groups experienced a rise in income.

Due to the economic progress in East Asia, the number of hungry children in the region will not rise, yet it will also not fall. In Africa, however, an additional 340 million children will go hungry and worldwide an additional 457 million children will not consume enough food (based on calories). What that means is that there will be 50 % more hungry children than today. Behind these hungry children there are many others who suffer from hidden hunger and whose futures are therefore destroyed. They do not necessarily feel hungry, but they are nevertheless malnourished and will suffer all of the health complications previously described. The examples mentioned above do not even take into account the economic crisis of 2011 and the negative impact which it will certainly bring forth.

Table 5.5 Projected variations in food consumption in connection with fluctuations in food prices (FP) and GDP in developing countries from 2006 to 2010 (Brinkmann et al. 2010)

Country	Rise in FP 2006–2010	Per capita GDP 2006–2010	Variation in food consumption in %	Population (mil.) 2005	Additional hunger cases (mil.) 2006–2010
Africa	37	–1	21.3	789	239
East Africa	37	32	1.0	1,395	0
Southern Africa	37	21	6.8	1,562	111
West Africa	37	4	15.4	196	21
Latin America	37	4	15.7	541	87
Developing countries				4,483	458

Food Riots

> If you pick up a starving dog and make him prosperous, he will not bite you. This is the principal difference between a dog and a man. (Mark Twain).

In the year 1775, King Louis XVI's controller-general Anne-Robert-Jacques Turgot decreed an edict to reduce price controls on flour and leave prices to the free market. These liberalization measures led to a rise in the price of bread, which resulted in the *guerre de farines*, or bread riots. Together with a general panic concerning price speculation, this situation eventually became one of the seeds of the French Revolution. Parisians were starving due to the fact that the French aristocracy was keeping the price of flour high by secretly stockpiling it in order to create a short supply. On July 13, 1789, one such warehouse was discovered and plundered by a mob. On July 14, the French Revolution began.

The modern-day crisis taking place in the worldwide grain markets reveals some striking similarities. Export embargoes, such as Russia currently has in place, poor harvests due to natural disasters, for instance the flooding which took place in Australia, combined with high prices for other foodstuffs make for a rather precarious situation and encourage speculation.

In reaction to the consistently high prices for food since the end of 2011, Abdolreza Abbassian, economist for the FAO warns that the longer we continue to see higher prices, the higher the risk is that violent conflicts will erupt because people can no longer afford to buy food (*Dow Jones News*). Why have revolts not already broken out in many places? The answer lies less in the preventive measures to stabilize prices than in the helplessness and inability of the victims to act. By correlating the Global Hunger Index, which shows the distribution of severe malnutrition in a particular country to political unrest, we can see that violent riots frequently occur in countries where food is scarce to extremely scarce (World Hunger Index 2008).

These armed conflicts remain on a local scale and uprisings are regarded as internal matters, thus inhibiting sensible measures which might improve the situation for the people concerned. Political solutions do indeed bring temporary relief and starving persons are supplied with food by aid organizations. Yet the issue of chronic undernourishment still persists. Nevertheless, it is merely a question of critical mass until such regional conflicts turn into nationwide revolts.

Conclusion

Chronic malnutrition is first and foremost caused by a lack of diet diversity resulting from inflation and limited availability. Stunting is the visible expression of chronic malnutrition and hidden hunger. Stunting cannot be prevented by means of an increase in calorie consumption nor by taking vitamin supplements. Price hikes have another lasting impact on poor rural inhabitants, namely the loss of their own resources, such as farm animals, farming equipment, and eventually their land, without the prospect of ever re-acquiring them. Their possessions are either sold to manage an immediate crisis, or they are used as a security deposit for credit which cannot be repaid due to increasing prices and/or bad harvests. And so the men go off in search of work as day laborers, far away from their families, while the women remain at home and mind the children.

Land Grabbing

The term 'land grabbing' is not only self-explanatory, but it very accurately describes what really takes place. Land is grabbed, snatched away, seized. Property is a lucrative business opportunity, particularly when the conditions are as attractive as they have been for some time.

Land grabbing is acquisition of property for dubious purposes or by questionable (illegal) means.

Box 5.3 Land ownership and loss thereof
In 1961, the World Food Programme of the United Nations was established. The aim of the program is to combat world hunger—in the very beginning by distributing food supplies. Since the program's establishment, world food markets have followed a development which is contrary to the requirements of hungry people around the world. The markets are ruled by global politics which put food exports above the nutritional needs of the population. In addition, the privatization of food manufacturing has led price speculation with staple foods to get out of hand to the detriment of the poor and undernourished.

In theory, a country's agricultural sector should export home-grown produce, thereby making a profit and import cheaper foodstuffs to feed the population. Yet this seemingly logical chain is precisely what has given rise to the current crisis concerning hunger and poverty. Globalization, especially with regard to the food sector, and in some cases internal corruption, has disempowered the poorer states. What has resulted is land occupation for the cultivation of export crops, including rice, wheat, and also for animal farming. These must then all be imported from other countries to feed the respective country's own population. The worst case scenario is when the land is used for growing flowers or other non-food crops, such as corn for biofuels. The continuous rise in staple food prices, which reached a peak in 2011, is making the future increasingly grim for the poor. African farmers are particularly affected. Those who managed to recover from the price shock in 2008 now need to repay their debts. This is credit which they received in 2007 in order to purchase seeds and fertilizer. They will ultimately have to see their land if it is not confiscated beforehand. This land will then be exploited by profit-seeking overseas firms.

Currently, there are 445 Mha of uncultivated land and 1.5 billion hectares of cultivated land worldwide (Deiniger et al. 2011). Roughly half of the uncultivated land is in Africa. Rising prices in 2007/2008 promised good returns on investment provided one was in a position to produce food. And so the great race for land began.

Since 2007, firms, investment funds, banks, and governments have been keen to get their hands on fertile land. Land grabbing seen a dramatic rise since the financial crisis of 2008 and, with more than 100 in total, more deals were signed in 2009 than ever before (Land Matrix 2012).

The World Bank estimates that between 2005 and 2009 45 Mha traded hands. This is the same amount of land area as Sweden and one-fourth of the arable land in Europe. It has also observed that most transactions apparently take place in regions with corrupt governments where no consideration is given to the land owners in the search for profit. Often, buyers are not aware of the fact that the land they purchased was stolen from poor peasants (World Bank 2010). The latest analyses from various organizations give a detailed report of the full extent of the situation (Land Matrix Partnership Analytical Report 2012). According to the report, 1,217 land ownership transfer agreements were signed with developing countries equaling 83.2 Mha. Only half of these agreements can be traced back to a reliable source. According to the authors of the report, much more land was probably sold and remains unaccounted for since the transfer process is anything but transparent. In many cases, neither the name of the investor, nor the means by which the land was procured are known.

A barely controllable form of neocolonialism is breaking ground wherever it can. What land grabbing essentially all boils down to is food grabbing with even more serious consequences for the poor than price hikes alone or droughts. The

land upon which food could have been produced is lost. The men must bid their families farewell in order to go in search of day jobs and the women and children stay behind in their state of desolation.

Who Are the Sellers?

> One morning they arrived—a military jeep and a pick-up truck full of soldiers and other young men. Apparently they had come from the city. They stood and help open black folders onto which they made sketches with their fingers. Jaunde was on her way to the field to check on the millet and meet up with her girlfriend Theti. As she approached them, the young men stepped politely aside. As they did so, one of them called over to the soldiers. A soldier stepped into Jaunde's path and told her that she was not allowed to pass. Jaunde told the soldier that she was on the way to her field. The soldier then called over to a man who introduced himself as a representative of the government. He kindly told her that she would need to present proof that the field was, in fact, hers. Jaunde had never heard of anything like an ownership deed. Her husband had inherited the land from his father. The pleasant man told her that without a deed, the land was not hers. She could not ask her husband, Tengo, because he was traveling the country in search of work. Money had to be earned in order to send their three children to school and to buy books and the appropriate clothes.

Jaunde is one of thousands of peasant farmers, not only in Africa, who cannot prove they are entitled to the land because they are missing the paperwork or because the municipality does not keep accurate records. This is land which has often been in the same family for generations and on which the family's food is grown. Usually, the women decide how the land will be used and so the rights of use fall to them, albeit not in black and white. The fact that women's rights are non-existent in many countries makes it easier for their land to be taken, or rather, to be stolen without any considerable resistance. The otherwise reputable global firms and governments which purchase the land at rock-bottom prices seldom ask whom it belongs to.

Owning the land is the basic requirement for a peasant farmer to produce at least enough food to feed the family. Such farmers are known as subsistence farmers. Yet their plots, usually one hectare or less, are in danger. If the farmer's land is not simply seized by large industrial farms or the government, it is often lost when the farmer is unable to pay back the debts which have piled up.

Land is ideally leased or purchased when the conditions are attractive, meaning low in costs, long in duration, and free of problems with former tenants or owners. It is not surprising, therefore, that most of the land which is up for sale or can be leased is located in Sub-Saharan Africa. This is land which has been 'cleansed' of all evidence of its former tenants and owners. 754 land ownership contracts have been signed in Africa, equating to 56.2 Mha. This is more than three times as much as in Asia (17.7 Mha) and eight times as much as in Latin America (7 Mha); (Land Matrix 2012). 70 % of the land area sold is located in 11 out of the 84 countries which have sold land. Of these 11, 7 are located in Africa: Sudan,

Ethiopia, Mozambique, Tanzania, Madagascar, and DR Congo. It is precisely these countries in which the Global Hunger Index describes the food situation as being alarming and, in the case of DR Congo, very alarming. So ultimately those countries which sell the most land are the ones which are among the world's poorest and have a shoddy infrastructure, particularly regarding the agricultural sector (Land Matrix 2012).

Box 5.4 Land grabbing

The scene is the Office du Niger in Mali. The land belongs to the agency which administers the large irrigation scheme in the Ségou Region of the country located 270 km east of the capital Bamako. Water from the Niger River is diverted into a system of canals, making the region now extremely fertile. 98,000 ha of land have been irrigated to date using a system based solely on gravity to pump the water to the fields. Technically it would be possible to irrigate 960,000 ha, thereby providing food for 700,000 people in addition to the shepherds who already make their living from this land. Yet it is precisely this land which Mali has been selling off since 2003 in response to pressure from the World Bank and other international financial institutions. So far, 540,000 ha have been sold and a further 379,000 ha have been agreed upon for sale (as of May 2011). In fact, a total of 2.5 Mha are believed to be up for sale across Mali. Such dimensions are difficult to fathom, especially in light of the fact that the food situation in Mali is categorized as 'serious' according to the Global Hunger Index. Added to this loss are the 150,000 ha which are over-farmed each year, whereby the situation is even further exacerbated by the fact that the population is expected to rise from 15 to 50 million within the next 50 years. 372,000 ha of the land have been bought by overseas investors in Canada, South Africa, China, Great Britain, Libya, and the United States to name just a few. In the same international vein, the land is intended for non-food and export crops. In cooperation with the Libyan government, 100,000 ha of land which has been ready since 2008 will be dedicated to producing rice. The Malibya project, as it is known, was once again endorsed by the Libyan foreign minister at the start of 2012 despite delays which have occurred since the outset.

Apart from that the land is being sold off in secrecy (i.e. the local inhabitants are not consulted) and without any kind of environmental or social impact assessments. The sale or rental price or is often cheap enough to be considered grotesque. But to make the deal even more attractive 10-year tax holidays are offered, in addition to water prices which do not even cover the actual costs to supply it. Officially, the buyers and leaseholders are praised for investing in the country's development. A closer look reveals, however, that this is not a very cogent argument. In Mali, entire villages have already been evicted and shepherds forbidden from passing through the land. Worsening an already dire situation regarding the local food supply, subsistence farming has been largely wiped out and migration forced on great

numbers of local inhabitants. The industrial farming taking place on the seized lands is also causing severe ecological issues and contributing to climate change, as well as accelerating the loss of biodiversity and reducing the levels of rivers and the ground water (also known as water grabbing). The latter in particular could turn out to be disastrous for the country. For the land which has already been sold off or leased, the amount of water diverted from the 4,180 km long Niger River would double each year. This would be a catastrophe for over 100 million people, farmers, and fishermen, who live upriver in Niger, Benin, and Nigeria. The fact that the Niger has already lost one-third of its water in the last 30 years shows just how precarious the situation is. Experts fear that the river will die, especially if the industrial plans for the area become a reality (Bernau 2012).

In Indonesia for instance, deeds exist for only 40 % of farming land. Rights to use the rest of the arable land are regulated by tradition (Colchester et al. 2011). In this way, the farming rights of some 60 to 110 million Indonesians are determined. Despite all politicians' promises to protect the farmers' property rights, much of this land is being sold to domestic and foreign investors and amalgamated into palm oil plantations (Colchester et al. 2011).

There are numerous reports about land being sold illegally in many of these poorer countries. In the end, the peasants do not have a loud enough voice to decry the land grabbing tactics they face. The standard argument used by many of the buyers, namely that the land they bought was unfertile wasteland anyway, is a bogus argument, a smoke screen.

In particular in Africa, a lot of land is no longer suitable for crop cultivation and is therefore sold to investors at bargain prices. How does this happen? The land is the wasteland left over from small-scale farms after it has been overused. Instead of being re-cultivated with the help of, for instance, fertilizer, it is simply left barren. Since small-scale farmers have hardly enough money to buy fertilizer, they usually have no choice but to move on in search of new land to farm.

For investors, there are two aspects regarding the land which are particularly important.

First, the land should be accessible, i.e., in close proximity to transport routes, cities, or harbors and it should be suitable for the crops to be grown. Second, the current production should be far below the potential production level once farming on the land has been industrialized (Land Matrix 2012). This explains why so much of the land which has been sold is in Africa. No African state produces more than 25 % of what is technically possible. For investors, the potential for profit is enormous. The fact that crop production is being increased not to feed the hungry, but rather to maximize profits is a travesty. If the former would be the case, then the peasant farmers could also benefit from the development of the land.

The hunt for profit is also illustrated by another phenomenon regarding land grabbing in developing countries. Investors prefer to target countries which have poor zoning administration and protection mechanisms (Arezki et al. 2012). That

way they can obtain the land faster, without red tape and, most importantly, cheaper than in countries which have such oversight authorities.

Who Are the Investors?

The investors are banks, insurance companies, large firms, commodities dealers, consortiums, and national governments. The latter often act as agents, in other words they have the ability to deal directly with other nations 'under the table' and then pass along the land to an enterprise located in their respective country (Anseeuw et al. 2012). The buying of land by overseas investors, particularly from China, India, and Saudi Arabia, is also intended to provide food security and prevent food crises such as those which occurred in these countries in 2008 and 2011. It is apparently of no interest to the investors that this is being done at the expense of even poorer countries.

The carrot which dangles before the eyes of the investors is, paradoxically, the profit which can be made from food security. Whoever believes that generosity is the driving force behind these transactions errs. It is about food security for countries which have enough financial means to provide for themselves, yet they must often import staple foods since they lack sufficient fertile land for farming or prefer to utilize this land for non-food crops (biofuels) or for industrial purposes, such as biogas or solar power facilities. It may also be the case that the climate prevents certain crops from being grown. The crisis of 2008 and the resulting hikes in staple food prices started a land grabbing boom in order to secure supplies of staple foods in the respective countries. Purchasing land is completely understandable, that is if one ignores the fact the buyers are from Europe, South Korea, Australia, Kuwait, and Saudi Arabia and the neocolonial tactics practiced by these countries are carried out in Sub-Saharan Africa or South Asia. Essentially, the necessary land is purchased outside of countries' national borders in order to grow crops or for other purposes than food production, such as biofuels or solar energy.

The promise of an influx of financial resources into countries to help spur their economies through the sale of their land is as false as it is absurd. Countries with an agricultural-based economy cannot improve their situation by selling off the basis of that economy. It is unclear and rather questionable how many local farmers end up being employed by these overseas enterprises and actually earning a living. The creation of jobs is also doubtful when many of these foreign companies send over their own citizens to work. Naturally, far less manual labor is needed on industrialized farms in comparison to peasant farms, thus resulting in a net loss of jobs. How then should jobs or wealth be created in Kenya, for instance, when the land is sold to investors who then grow jatropha, a type of inedible nut used in biofuel production, export the product, and take the already scarce water reserves away from the local farmers?

The British New Forest Company (NFC) set up the National Forest Authority in Uganda (NFA) with the purpose of licensing forest areas. A result of this

agreement has been the expulsion of local farmers on the grounds that, according to the NFA, their occupation of the territory is illegal since the land is supposedly not theirs. Of the 20,000 inhabitants, only 31 families had written proof that the land was theirs, according to the local authorities. The NFC has refrained from intervening since it does not feel itself to be responsible and until the legal battle is concluded, those who have been forced off their small farms will remain among the landless poor. Once again, some new passengers have joined the hunger carousel.

Land grabbing is a silent process. It happens well out of the public eye, although it is an immense problem which can suddenly set off local riots.

The countries and investors who purchase such land have three main criteria.

- First, the land must be suitable for cultivating crops for the homeland population so that imports from other countries and thus costs can be reduced. This also reduces the risk of a short supply of food due to drought. This is especially relevant for the rich Gulf States, as well as China and India.
- Second, the land must also be suitable for growing fodder and non-food crops. The underlying reason might be a lack of suitable land within the home country or for trade purposes. Europe and China are high on the list of potential buyers in this respect.
- Third, the land must be well irrigated so that, for example, such export crops can be grown. Both private investors and various countries are among the interested parties for this reason.

What Is the Land Used for?

Approximately 78 % of the land which is sold or misappropriated is used to grow produce. 75 % of it, in turn, is used for the production of bioethanol and biodiesel. That leaves 11 % which is used for food crops, whereby most of these are exported. The remaining 22 % of the land is mined for minerals, used for industrial purposes, or set aside for the tourist industry or forest cultivation (Anseeuw et al. 2012). Africa tops the list of non-food crop land use since 66 % of the land sold is used for the production of biofuels, compared to Asia (52 %) and Latin America (35 %).

According to Oxfam, 227 Mha worldwide have been leased or sold to foreign investors since 2001 (Deininger and Byerlee 2011a, b). This is roughly the same surface area as Western Europe. How much land has really been sold or leased is difficult to ascertain since many deals are not made public.

Ethiopia despite having a food situation which ranges from alarming to very alarming has already sold 8 Mha of land. In we analyze the data from the Land Matrix concerning land use in Ethiopia, it quickly becomes obvious that the plight of local farmers and their families can hardly be improved. By January 2012, 71 land sales or leasing contracts had officially been signed. It is unknown what the

real number is. Of the 71 intended projects for the land, comprising an area of 8.5 Mha, food production (rice, tee, teff, and tomatoes) makes up a mere 3 %. 1.5 Mha is used to produce jatropha-based biofuel. The fact that the allocation of 4.5 Mha has yet to be determined is sobering to say the least. The remainder of the land is used to produce various cereals (which are presumably exported), cotton, oilseed, and flowers. The 'buyers' of most of the land are from Saudi Arabia and India. The United States, Great Britain, and the Netherlands have purchased smaller areas for growing various crops, perhaps to be used as experimental stations.

The Gulf Cooperation Council (GCC), a consortium of six Middle Eastern states—Bahrain, Qatar, Kuwait, Oman, Saudi Arabia, United Arab Emirates—has outsourced food production to Pakistan, Sudan and other countries in Africa and Asia. Kenya signed an agreement with Qatar allowing for 40,000 ha in Kenya to be used for growing fruits and vegetables to be exported to Qatar (IFPRI 2009).

Such deals are literally pay-dirt for speculative investors irrespective of the actual harvests. Land deals fulfill all of the economic conditions for making a profit through speculation. The earth's usable surface will not expand to any significant degree, yet the demand for it is rising day by day as the population constantly grows, the current growth rate being 200,000 people a day.

Do Small-Scale Farmers Benefit at All?

Are jobs created? Do they have the potential to acquire technical innovation to increase harvests? Hardly. Overseas investors decide what will happen with the land and what will not. This ranges from the local food prices to transport costs, which are very high in Africa to begin with. It remains to be seen how changes to the existing infrastructure will benefit the local farmers.

The growing list of land sales and leasing agreements (IFPRI 2009) is truly astonishing. Land is being leased for the cultivation and export of wheat, vegetables, rice, and others. These foodstuffs are urgently needed by the indigenous population and so they must be imported at high costs or supplied by aid organizations. The Philippines, for instance, where food scarcity is quite serious, sells arable land to South Korea and Bahrain. Half of Filipinos live in rural areas. Most of them are subsistence farmers or fishermen. Many of them live in poverty and are undernourished. It would be superfluous to mention what it means if their land is snatched away.

What protection do these people have from land grabbing carried out by their own government for the sake of investors? Who is there to defend the fertile land on which their food grows? In Africa, the rights of peasant farmers are not always dealt with gingerly. Uganda recently evicted thousands of farmers from their land in order to sell it to a British firm (Oxfam 2011).

A typical example of land grabbing is the deal which was signed between Nile Trading & Development Inc. (NTD), a company located in Dallas and Mukay Payam, a Sudanese cooperative. The cooperative signed a 49-year lease for 600,000 hectares, or 6000 km^2, of fertile fields with NTD with the option of leasing an additional 4000,000 hectares for $25,000. The cooperative is a local, self-governing association without any legal basis for leasing the land and has three very influential persons from the district among its members. The lease was approved, however, by the local authorities and it guarantees NTD the following rights:

- the right to all types of forestry, including the processing of existing forests and the utilization of the wood;
- the right to sell carbon credits based on wood;
- the right to use the land for agricultural purposes, including the production of biofuels (e.g. jatropha and palm oil);
- the right to assess the feasibility and produce further raw materials, such as oil, natural gas, and coal for local markets and exporting;
- the right to lease the land and the above-mentioned rights.

90,000 people live in this region, most of them are subsistence farmers. Their food security is without a doubt in grave danger. The deal is still pending approval by the Sudanese government and, therefore, NTD cannot proceed yet with its plans. However, this is a classic example of what is taking place around the world and how it endangers local populations. It is hardly plausible when a company which deals in raw materials and works closely with large firms, such as Kinyeti Inc., an Austin-based firm dealing in tropical timber, suddenly has the idea to help local farmers.

The fact that rich nations are securing food, animal feed, and fuel in order to secure prosperity at the expense of poor nations which need this land to survive is, quite simply, absurd. A better solution would be to cultivate land which has hitherto been unfertile than to sell fertile land for purposes other than food production. This misuse of resources continues to send the number of hungry persons and dying children upwards.

Were rich nations to invest in agricultural projects in poorer countries which provide for the local population and export surpluses for profit, then the situation would look completely different. It is both imperative and possible for persons living in countries with a developed economy to pay prices for food which correlate to the costs for their production and distribution without subsidies instead of bargain hunting for cheaper and cheaper products. It need not be surprising when food scandals are uncovered in Europe, for example, when producers resort to underhanded tactics due to increasing pressure to drive down prices. If we paid fair prices for African wheat from fields which we helped to cultivate for flour production, then the bread roll we eat for breakfast would cost €1. Instead our governments and food manufacturers buy up land in Africa in order to avoid high import taxes so that our bread roll only costs €0.30 or even less.

Box 5.5 Say it with flowers

The next time you are at the check-out and you want to buy a bouquet of roses for $2.50 or less, you should first stop and think. Many of the inexpensive flowers on offer come from Africa, primarily Kenya. Yet why should you refrain from buying them? That does create jobs after all. In reality, this is a particularly rank case of land stealing. Jobs are indeed created, but these are extremely low-paying ones without any health or social benefits or safety regulations. Women who look after the flowers earn €30 to €50 per month, depending on the farm. Such wages are hardly enough to feed a family. The roses are watered using water which is desperately needed for food production. Between 4–5 l are needed per rose. Yet roses have become an important source of income for Kenya. Their sales account for 5 % of the country's GDP. But roses cannot be eaten and the money earned from 16 h of work a day is not enough to buy food for the family. The women work long hours, leaving little time working on the family's own farm and so the last opportunity to enhance the family's diet goes begging.

With every cent that we save on a bread roll or fuel, just to name a few examples, we endanger the survival of children in Africa. We are guaranteed protection from rising prices on the world commodities markets by the trade policies of our respective federal governments. These policies, however, function at the expense of children and their mothers in Africa and Asia. Promises are made to voters that these trade policies benefit developing countries by raising productivity. Yet how should this be the case when the hunger carousel is turning with more momentum than ever before, with an additional 150 million people onboard since 2008 (FAO 2010)?

The situation with biofuels is just as pointless. In Germany, rapeseed and sunflowers are grown for diesel fuel production on fields which could also be used to grow wheat. At the same time, Germany has bought land in Africa to produce diesel fuel from palm oil. There exists legitimate skepticism regarding land acquisition in countries where massive areas are offered to overseas investors for biofuel production. The land is labeled 'wasteland' or 'underdeveloped' by the federal government or local authorities and seized from the poor, who are then left completely without land.

Ben White (2010) describes the takeover 38,000 ha of forest land by a Norwegian biofuel producer. The contract was arranged with the local magistrate, who was not able to read it and shortly thereafter the leveling of the forest was started in order to make space for jatropha. The local inhabitants received promises of employment and a decent income. These were empty promises, however, and the people ultimately wound up losing the foundation of their livelihood and income. The regional advisory and information network system (RAINS), a Ghana-based NGO, intervened and managed to stop the destruction of the forest. 2,300 ha had already been cleared, however.

The lack of government regulation is one aspect, the lack of scruples on the part of European firms is another. Further examples of land theft would be too numerous to mention. An appraisal of the current situation by the Global Alliance for Improved Nutrition (GAIN) in 2009 sums it up quite accurately: The major land grabbers are not countries or governments, but rather corporations who help themselves to the land often times without even having to pay for it (GAIN 2009).

What becomes of those lovely promises of jobs and a better diet is poignantly illustrated by an example from Kigali, a rural area in Rwanda (Veldman and Lankhorst 2011). For generations, thousands of peasants had earned a living as subsistence farmers in the marshy delta regions surrounding Kigali. In 2005, the government created a new law to intensify land use, thereby bringing the entire region, in particular the rivers, valleys and forests, under government control. The new laws were meant to be an incentive for investors to buy large amounts of the land. It is part of a political agenda to eliminate poverty. Rwanda, in fact, is one of the poorest countries in the world. Farmers were ousted from their land as early as 1997 and the sugarcane plantations were handed over to a Ugandan firm. The disenfranchised farmers were taken on as low-wage laborers. Many of them could barely keep their heads above water by simultaneously running small (usually less than 1 ha) sugarcane plantations of their own. The women also worked in the fields, earning less than $1 a day. According to the farmers who were surveyed, they were not able to buy the same produce which they had previously grown themselves, such as beans or sweet potatoes, with the little money they earned. The few farmers who have thus far managed to make a minimal profit will also be unable to hang on to their land much longer. The end result is more poverty and for the families themselves the only choice is no choice—they too will soon be forced off their land.

Conclusion

Let us be clear about the facts. The buyers are companies operating in their own best financial interests and not out of charitable motives. These companies will do whatever it takes to keep profit margins as high as possible in the interests of their stakeholders. This is only possible if production and distribution costs are kept low. Particularly the large commodity producers, such as Cargill, BP, the Carlyle Group, seem to be quite indifferent to the wars and ruthless dictators in the countries in which they invest. In either case, no attention is paid to the needs of small-scale farmers whatsoever.

Box 5.6 Tirana declaration

The following is taken from the Tirana Declaration, which was signed by 116 organizations, including the World Bank, the United Nations and the FAO:

"We denounce all forms of land grabbing, whether international or national. We denounce local-level land grabs, particularly by powerful local elites, within communities or among family members. We denounce large-scale land grabbing, which has accelerated hugely over the past 3 years, and which we define as acquisitions or concessions that are one or more of the following:

- in violation of human rights, particularly the equal rights of women;
- not based on free, prior and informed consent of the affected land-users;
- not based on a thorough assessment, or are in disregard of social, economic and environmental impacts, including the way they are gendered;
- not based on transparent contracts that specify clear and binding commitments about activities, employment and benefits sharing, and;
- not based on effective democratic planning, independent oversight and meaningful participation."

The attractive promises made by the buyers, namely that the infrastructure will be improved and poverty reduced, may hold true in individual cases. All in all, however, they are an illusion that is meant to soothe the fears of the population, whose governments are involved in taking away their land.

In January 2012, a comprehensive analysis of the selling off of land (Anseeuw et al. 2012) came to the following conclusion:

- The global need for land will presumably continue, even if the sharp rise in deals which occurred from 2005 to 2008 has leveled off in the meanwhile.
- The rights to land as a resource and as a means of improving the quality of life for rural communities are being endangered by this selling of vast areas. There are few indicators to contradict labeling this phenomenon 'land grabbing'.
- The poor carry an unfairly high part of the costs, and receive relatively few benefits due to the fact that their respective governments do not manage the situation responsibly and do not protect the rights of the peasant landowners. On the contrary, governments are often party to corrupt land deals and illegal contracts. In the end, the farmers, and especially the women, fall along the wayside.
- Legal protection of the land, which is weak at best, leaves the farmers defenseless which their land is confiscated by the local authorities or the national government and offered up for sale. This is often the case when a piece of land has been in the same family for generations and, therefore, no written proof of ownership exists.
- Governments which offer land to investors are hardly interested in the increasing impoverishment of their people which is happening as a result of this

'land rush'. The same applies to the lack of international laws to curtail this development.

The plight of the hungry is worsened by the fact that a large percentage of the land which has been legally and illegally acquired is used for the production of biofuels, with 13.1 Mha reserved for palm oil and 10.1 Mha for jatropha. We cannot allow harvests from the fields where small-scale farmers work to be maximized for the sake of maximizing profits and not for the sake of producing as much food as possible to feed the hungry.

On the Poverty Carousel: Biofuel Is the Driving Force, Hunger the Companion

The carousel turns and turns without the need for fuel. The passengers onboard the carousel are pushed along by donkeys, cows, and their own legs. They are hardly in a position to prevent biofuels from minimizing theirs and their children's prospects of receiving an adequate diet. The quality of their diet, in particular, is at risk when prices for staple foods increase as a result of biofuel production.

Interview with Nestlé's Chairman of the Board "Biofuels send millions into extreme poverty"

Peter Brabeck-Letmathe, Nestle's Chairman of the Board of Directors, speaks about world hunger, further rises in food prices and political mistakes.

We are witnessing a fight for the world's food resources. How will we manage to feed the world's population in the future?

First of all, we need to set priorities. That means that food must be used to feed people and not to power vehicles. It is preposterous that nowadays more than half of American corn and one fifth of sugar cane go into making biofuels, while at the same time, there is not enough food to feed humanity.

What must be done concretely?

It is simple. We need a ban. No food for fuel! Europeans could really profit by taking the initiative.

However, we are a long way from achieving such a ban.

The crazy thing is that politicians created the current food scarcity by promoting the production of biofuels. This is the underlying cause for the explosion in food prices and the unrest in developing countries. Biofuels have sent hundreds of millions of people into extreme poverty. I find that to be irresponsible.

In Brazil, large land expanses are being bought up. China or Saudi Arabia is believed to be the buyer. Should western countries take action?

Western countries already took action a long time ago by setting up colonies. These were not a Chinese invention, but a European one. Nowadays, countries which are experiencing water shortages in particular are trying to acquire land in order to secure food for their citizens. This is happening even more in Africa than in South America.

And is this happening at the expense of the indigenous people?

There are pros and cons. On the positive side, an infrastructure, jobs and modern agricultural techniques are being created in Africa. On the negative side, local farmers are losing their farms and their ability to compete. Thus, they are migrating to the cities. This

> is a social issue which requires government regulation. So-called land grabbing can otherwise have extremely unpleasant consequences.
> *Will food prices experience a turnaround?*
> The days of cheap raw materials are over. In the long run, prices will continue to rise. The demand is increasing sharply, after all. Yet that does not eliminate the possibility of temporary dips in food prices.
> *How does speculation affect food prices?*
> Irritating, but it is not a decisive factor. It makes the fluctuations more sudden and accentuated. But forbidding it would not have any long-term effects.
> (*Frankfurter Rundschau*, 22 Aug. 2011)

That more or less says it all. However, the appeal has so far fallen on deaf ears. Turning over large profits in the name of ecology and at the expense of the poor and defenseless is simply too good a deal for those without scruples to pass up. Recent developments in Germany and the rest of the European Union indicate that a rethinking process is underway. Politicians have begun to realize that the supposed benefits to the environment which biofuels bring have less to do with keeping the environment safe, but rather more to do with keeping the facts out of sight and that the business of producing biofuels from food crops has resulted in more undernourishment worldwide. If politicians react sensibly to the situation, then we can expect to see, instead of E10 and E5 gasoline, E0!

Full-Bodied Promises

When research and development in biofuels first started, two essential ideas stood at the forefront. First, oil will one day become scarce and second, climate change will get out of hand if the output of greenhouse gases is not controlled. The first argument is about business. It is a business model. There are more than enough customers who will buy biofuel (if it is cheaper than conventional fuel). At the same time, consumers, to which group we all belong, are relieved of the necessity of using fuel sparingly when the supply is increased by means of biofuels. The second argument is political. It is aimed at gaining acceptance for biofuels among consumers, even though it too contains a business model in the form of carbon credits trading. And yet there is more. Proponents of biofuels also argue on humanitarian grounds. They claim that millions of hectares of unused land could be put to use. By doing so, jobs for the poor rural inhabitants would be created and the farmers could run their own biofuels businesses and thus feed their families. One is lead to imagine a blossoming African landscape and a booming African economy.

Ben White, who is a highly respected sociologist, paints a different picture of the future (White and Dasgupta 2010). In light of the fact that the world's population, particularly in developing countries, will require more calories in the future, and not less, and that developing countries are being drained of their land (which is needed by developed countries), he writes:

> The nightmare scenario, then, is one in which increasing global energy demand fuels the corporate thirst for land on which to grow these land-intensive crops, until all remaining forests and other cultivable spaces are taken up with monocrop plantations and/or contracted smallholder monocrop farms—mile after mile of rows of oil palms or jatropha bushes, with nothing else growing or living there except impoverished plantation workers or contract farmers, and millions of rats (White and Dasgupta 2010).

The rationale behind using biofuels for 10 % of the energy consumed by vehicles, particularly from grain, but also from palm oil and jatropha, is that greenhouse gases will supposedly be reduced. In front of the backdrop of stopping climate change, this seems like a reasonable measure. The argument that the production of biofuels would endanger food security is summarily dismissed on the grounds that biofuel production creates jobs and thus reduces poverty. Yet those who are familiar with food security, especially in poorer countries, have strong arguments of their own.

Development of Biofuel Production

In 2007, the United States Congress passed a law which was required a 5-fold increase in biofuel production to 35 billion gallons (132 billion liters) by 2022. The European Union decided on a 10 % supply of fuel from renewable sources by 2020. While the EU is the world's leading producer of biodiesel, the USA and Brazil are the top producers of bioethanol. Nearly 40 % of corn harvests in the USA are used to produce biofuels. Large land expanses have been rededicated to biofuels alone, resulting in mono-cropping and the draining of the soil. Rice and soybean fields were each reduced by 16 % in total in 2006/2007 due to the increase in corn production in the USA. This resulted in a dramatic rise in the price of soybeans by 75 % (Mitchell 2008). In much the same way, fields in Europe where wheat was once grown are now being used for oilseed production. The eight biggest wheat exporting countries increased the total land area being used for rapeseed by 36 % while decreasing the area dedicated to wheat production by 1 % from 2001 to 2007 (Mitchell 2008).

Rises in global food prices, in particular for corn and vegetable oil, triggered a hike in staple food prices in 2008 and 2011, ultimately leading to all-time high prices. Jacques Diouf, president of the FAO, urged developing countries to re-consider turning to biofuel production. To date, according to Diouf, 120 million tons of cereals have been diverted away from consumers to be used in biofuel production (Reuters 2011). The ones who are on the receiving end of price hikes are those who have nothing anyway—with consequences already described.

The rise in biofuel production will certainly have a negative impact on the prices of those foods which account for 80 % of the energy and protein consumed by the world's population. Since biofuels are generously subsidized, energy companies will be even keener to continue producing them. Prices for crops which ultimately could, but in fact do not end up being processed into biofuel will most certainly go up. Various American state organizations have concluded that the

40–70 % rise in the price of corn and soybeans is due to their role in biofuel production (Mitchell 2008). There is a general consensus that biofuel production has a direct impact on staple food prices. The food situation for poor countries and their respective populations will thus become increasingly critical and the threat to their existence ever greater. The case for a rise in productivity and prosperity in poorer regions, such as Africa, through the adoption of biofuel production has often been made. However, this can only happen when a fully functioning government is in charge. Since many of the poor farmers are now without land on which they could theoretically produce food and biofuels for their own needs, as well as to be sold for profit, a fair distribution of the existing land would need to precede any such chances for small-scale farmers. Yet so much land is being sold to big investors, such as the Chinese government, that the logical question which must be asked is whether or not any land is left for the farmers. It still remains to be proven that the production of biofuel in poor countries creates jobs. Whatever the case may be, the fact that prices have risen means that such jobs, should they exist, are not especially well-paying if the producing firms want to remain competitive.

When palm oil plantations are created, the farmers whose land was taken are promised jobs and income. Normally, the income is supposed to arise from the running of small oil mills, which the farmers obtain from the plantation owners, usually on credit. The palm oil fruits must be delivered to the mill promptly after being harvested, however, otherwise the oil diminishes in quality. If the transport routes are very long, the roads poor, or if any other hindrance should occur, the oil becomes unusable. Thus the farmers, who must organize the transport, as well as the mill operators, carry a very high risk. In the end, many are forced to give up the oil mills and work for years in the plantations to pay off their debts. Again it is the local families, and especially the children, who fall by the wayside. Land which could have been used to feed the local population is lost. Once land is used as a palm oil plantation, nothing else will grow on it for a very long time.

Worthless Seed on Precious Soil: The Jatropha 'Case'

The jatropha nut was introduced as a source of biofuel to refute the argument that precious food and land which could be used for growing food crops are being wasted on biofuel production. Proponents of jatropha claim that it grows particularly well on scraggy soil, does not require that much water or any fertilizer and there are hardly any pests that befall it. Such are the arguments which the silver-tongued advocates of jatropha put forth. One of the scientists who has been involved with jatropha for many years is Prof. Klaus Becker from the University of Hohenheim in Germany. He claims that an oil market can be established in India by means of a project which is funded by Daimler. "The plant itself is inedible and therefore it does not supplant food crops." It is precisely this assumption which is just as false as the arguments concerning the conditions under which the plant flourishes, as was seen in Mozambique (Ribeiro and Matavel 2009).

Mozambique began producing biofuels after its national government allocated 5 Mha of fertile land (one-seventh of the country's total arable land) for biodiesel, in this case primarily from jatropha, without consulting local politicians or special interest groups. The above-mentioned arguments were revealed to be myths in a comprehensive study which proved that jatropha does, in fact, compete with food crops.

Myth #1: Jatropha is a low-maintenance, high-yield plant which grows on scraggy soil.

- Nearly all of the fields where jatropha was grown were agricultural crop land. Both fertilizer and pesticides were applied to the plants.
- In the end, the actual harvests barely reached the projected margins.
- Investors' claims that there is a high potential for production in Mozambique due to the fact that a lot of the land is not suitable for food crops is correct to a certain degree since 70 % of the land is forests, which would first need to be destroyed in order to make room for agriculture.

Myth #2: Jatropha does not need water.

- Large parts of the plantations required more or less continuous irrigation in addition to water received from rainfall.

Myth #3: Jatropha does not pose a risk to food security.

- In Mozambique, jatropha is grown by subsistence farmers instead of food crops. Normally, there is little left over to earn additional income with. 87 % of farmers in Mozambique are subsistence farmers, who consume 75 % of what they produce. By growing jatropha, they run the risk of not producing enough food to meet their needs. When land is sold by ignoring the ownership rights of the farmers, malnutrition and poverty for these individuals will directly follow.

An interesting retort was delivered by FACT, a global foundation with headquarters in the Netherlands. This non-profit organization principally supports the creation of jatropha plantations, as well as other biofuel crops. FACT acknowledges that the arguments in favor of jatropha are actually not accurate. However, they maintain that production should carry on so that new insights can be collected. In the end, they are willing to accept increasing poverty levels among small-scale farmers and their families.

Here are some figures illustrating the development of biofuels: Since 1975, palm and soybean oil production has risen from 3 million tons a year each to 50 and 40 million tons a year respectively. Rapeseed oil has also risen, climbing from 2 to 22 million tons a year. During the same time period, the demand for oil as a foodstuff has also risen—from 21 million to 105 million tons. In the so-called non-food sector, the demand for oil was below 1 million tons a year in 1975. By the year 2000, it had risen to nearly 7 million tons. Another massive jump came with the development of biofuels. By the year 2010, the demand had reached almost 40 million tons. At the same time, land used for oilseed production went from 530 Mha in 1965 to 650 Mha in 2010. The increasing demand, particularly for fuel, can only be met by increasing the land area or by producing more crops on existing fields. It seems, however, as if the harvest capacity has already been reached. The increase in palm oil production between 2000 and 2010 was 0.8 t/ha,

from 3.8 to 4.6 t/ha. A very minimal increase has also been observed with regard to soybean oil. The only option left of these two is to increase the amount of land used for production, as is especially true for palm oil, or to look for other resources.

Palm oil is the most common source of biodiesel, followed by coconut, rapeseed, sunflower, and soybean oil. Bioethanol has a much wider spectrum of food-crop sources. The most concentrated sources here are sugarcane and sugar beet, followed by sweet potatoes (an important source of pro-vitamin A), cassava, rice, corn, wheat, rye, and millet, which are all recommended for bioethanol production in Africa (Johnston et al. 2009). The complete gamut of staple foods is being processed into fuel. Each time we step on the pedal to accelerate we are doing so at the expense of millions of people who will no longer able to afford food due to its competition with fuel.

The government of Indonesia intends to increase the size of palm oil plantations in the next few years from 8 million to 20 Mha. By doing so, Indonesia is taking advantage of the European market's target of 10 % of energy from biofuels. Projections of the demand for palm oil (which is cheaper to produce than other oils) among the world's population see a doubling to 240 million tons by the year 2050 (Corley 2009). In order to fulfill this rise in demand, an additional 12 Mha could be added to the land already in use without needing to destroy any forests. However, this is not the case with bioethanol.

Large quantities of palm and soybean oil need to be imported into Africa to satisfy the demand there. If palm and soybean oil are produced in Africa to be processed into biofuels under the pretense that this creates jobs, then the result will either be that the people need to switch to rather worthless peanut oil or will have to do without oil altogether.

It must also be kept in mind that bigger harvests require more fertilizer and water. Mono-cropping will continue to diffuse the soil, rendering it useless for other crops. The resources in question here will thus become even scarcer and will add to climate change if used for biofuel production.

A Source of Vitamins Is Sacrificed

Palm oil has been used in cosmetics, lubricants, and also as a foodstuff for many years. Its price has been rising on the international markets since its application in biodiesel production. The amount of it produced doubled between 2000 and 2010. The biggest business markets for palm oil, primarily as biodiesel and nearly 80 % of which comes from Southeast Asia, especially Indonesia and Malaysia, are Europe, India, and China. There are currently 4 million and 7.5 Mha of palm oil plantations in Malaysia and Indonesia respectively. The majority stakeholders are investors who trade through European banks (Colchester et al. 2011). Much of this land was acquired through illegal dispossession and the expulsion of the farmers who had been living on it, or through destruction of the rainforests. According to an analysis by the World Bank, less than 40 % of the land was properly purchased

on the basis of legally sound contracts (Colchester et al. 2011). The fact that much of the land is owned by consortiums consisting of domestic and foreign investors makes it difficult to see exactly who acquired what and by what means. The fact is in any case that numerous small-scale farmers were expelled from their land and are now plagued by poverty, hunger, and high child and maternal mortality rates.

Palm Oil and Nutrition

Palm oil varies depending upon which of the two sources it is extracted from. Oil from the fruit is rich in pro-vitamin A and other micronutrients, whereas oil won from the seeds is high in fat and is primarily used for industrial purposes. When the raw palm oil is refined, it loses nearly all of its nutrients and its deep orange color, which comes from pro-vitamin A and vitamin E.

Raw palm oil is a valuable foodstuff with a high concentration of calories and the highest amounts of pro-vitamin A and vitamin E of any plants. 100 g of palm oil contain approximately 60–90 mg of pro-vitamin A, depending on the conversion factor that equates to 30,000 RE. 0.3 g of palm oil per day is enough to satisfy 100 % of the RNI for an average adult. Other foods contain much less by comparison (see Table 5.6).

Palm oil is an outstanding source of pro-vitamin A. If poor people can no longer afford it, then there will not be another even remotely comparable source available to them.

In addition to coconut oil, which has much less nutritional qualities, palm oil is the top seller among oils worldwide. Ever since countries such as Indonesia and Malaysia recognized the economic potential of supplying world markets with biodiesel made from palm oil, the palm oil business has boomed. The price of 1 ton of palm oil went from $300 in 2002 to more than $1,100 at the end of 2011. The price is therefore even higher than it was during the food crisis in Indonesia in 2008. It is not only palm oil which has skyrocketed in price, but rather all edible oils.

In Indonesia, the largest producer of palm oil, it is one of the population's staple foods. Since 2007, the price of palm oil has risen by over 50 %, meaning poor people will either have to consume much less of it or do without it altogether. The government has offered poor households an alternative in the form of soybean oil,

Table 5.6 Pro-vitamin A as source of vitamin A in various foods (Scrimshaw 2000)

Source	RE[a]/100 g (portion)	Relative activity
Palm oil (raw)	30,000	1
Carrots	2,000	15
Green leafy vegetables	685	44
Apricots	250	120
Tomatoes	100	300
Oranges	30	3,750

[a] *RE* retinol equivalent = 1 mg retinol from 6 or 12 mg pro-vitamin A

which is rather worthless from a nutritional point of view. However, that means that an important source of vitamin A has been replaced by a type of oil which does not contain any vitamin A at all. So yet another large number of hidden hunger victims has joined the hunger carousel.

According to a dietary study conducted in Indonesia in 2008, the traditional Indonesian diet contains 21 ml of raw palm oil per person per day. This amount contains a daily dose of 10–15 mg of β-carotene. The price of 1 liter of edible palm oil was $1.28 in 2011. In contrast, the same amount had cost only $0.30 in 2000. The poor inhabitants of Indonesia in Central Java on average earn $50 a month. Of that money, at least 60 % is allocated for food, i.e. $1 a day. This does not leave much to be spent on expensive palm oil. Varying prices will certainly continue to worsen the problem of hidden hunger.

In a study conducted in India, pregnant women were given red palm oil containing 2.4 mg of β-carotene everyday during weeks 28 to 36. The women in the control group were given the same amount of peanut oil, which did not contain β-carotene (Radhika et al. 2003). The result was that women and newborn infants in the first group had a better vitamin A status in comparison to those in the peanut oil group. The women in the first group likewise were able to gain weight more effectively and their newborns were less likely to be born prematurely or with a low birth weight. All in all, this study showed that even a small amount of palm oil can have a strong impact on the health and the future prospects of mothers and their children. In comparison to vitamin A supplements, red palm oil supplies not only vitamin A, but also vitamin E and fatty acids, in other words, energy.

Red palm oil was given to children who had been diagnosed with a vitamin A deficiency in various studies. In one of these, schoolchildren in Burkina Faso were given 15 ml of raw palm oil three times daily for one year. The concentration of vitamin A in the blood of these children was then compared with that of children who had been given 60 mg capsules of the vitamin or were in the control group. Children in the palm oil group underwent a similar reduction in vitamin A deficiency (serum retinol <0.7 μmol/l) as those who had been given capsules, namely from 47 % to 13 % and 17 % respectively. In comparison to waffles which had been enriched with vitamin A, 450 schoolchildren in South Africa who had been given red palm oil showed a better rate of improvement concerning their vitamin A deficiency. In addition to experiencing a reduction in vitamin A deficiency, the palm oil group also benefitted from the oil's other positive qualities (van Stuijvenberg et al. 2001).

Giving red palm oil to pregnant women in their third trimester resulted in a significant improvement in their vitamin A status, both for themselves, as well as for their newborns in comparison to the control group (Radhika et al. 2003). The percentage of anemic mothers was also significantly lower in the palm oil group. The concentration of pro-vitamin A in the mother's milk was also higher (Canfield et al. 2001), thus breaking the chain of vitamin A deficiency which is often passed along from mother to child.

In Nigeria, a country with a high vitamin A deficiency rate among children and expectant mothers, red palm oil is one of the types of oil most often used and it is,

without a doubt, an important source of vitamin A for the Nigerians. In Burkina Faso, the enrichment of food served to children (ages 7–12) in primary schools using red palm oil resulted in a clear reduction in the rate of vitamin A deficiency among the children (Zeba et al. 2006). In the meanwhile, many studies have been conducted which conclude that a diet which contains even a small dose of red palm oil can greatly help to reduce vitamin A deficiency and the illnesses which result from it (Rice and Burns 2010).

There are numerous reasons for preferring red palm oil over supplements and enhanced food products:

- Palm oil is a traditional and accepted type of food.
- In comparison to other pro-vitamin A-rich foods, such as carrots and mangoes, pro-vitamin A is already dissolved in palm oil, thus enhancing its bioavailability.
- Red palm oil is available the entire year, unlike seasonal fruits, for instance mangoes.
- Red palm oil does not only contain pro-vitamin A, but rather it also contains other important micronutrients, some of which in large amounts.

If the population manages to become better informed about the importance of palm oil in their diets, perhaps thereby reducing resentment towards it which also exist, then an important step in combatting vitamin A deficiency will have been taken. This will also help to disempower the argument that palm oil is unhealthy due to its high concentration of LDL cholesterol, which, in fact, is another mere pretense.

Box 5.7 Palm oil is unhealthy?

The argument which is constantly repeated, namely that palm oil contains too much saturated fat, is wrong for a number of reasons. Let us take a look at its composition:

- *52 % saturated fat:* 40 % palmitic acid, 6 % stearic acid, 6 % other saturated fats
- *38 % monounsaturated fat:* 38 % oleic acid
- *10 % polyunsaturated fat:* 9 % linoleic acid, 1 % α-linolenic acid

The percentage of saturated fat is indeed high, however palm oil also contains a number of healthy, i.e., mono and polyunsaturated fats. It is comparable to olive oil with regard to its concentration of monounsaturated fat.

Saturated fat has a bad reputation. Consuming too much of the substance over a longer time period can eventually lead to arteriosclerosis. Arteriosclerosis is a disease which affects the elderly, i.e., the over 65-year olds. This is an age which hardly anybody living in poverty-stricken areas reaches, usually because their vitamin A deficiency makes them highly susceptible to infections. However, recent analyses have increasingly cast doubt on the link between fat consumption and arteriosclerosis. People who are hungry and living in poverty can only afford to buy small amounts of oil. This in itself excludes any danger of an overconsumption of saturated fat.

If prices for raw palm oil were stable and affordable for the poor, then red palm oil would fulfill all of the criteria for food security. Yet it is the rise in price of palm oil which makes this impossible.

Food Security Is in Danger

There is a general consensus that the rapidly expanding market for biofuels will endanger food security for two main reasons—rising prices and falling incomes. The result for poor families is a reduction in diet diversity and thus also in dietary quality. This will play an especially big part in worsening the problem of hidden hunger.

Regardless of how biofuel production will ultimately come to affect food prices, we can be certain that a decrease in staple food prices will definitely not occur.

Agricultural production is closely linked to energy production and, as such, the energy sector. On the one hand, this fact is due to indirect costs, for instance the price of fossil-based fertilizer or insecticides, and on the other hand, direct costs which arise from the production, processing, and transport processes. Since the energy market is (three times) bigger and more strongly centralized in comparison to the agricultural sector, the energy is going to have a much bigger impact on agriculture than vice versa. Agricultural producers have to live and work with the prices which are determined by the energy sector. The impact of the price of raw materials for biofuel production will have relatively little impact by comparison (Ewing and Msangi 2009). Then again, investing in biofuels can be profitable if production is supported by the government in the form of tax breaks and other measures, as is already the case in some countries, thereby undercutting the price of crude oil. Yet this is only the case in countries whose governments are the major producers, leaving small-scale farmers along the wayside once again.

The FAO views the fact that the prices of nearly all staple foods have not only risen but have remained at high levels and will continue to do so with particular concern (OECD/FAO 2008–2017). According to the FAO's calculations, in comparison to the time between 1998 and 2007, the prices of wheat, corn, and skimmed milk powder will rise by 40–60 %, of butter and oilseed by 60 % and of vegetable oil by 80 % between 2008 and 2017. A major cause of this will be the increasing demand for cereals, oilseed, and sugar, which are needed in biofuel production. These price developments are also directly connected to the crop losses in the major exporting countries, such as Australia and Canada. The fatal link between agricultural production costs and energy prices have caused, for example, fertilizer prices to skyrocket by as much as 160 % (USA in 2008). This, in turn, impacts the end price of produce. Rising fossil fuel prices naturally heighten the demand for alternative energy sources, such as biofuels.

According to investigations conducted by the IFPRI (Rosegrant 2008), prices for cereals could be significantly reduced (corn, wheat, and cassava by 20 %, 8 %, and 14 % respectively) by stopping biofuel production completely. This, however,

is neither in the economic interests of the producers in the energy sector, nor of politicians. We can therefore expect staple food prices to continue to rise due to biofuel production, the degree depending on specific factors (see Table 5.7).

Even if a consistent improvement in biofuel production does take place, i.e., the creation of second-generation biofuels using biomass which contains lignocellulose obtained from waste products, harvest leftovers, wood etc., prices for the most important energy-rich staple foods are going to rise nonetheless and exacerbate the problem of hidden hunger. The number of people suffering from hidden hunger will be far larger than the estimated number of undernourished persons since these projections are based upon the available amount of calories, which can be increased by means of bigger harvests. Depending on which of the three scenarios actually occurs, the number of hungry persons will increase by between 40 and 140 million by the year 2020. The majority of these people will live in South Asia (20–80 million) and Africa (10–20 million).

Already in 2008, according to the World Bank's calculations, 300 million more people joined the ranks of the hungry because of the price hikes. The IFPRI maintains that biofuel production contributed to this rise in prices by 30 %. Biofuels have endangered the lives of 100 million people and have plunged a further 30 million into extreme poverty (Oxfam 2008; Rosegrant 2008). In 2008, Oxfam observed that if the run on biofuels continues in the same manner, that will result in an additional 600 million undernourished persons. For every percentage point that prices increase, 16 million people will go hungry. The events of 2011, namely the growth in the size of the hungry masses during the price hikes, confirm this assumption.

What is actually going on? We are the consumers. We buy biofuels and rely on the statements made by politicians regarding the legality of the entire production process. In Africa, Indonesia, and other poor regions of the world, farmers are being forced off their land, or they are being resettled, or simply expelled.

Table 5.7 Price increases on world markets in percentage terms according to three scenarios (Rosegrant et al. 2006)

	Scenario 1		Scenario 2	Scenario 3
	2010	2020	2020	2020
Cassava	33	135	89	54
Corn	20	41	29	23
Oilseed	26	76	45	43
Sugar beet	7	25	14	10
Sugarcane	26	66	49	43
Wheat	11	30	21	16

Scenario 1: continued strong growth in the biofuels industry without technical developments. Scenario 2: production of cellulosic biofuels. Scenario 3: strong growth in the biofuels industry using new technology and production methods

Corruption, greed, and ignorance of the rights of the local inhabitants are the guiding principles behind the boom which has profited the farmers least of all. Instead they can get onboard the hunger carousel, which continues to spin energetically thanks to biofuel.

In order for peasant farmers to be in a position to profit from the production and sales of biofuels and simultaneously enjoy food security, there would need to be certain logistical and structure-changing endeavors. Small-scale producers should be able to compete in the market and not be hopelessly disadvantaged, as is the case with other types of produce. Helpful initiatives include, for instance, networks and cooperatives, which are involved in all areas—from production to marketing to pricing. Yet only a small amount of pessimism is required to imagine that this plan, barring a few exceptions, can hardly work.

The price policies of the governments of the producing countries, particularly subsidies and tax relief measures for producers, will make it difficult for African countries to exist and remain competitive on the world market. If a different course is not plotted soon in order to enable developing countries to be active in the world marketplace on equal footing, then the same development will occur which has famously taken place already in agricultural markets. Poverty will continue to increase, especially due to the fact that developing countries are already at a disadvantage due to land grabbing, which has taken away the farmers' ability to grow food, and the move of the rural farmers into the cities. The energy sector will certainly continue to operate in an even more inhumane manner than the agricultural sector, which is hardly concerned about the connection between food production and nutrition.

We should not fool ourselves or let ourselves be fooled. The poor will benefit little from the jobs which they have been promised. As long as the prices for staple foods continue to climb or at least remain at the same level as during the crisis in 2008, they will have virtually no chance of escaping poverty. They will also have equally little chance of getting off the hunger carousel alive and the problem of hidden hunger will continue to grow thanks to rising food prices.

The most recent price hikes during the food crisis in 2011 illustrates reality in Africa (see Fig. 5.10), whereby it is equally valid for Asia. Within a month, the prices for some staple foods rose dramatically. In some countries, prices increased by 100 % compared with those in 2010. With the exception of Mozambique, there is no African country which was spared from price hikes throughout 2011. Inflation of as much as 120 % means having to do without certain foods, even for those somewhat higher up the social ladder.

The International Monetary Fund (IMF) estimates that biofuels make a 35 % contribution to the rise in staple food prices, whereas the World Bank believes the figure to be as high as 65 % (Oxfam 2008). The OECD (2009) has estimated that 60 % of the reason for the increase in demand for cereals can be traced back to biofuels in the period 2005 to 2007. It is a fairly safe assumption that the rise in demand, coupled with the economic developments at the time, is responsible for the food crisis of 2008. The rise in the price of cereals, especially corn in 2012, speaks for itself.

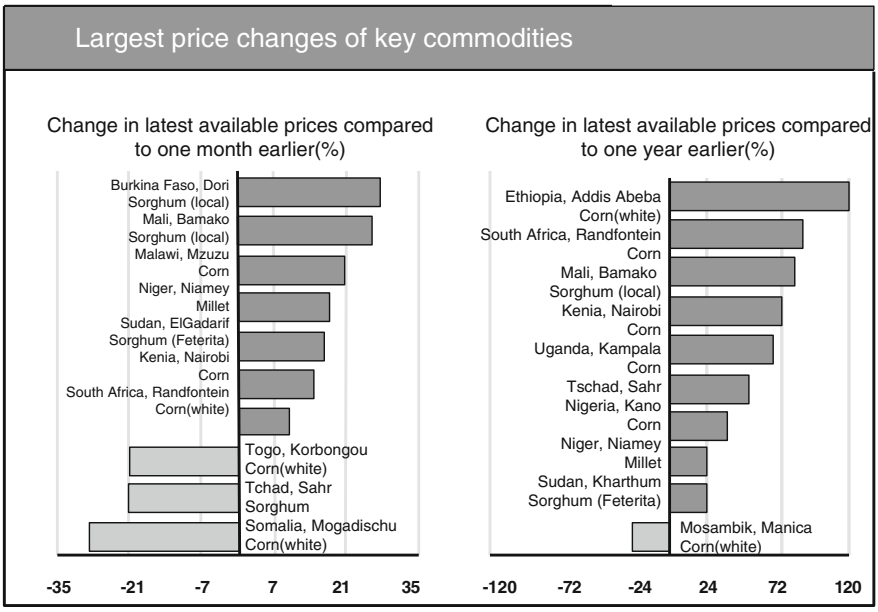

Fig. 5.10 Price increases in African countries within a month/year (FAO 2011)

The impact of rising food prices on the food security of poor households is very complex and is subject to short-time fluctuations. The majority of rural inhabitants of poorer regions live off what they produce themselves and are, at best, only able to see very little of their produce. They are generally referred to as net buyers. Net buyers suffer more from rising food prices than net sellers, who are in a position to sell more of their produce to secure their income. However, there is only a small number of farmers who are in such a position to sell produce, namely 10 %. If they sell their own produce at the local market and raise enough money thereby to send one of the children to school, then they do so at the expense of the family's food security. The reasons for this low percentage are the extremely small plots, the lack of farming supplies and equipment and various internal and external issues. When plots are sold off to foreign investors wanting to produce biomass for energy purposes, then the farmers' chances of turning from net buyers into net sellers become even slimmer. Many small-scale farmers find themselves in debt due to loans they received to buy fertilizer and equipment. Since there is virtually no possibility to keep their creditors at bay, they descend further and further into poverty.

The rise in jobs and reduction in world hunger thanks to biofuel production, which was promised at the World Economic Forum Annual Meeting 2012 in Davos, is pure mockery. Although the virtues of second-generation biofuels were sung at the convention, this does not alter the fact that land is needed for biofuel production and it is land, most of all, which is needed even more by small-scale farmers to grow their own produce. Second-generation biofuels, however, will

only experience a breakthrough once they are proven to be more profitable than the current first-generation biofuels. To accomplish this, the subsidies which are allocated to the first-generation biofuels would have to be diverted to the second-generation, or alternatively, both would need to be subsidized simultaneously. Yet doing the latter would only exacerbate the problem for the poor. The development of second-generation biofuels is halted by, for instance, laws in the United States which give priority to corn-based ethanol and restrict the production of second-generation biofuels (Oxfam 2008). What is more, second-generation biofuels will take considerably longer to produce than has been hitherto promised (Service 2010). Until now, there have been only very few pilot projects to produce second-generation biofuels that have produced nominal quantities (Richard 2010). The issues of whether or not sources can be found which do not require more land, such as lignocellulosic biomass from trees and steppe grass available throughout the whole year, and whether or not the disastrous resettlement policies of various governments will continue remain open.

Since current biofuel production makes use of certain staple foods, namely wheat, corn, and rice, these three essential foodstuffs will remain the Achilles' heel of food security and will be more strongly subjected to price fluctuations.

The relationship of food prices to energy prices is most obvious in countries which must import foodstuffs whose biomass can be used for the production of biofuels, such as corn, wheat, rice, and vegetable oil. Countries such as Haiti and the Comoros are particularly affected by this. These countries are completely dependent on fuel imports. It is, therefore, not surprising that the poor have come to make up more than 50 % of the populace. In the end, prices at the local markets will reflect the above-mentioned situation to such a degree as they already have due to currency issues, such as the devaluation of the dollar, and also the financial policies of the respective countries. Countries can counter the effects of rising prices with the appropriate financial policies on a short-term basis, but they will lack the resources to be able to effectively continue in the long run. Countries which are poor mirror the economic condition of their inhabitants. They are net buyers of energy and foodstuffs. Their chances of being able to pile up reserves for their own people at some point are minimal.

Ultimately, prices on the world markets will rise if the ambitious plan of the EU to obtain 10 % of its energy from biofuels is put into practice, according to the IFPRI. Corn will increase by 26 %, oilseed by 18 %, manioc by 11 %, and wheat by 8 % (Rosegrant et al. 2006). In 2001, Benjamin Senauer, a renowned economist, warned that global prices for foodstuffs, particularly cereals, would increase by 20 % due to biofuel production. According to him, this would result in a rise in chronic malnutrition by 440 million people by the year 2025.

Conclusion

The countries which are best suited for producing biofuels, including those of the second generation, are located in Sub-Saharan Africa, East Asia, and Latin America. Biofuel production can only have a beneficial effect on the income levels

of the poor when the production and sales processes are reasonably regulated. Presumably, Europe production will be geared towards satisfying the European demand for biofuels. From an economist's viewpoint, biofuel production and all that it brings forth can be viewed positively. This includes the assumption that rules will be put into place and obeyed which prevent profit-making by a few and allow for those who pursue smaller scale production to share in the profits. However, such an assumption does not take into account the diversity of local family structures which would need to be incorporated into any small-scale production undertakings. In addition, biofuel production requires resources, such as labor, land, and water, which are all needed for food production, as well. This aspect is magnified when it comes to plantations. The potential profits from running such plantations naturally depend upon how much can be harvested. That is why land with shoddy soil or which otherwise is unsuitable for food crops is not chosen, but rather land with good soil quality is chosen for non-food crop plantations.

A critical assessment of land use, soil quality, availability of water, harvests, and use of produce based upon data collected around the world came to a sobering, if not completely alarming conclusion (Johnston et al. 2009). The harvest projections for biofuel crops were inflated by more than 100 %. How is this possible? Harvests do not merely depend on the composition and preparation of the soil, but also on the infrastructure, political climate, and economic circumstances of the respective country. According to Johnston et al. (2009), the spread of biofuel production, especially in developing countries, will sometimes have to deal with other basic circumstances than those expected, rendering calculations based on what has hitherto been achieved baseless.

In other words, what this means is that the ambitious targets can only be reached by means of fertilizer, supplementary irrigation, or additional land. For developing countries which already produce biofuels for their own needs and, most especially for the transportation sector (e.g. Indonesia), this means either destroying more forests, reallocating land, or otherwise having to accept limitations to economic growth. It is nearly inconceivable what that will mean for the country's land and water resources. The radical enlargement of land allocated to non-food crops has already started to have an impact: less biodiversity, the destruction of tropical forests (roughly 5–10 Mha per year), and a loss of CO_2 absorption coupled with rising emissions levels.

To understand just what increasing biofuel production, including uncontrolled expansion and yield increases, means in light of these circumstances, one should take a long look at the figures which were compiled by Foley et al. (2011). In the past 50 years, the total area of irrigated cropland has doubled, thereby using 70 % of the freshwater available worldwide. The use of fertilizer has jumped by 500 % (more than 800 % for nitrogen alone), leading to the increasing contamination of the ground water, air, and earth. The agricultural sector is responsible for 30–35 % of the greenhouse gases produced worldwide, the majority of which result from deforestation, methane emissions during rice production, and nitrogen oxide emissions arising from the use of fertilizer (Foley et al. 2011).

It is unnecessary at this point to refer to the perilous link between the pressure to produce more crops and food prices. With regard to the poor, it is already quite obvious that they get the short end of the stick and that the number of hungry persons will inevitably keep rising.

Climate Change and Hidden Hunger

Since this is hardly the appropriate context for a discussion on the how and why of climate change, it is sufficient merely to mention that its existence is undisputed and that the earth's temperature is rising. What are then the implications for food security?

An increase in temperature will have both direct and indirect effects on food security, including:

- changes in yields,
- changes in food composition,
- changes in food prices.

In order to the human race to be adequately fed (with regard to calories), more and more staple foods must be harvested. Yet this increase in yield should not damage the earth's atmosphere. After all, nearly 50 % of CO_2 emissions and almost 60 % of N_2O emissions are produced by the agricultural sector. Bigger harvests, also to feed the biofuels industry, will inevitably contribute to global warming.

It is precisely this development which can spark discussions on to what extent the much-needed increases in crop production to feed the world's population contribute to climate change. If temperatures rise above 30 °C, the yields of nearly all sorts of produce fall (Schlenker and Roberts 2009). If the earth's average temperature were to rise slightly, the average yields for corn and soybean would decrease by 30–46 %. However, if it rises more dramatically, as it is expected to do, then it would cause a loss of crops of between 63 and 82 % (Schlenker and Roberts 2005). The underlying cause for this change in yields is the ideal temperature for photosynthesis, which is between 20–25 °C. An average increase in the earth's temperature, however, would entail further consequences. Under such conditions, plants grow and ripen faster, causing them to lose essential components, including protein, fat, and micronutrients, such as vitamin C and zinc. Although scientists are feverishly working on the cultivation of cereals which can better withstand higher temperatures and water shortages, there are still no large-scale production schemes in sight. Studies conducted by the International Rice Research Institute (IRRI) showed that as the nighttime temperature increased, crop yields decreased by 10 % for every degree Celsius (Peng et al. 2004).

According to an analysis by the IFPRI (2009), wheat, rice, corn, and other grain harvests will decrease at different rates and in developing countries most of all. Some regions, for instance China, may experience a reduction in grain harvests. This is due to a rise in global temperatures and CO_2 levels, as well as the

increasing shortage of water. Depending upon how the situation develops, the IFPRI's report predicts a reduction in wheat harvests (i.e. irrigated crops) of between 20 and 34 % in developing countries and between 0.1 and 5.7 % in developed countries. With the exception of rice, which varies between 0.5 and 18.5 %, the yields of other cereals are expected to decrease by more than 10 % in developing countries.

In mathematical terms, these deficits will lead to shortages first of all and not to the projected surpluses of available energy sources. The amount of available calories per person will be 1,925 kcal in Sub-Saharan Africa (versus 2,000 kcal in 2000) and 2,225 kcal in South Asia (versus 2,420 kcal in 2000). When we compare the number of calories which will be available daily to each person in developed versus developing countries, the figures are 3,200 kcal versus 2,410 respectively (IFPRI 2009).

Based on yield gaps (i.e. the potential for higher yields by means of technology and fertilizer) which exist in developing countries, as well as the potential for the further expansion of farming lands, it is very well possible to predict a positive trend (Tilman et al. 2011). Such a development is certainly feasible, yet it will undoubtedly lead to higher CO_2 emissions, and it also uncertain to what extent this would benefit the small-scale farmers and especially landless farmers. The problem of hidden hunger will be the same as before in any case since these calculations are concerned exclusively with increasing grain harvests. Whether or not this grain will contain any micronutrients at all has yet to be adequately examined, however it is doubtful.

Nelson et al. 2010 have plotted the development in three different scenarios based upon income and population. In comparison to complete damage control, whereby the concentration of CO_2 in the atmosphere would be the same in 2050 as it was in 2010, climate change as forecasted by the Intergovernmental Panel on Climate Change (IPCC) will result in a substantial cutback in the amount of available calories.

Figure 5.11 shows the daily amount of available calories for all developed countries, developing countries, and the 40 poorest countries. The assumption that income levels will rise among the poor should the optimistic scenario come to pass seems rather questionable. In that case, according to the analysis, the poor would have access to more energy, which does not necessarily mean an improvement in dietary quality. If complete damage control is not achieved, then the amount of available energy will decrease starting in 2030, according to the pessimistic scenario. The per capita number of calories in developing countries will not reach the necessary level of 2,400 kcal and in the 40 poorest countries less than 2,000 kcal will be available to each person. This also means that the poorest members of these groups, whose numbers will also increase, will even have much less.

According to Nelson et al. (2010), if climate change continues to the same degree as hitherto, corn harvests will decrease by 52.6 million tons, rice by 37.6 million tons, and wheat by 66.7 million tons. This, in turn, will lead to an additional 11.5 million undernourished children by the year 2050. The number of malnourished children is undoubtedly much higher. Climate change also causes

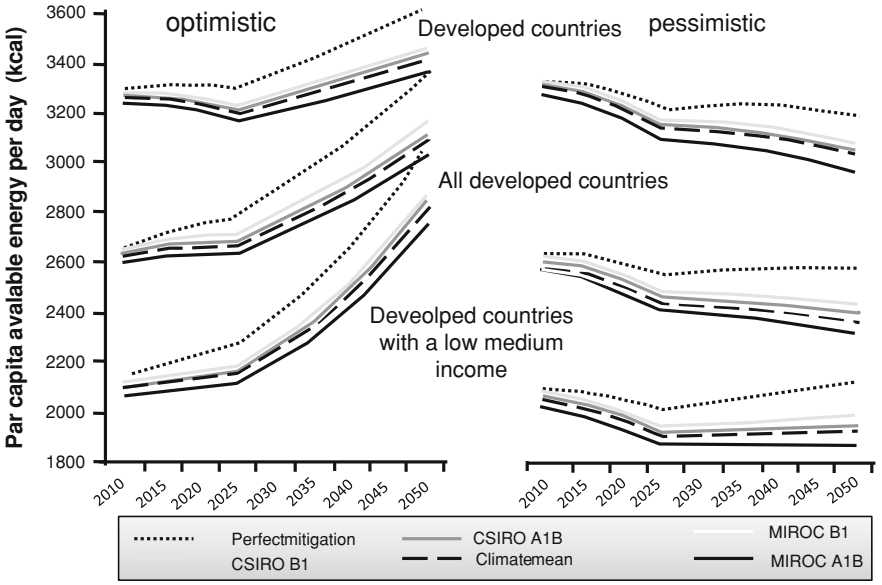

Fig. 5.11 Change in the amount of available calories by the year 2050 according to an optimistic scenario (strong economic growth vs. slow population growth) and a pessimistic scenario based on various models, as well as a (consciously naïve) assumption of complete damage control (Nelson et al. 2010)

extreme weather patterns which may bring about droughts or flooding in some regions which had so far not been affected by bad weather. It can also lead to the prolongation of adverse weather conditions. This makes matters even worse, since crop losses push food prices up and force even more people to join the ranks of the hungry. How varying crop yields and price fluctuations affect one another in light of various climate change scenarios is not straightforward. In the end, the only fact which is clear is that the ranks of the poor will swell and there will be no opportunity for their children to grow properly and develop.

The Influence of Climate on Food Composition (Quality)

Rising CO_2 levels in the atmosphere are also capable of increasing yields, depending on the location of the crop fields. On an intermediate-term basis, however, the CO_2 will alter the composition of produce. One reason for this is that higher yields go hand-in-hand with an increase in the starch contained in the cereals, at the expense of other components. The expected rise in CO_2 in the atmosphere will cause a blocking of NO_3 assimilation in the protein of wheat. The result is 20 % less contents (Bloom et al. 2010). Experimental studies with wheat and selected CO_2-related atmospheric changes showed a significant

reduction of various amino acids, primarily those containing sulfur (Högy et al. 2010). Since certain sulfurous amino acids are essential to humans, this means a loss of quality which can result in another type of hidden hunger, namely a lack of protein. Another consequence of climate change is the so-called diluting effect, which was already observed and described more than 50 years ago. The diluting effect describes the thinning of the mineral components (zinc, iron, copper, magnesium) in vegetables and cereals as yields rise with the help of fertilizer (Davis 2009). The same effect can be achieved through climate change.

Professor Andreas Fangmeier and his project team at the University of Hohenheim observed that an increase in biomass is achieved when CO_2 levels in the atmosphere rise, while at the same time a peculiar loss of quality occurs (Högy et al. 2009). This may be appealing to the producers of biofuels, yet it is certainly not encouraging with regard to nutrition. When the concentration of amino acids, which are vital to humans, in food decreases, then the malnourished populations must not only do without micronutrients, but they must also make due with an inferior form of protein. Lysine and methionine have already shown clear signs of diminishing. Wheat is a poor source of these vital building blocks of protein (also known as limiting amino acids), which the body cannot produce on its own.

It is not only the concentration of amino acids which is decreasing in produce, but also the amount of micronutrients, such as zinc and iron, but also selenium, copper, and manganese. On the flip side, concentrations of hazardous substances, such as lead, are increasing. Reductions in iron of roughly 6 % per kg of dry weight may seem minimal (Högy et al. 2011), however, taking into account poor bioavailability, people whose diets (must) consist mainly of cereals are in danger of developing iron deficiency anemia. How climate change affects fruit harvests and the vitamin concentrations in fruit and vegetables is still completely unknown since this topic is yet to be researched.

Impact on Price Development

Depending on which climate change scenario becomes a reality, the prices of rice, wheat, and corn could more than double compared with prices in 2000 (IFPRI 2009). In a comprehensive analysis, it was estimated that the number of people suffering from undernourishment will increase by 20 million by the year 2020, by 40 million by 2050 and by 90 million by 2080 due strictly to climate change (Parry et al. 1999). The IFRI report describes a rise in the number of malnourished children under the age of five in Sub-Saharan Africa from 33 million in 2000 to 52 million by 2050. In South Asia, however, the IFPRI predicts a decline from 76 million in the year 2000 to 59 million by 2050.

The impact of climate can be clearly seen in the model constructed by the International Institute for Applied Systems Analysis, or IIASA (see Fig. 5.12). Scientists at this renowned think tank have come to the conclusion that there is a

near direct correlation between rising CO_2 emissions and the number of undernourished persons (Fischer et al. 2005).

The analysis factors in the models of climate change until 2080. Depending upon which scenario becomes reality, between 100 and 150 million undernourished people will be living on the planet. Making use of various models of climate change, the authors of this report arrive at the conclusion that between 20 and 40 countries, primarily in Africa, but also in Asia, will encounter difficulties with regard to food security and that they will lose between 10 and 20 % of their cereal producing potential. These countries have already lost 10 % of their productivity in comparison to 1990. Such predictions do not rest upon pure pessimism and may even, in fact, be exceeded.

Taking cereals and meat as the main staple foods, with cereals being low-quality foods and meats being higher quality, the IFPRI report provides an exact prediction of how the situation will develop.

Without any notable climate change, annual meat consumption per person in developing countries will fall from 41 to 37 kg. In developed countries, it will drop from 100 to 92 kg under the same climatic conditions. Regarding cereals, the annual amount consumed per person in developed countries will plummet from 130 to 94 kg and in developing countries from 148 to 114 kg. For the poorest of the poor living in Sub-Saharan Africa, meat consumption will decrease from 18 to 16 kg and cereals from 115 to 89 kg. On a daily basis, cereal consumption will fall from 315 to 244 g. In terms of quantity, this equates to the amount of meat eaten daily by the average person in developed countries. In Sub-Saharan Africa, however, only 44 g of meat are consumed daily. This is an average value, meaning that some people consume twice that amount, while others consume no meat at all. If we take a look at how prices will develop in comparison to today and factor in climate change, it is likely that the prices of rice and most other cereals will

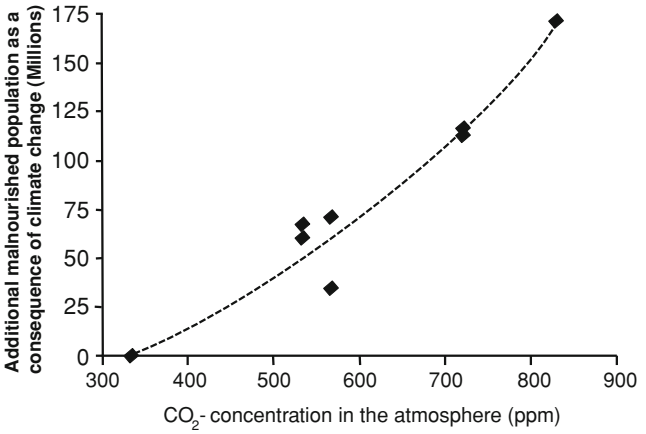

Fig. 5.12 Increases in the number of undernourished persons in relation to atmospheric CO_2 concentrations (Fischer et al. 2005)

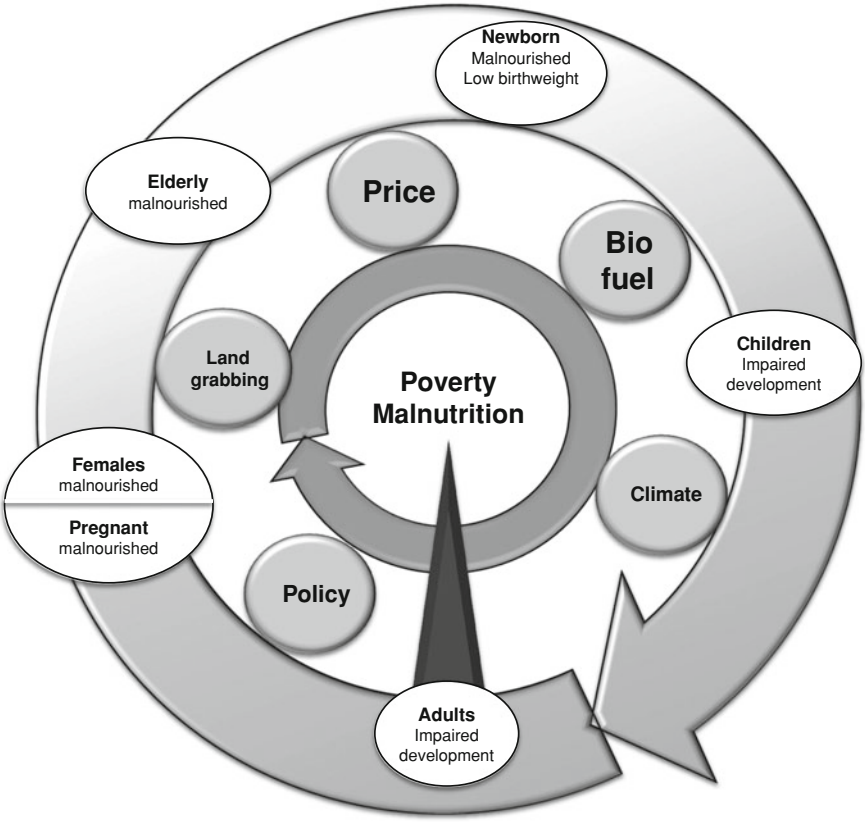

Fig. 5.13 The driving forces of the hunger carousel

double, while wheat will cost three times as much. It is hardly likely that productivity and income levels will increase to the same degree during the same time period. The result of this development is that child mortality, which was estimated in the report to reach 137 million, will possibly be much higher (Fischer et al. 2008; IFPRI 2009).

Conclusion

Biofuels, land grabbing, and climate change will lead to a continuation of rising food prices similar to the price shocks in 2008 and 2011, but on an even greater scale. The prices for staple foods will remain at least as high as they presently are. According to the FAO, the prices of rice, wheat, corn, and oilseed on the world commodities markets will respectively be 40, 27, 48, and 36 % higher in the period from 2015 to 2020 than they were between 1998 and 2003. Consequently,

poverty will not decline, but rather it will continue to be on the rise. Price increases, particularly price shocks, have a devastating effect at the microeconomic level—households sink into poverty and lose the possibility to produce their own food (i.e. as investment possibilities vanish). On the macroeconomic level, price shocks make it impossible to cultivate surplus produce and also lead to a decline in productivity.

The calamitous link between biofuels, food prices, climate change, and politics will more or less ensure that the vast majority passengers onboard the hunger carousel remain onboard (Fig. 5.13). The same applies to those affected by hidden hunger. Africa will be particularly impacted by these developments since the countries and organizations which are snapping up the last bits of available land are not intending to produce food for the African market, but rather to be exported. Technological advances, which require funding to be realized, however, could contribute to producing higher yields in an ecologically friendly way and to reduce crop losses, which currently stand at 30 %. While food is mostly lost before it makes its way to consumers in developing countries, in developed countries the converse situation occurs. Here products are thrown away because of government regulations, as well as due to consumers' indifference to wasting food.

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Ways Out of the Hunger Crisis?

6

A British study Foresight. The Future of Food and Farming (2011) defines five key challenges for the next 40 years, three of which concern food:

1. *Balancing future demand and supply sustainably—to ensure that food supplies are affordable.* The goal is an adequate supply of affordable, nutritious, and secure food for a growing world population. The demand for food is expected to increase by 40 % by the year 2030 and by 70 % by the year 2050. This is a significant challenge faced by politicians.
2. *Ensuring that there is adequate stability in food supplies—and protecting the most vulnerable from the volatility that does occur.* Non-economic factors, such as extreme weather occurrences and climate change, come into play here and are difficult to calculate. Political unrest within certain regions can also help to trigger price fluctuations on a local basis. Prices are easier to control and in this case it is up to politicians to use their influence to steer the commodities markets and to prevent the possible negative effects of trade restrictions.
3. *Achieving global access to food and ending hunger.* The developmental goal of cutting the number of undernourished persons in half by 2015 will not be achieved, barring a few exceptions, such as China. The situation is the same today as it was in 1990! Today, a billion people do not consume enough calories on a daily basis and another million people suffer from hidden hunger. Various factors, including prices and regional average income levels, contribute to causing hunger, as do other factors such as availability and non-economic aspects, for instance war, corruption within the government and climate change.

The last point, eliminating hunger, deals with the issue of food security. If the FAO's definition is taken to heart, the implementation is the real challenge, yet it can lead to a reduction in world hunger and especially a reduction in hidden hunger. Merely guaranteeing an adequate amount of calories draws attention away from the real problem.

The underlying causes for price increases are not exactly encouraging, also due to the fact that they are closely inter-related and it is not easy to control the momentum.

H. K. Biesalski, *Hidden Hunger*, DOI: 10.1007/978-3-642-33950-9_6,

The price of oil is one of the primary forces which influence food prices, and it has far-reaching effects, both within the poorer countries suffering from rising prices, as well as beyond. The climate, water, commerce and price speculation contribute their fair share to the situation, as well. Although the forces at work are interrelated, they are nevertheless the respective domains of different interest groups. That is why the fourth pillar of food security, price stability, is so elusive, if not an illusion.

The challenge that leading agricultural scientists have emphasized is food security for 9 billion people by the year 2050. According to the scientists, this can only be achieved by increasing the harvests of the most important staple foods (see Table 6.1).

Wheat, rice, millet and corn are cultivated on 83 % of the land used to grow cereals. This equates to 56 % of arable land worldwide. Opinions are divided as to whether or not harvests can be increased by the projected 50–70 % (Smil 2005; FAOSTAT.fao.org 2009) taking climate change and biofuel production into account. Regardless of how much crop yields can be increased, this alone will not solve the problems facing worldwide food security. To ensure food security requires not only bigger harvests, but also quality enhancements, both in the production process and regarding availability to consumers.

In the near future, 9 billion people will need to be fed. Is this at all possible to achieve and, if so, how? And not to be forgotten: How many of these 9 billion people will be fed *adequately*? Measuring the amount of food (i.e. calories) is relatively easy. From 1961 to 2007, the amount of available calories per person rose continuously from 2,250 to 2,750 kcal (Kastner et al. 2012). There was a significantly larger increase in high-quality food consumption (vegetables, fruit, oils, meat) than in cereals. Consumption of roots and spuds even decreased. These facts indicate that there was a divide in terms of the quality of food consumed by higher income and lower income families, with the former enjoying more high-

Table 6.1 Worldwide production of essential staple foods (Jaggard 2010)

Variety	Hectares (mil.)	Tons (mil.)
Wheat	214.2	606
Corn	158.0	792
Rice	155.8	660
Millet	46.9	63
Soybeans	90.2	221
Dried beans	26.5	18
Rapeseed	30.8	51
Sunflower	21.5	27
Sugarcane	22.7	107
Sugar beet	5.2	44
Potatoes	18.5	309

quality products, while the latter consumed more low-quality foodstuffs. This is precisely what must be considered regarding food security for a growing population and the use of arable land.

A population group's choice of food, and thus, the amount of land necessary to produce it is primarily dependent on income. When income levels rise, birth rates fall. There is a greater demand for meat, vegetables, and vegetable oil, which will certainly lead to a greater demand for farmland, as well. Already today, 90 % of calories and 80 % of fat and protein consumed by people worldwide are produced on farmland (FAOSTAT. fao. org 2007). The authors of a study on possibilities to feed a growing population come to the sobering conclusion that food quality has indeed improved in many countries. However, the amount of farmland has shrunk (Kastner et al. 2012). This reduction in the surface area of farmland is a sign that technology and improved growth conditions are doing their part to optimize production. It is developed countries most of all, but also countries such as China, which have reaped the benefits of improvements in food quality and agricultural engineering. Africa and parts of South Asia, on the other hand, have not benefitted at all. Poor nations are under threat from the fact that various interest groups will be in fierce competition for land, including animal farmers and producers of biofuels and animal feed, combined with climate change and rudimentary farming techniques often employed there. More than 60 % of small-scale farmers employ no real technology and can also not afford to buy expensive seeds or fertilizer. Only by means of improved farming techniques, especially with regard to cultivation and seed quality, can the ambitious goal of providing adequate energy for the world's growing population by achieved. This can only go hand-in-hand with an improvement in the quality of food available to everyone when the financial resources of the population rise simultaneously.

The different models that have been proposed by political organizations and NGOs are all sensible in their own right. They do tend only to focus, however, on certain issues. Comprehensive and multi-sectorial approaches are costly and often as ineffective as models which are more narrowed in their focus. Yet sustainability is an absolute must so that the poor are in a position to be able to provide food for their families without the need for hand-outs. Nevertheless, short-term solutions must also be found to address the acute problems of hunger and hidden hunger. Emergency intervention measures have one essential disadvantage. A person's life may be saved by curing an iron or a vitamin A deficiency, yet that person still remains onboard the hunger carousel if hidden hunger and its various causes are not dealt with.

Strengthening the Role of Women

By now it is presumably apparent that the passengers onboard the hunger carousel are mostly women and children. Males are harder to find, barring those under the age of five and the high mortality rate among them. Although the solutions which will be presented in the following section depend upon the income of the men in

order to be realized, the most often paltry sums of money to purchase food must make their way into the hands of the women.

The nearly indescribable world in which women in poor countries live is poignantly depicted in *Half the Sky: Turning Oppression into Opportunity for Women Worldwide* by Nicholas Kristof and Sheryl WuDunn. The book illustrates the miserable life that women lead in-between abortions, circumcisions, and male caprices. Added to that is the fear of pregnancy since it can often spell death and the angst of not being able to provide for their children's nutritional and health needs in countries where every fifth, and in extremely poor families even every third child dies. War, banishment, violations on the part of the state, and a lack of protection render the women nearly incapable of taking care of the upcoming generation whose guardians they are. They remain onboard the hunger carousel until they become the focal point of the measures conceived by men to combat hunger.

According to the WHO, health encompasses total physical, mental and social well-being, which enables one to carry out daily activities and to reach one's goals. In light of the reality these individuals face, this definition sounds almost like pure sarcasm. Nevertheless, it is the foundation for a better future for poor countries.

Healthy, well-nourished mothers give life to healthy babies. These babies, in turn, will grow up into healthy adults. The chances that mothers and their newborns survive would then be much higher. Children who undergo a normal development have the physical and psychological wherewithal to deal with life—a life which they can form and be productive in. The health and well-being of women are determined by the socio-economic developments in their country of residence (Thompson 2005; WHO 2005).

The 'positioning' of women in the center of development, and thus away from the hunger carousel, starts with medical supervision during pregnancy, as well as during and after childbirth. It is simply unacceptable that 60 million women give birth without proper care at home every year, whereby home births in developing are nothing like those in developed countries. The birth takes place in a tent, small hut or out in the open without any kind of hygienic standards or possibility to manage complications. That is why, year after year, 600,000 women die during or shortly after childbirth. If mothers are not taken care of, then newborns are mostly left to their own devices—with an estimated 2 million of them dying each year. Nobody really knows exactly how many deaths occur this way. It is a very large gray area. The unspectacular manner in which these children die leaves their deaths hardly noticed and will continue to do so until the outcries of the women are heard and amplified.

We sometimes see images of mothers holding starving children in their arms and it is not the mothers which move us, but rather the children. These are children who suffer because their mothers suffer. The 'objectification' of women, their reduction to an object without human dignity by male-dominated societies as described by Thompson (2004), is ultimately what renders mothers alone and defenseless. As long as the masculine self-image which is prevalent in many societies is coupled with a drive to bear more children, women will suffer further impoverishment, which in turn will be passed along to their offspring. The popular

adage that the wealth of a family is its children is actually the direct route to misery and poverty for mother and child in many cases. Children as a poverty trap—this situation has also been described in Germany and is given as one of the reasons for the rise in the number of abortions. The fateful link between mother, child, and social status receives far too little attention in rich countries without a doubt. When the issue of human rights is rightly voiced in various countries, then the issue of women's rights must also be vocalized, including in countries whose human rights records are deemed to be 'clean'. In the same way if there is a demand for more female corporate executives in countries like Germany, then perhaps it should be considered to give women proper representation in situations in which they themselves have the final say, namely pregnancy and managing the diets and development of their children.

If men had to deal with the same degree of hunger as women currently do, mass protests would erupt. Undernourished women are the status quo in poor countries. Roughly 70 % of the poorest people on earth are women (Department for International Development 1999). When Fogel (2010) makes the connection between malnutrition, growth, life expectancy, and productivity, an essential argument for this is the fact that the daily amount of calories burned during heavy physical labor is higher than the calories available in food. This situation is no different in countries where poverty and hunger dominate. In fact, due to the manual labor women in poor countries must perform, their caloric requirements exceed the amount of calories available to them in their diets. If pregnancy and lactation are added to this, the gap widens even further (Food and Agriculture Organization 2010, 2011).

In some countries, upto 50 % or more women work in the fields. The double strain of fulfilling their maternal duties and managing the family's sustenance and well-being can be seen in the high maternal and child mortality rates which poor countries have.

When it concerns the causes and effects of poverty, it is certainly women and children first. Poverty as the basis for malnutrition and mortality also affects women most of all, particularly mothers of small infants in rural areas. Studies conducted in 11 countries with more than 320,000 households have chillingly confirmed this fact (Graham et al. 2004). As poverty increases, the number of deaths among women due to maternal, as well as non-maternal causes rises sharply (see Table 6.2). In Indonesia, the mortality rate among the poorest class was three to four times higher than among those with the highest income levels.

The WHO's estimates are unambiguous. An increase in poverty means an increase in mortality (www.who.int/whosis/mme_2005.pdf). Eighty-five percent of all female deaths occur in South Asia and Sub-Saharan Africa. Eighty-five percent of these women are in the low-income bracket. There are no data available regarding males. Health and income go hand-in-hand. The poor live shorter lives, regardless of what the economy of the country they live in is like. In the United States, the average life expectancy of the poorest group is 25 % lower than that of the richest group (Cutler et al. 2006). An article appeared in the *Süddeutsche Zeitung* (15 Dec. 2011) regarding pensioners and claiming that "whoever is poor

Table 6.2 Maternal mortality and poverty (Graham et al. 2004)

Region and income bracket	MMR (per 100,000 live births)	Deaths	Lifelong risk of maternal mortality	Uncertainty margin re. MMR estimates	
				Lowest estimate	Highest estimate
Region					
East Asia and the Pacific	150	45,000	340	82	270
Europe and Central Asia	42	2,600	1,400	25	99
Latin America and the Caribbean	130	15,000	280	81	230
Near East and North Africa	200	15,000	160	92	380
South Asia	500	187,000	59	300	770
Sub-Saharan Africa	900	270,000	22	450	1,500
Income bracket					
High income	9	1,000	6,700	8	17
Above-average income	91	9,000	540	65	150
Below-average income	180	74,000	270	94	300
Low-income	650	451,000	40	350	1,000
Worldwide	400	536,000	92	220	650

dies younger". The increase in the size of the low-income bracket, which was given as a reason, is another way of saying that poverty is on the rise.

Food crises triggered by limited availability or rising prices can have a fatal impact. Women undergo an additional strain in their work due to the fact that the men go off in search of work in order to earn money for the family (Bhalotra and Umana-Aponte 2009).

What applies to mothers applies equally to children. Even price shocks can increase the mortality rate of children under the age of three (Baird 2009). A decrease in GDP, i.e., buying power, by only 1 % increases child mortality by 0.24–0.4 per 1,000. They die because their diet gets even worse temporarily.

Economic fortification and improvements in food security must first of all begin with the women so that they can be freed from the hunger carousel. Only then can other passengers gradually get off the hunger carousel, too. A prerequisite is, in addition to a reduction in poverty, the fortification of all pillars of food security.

The plight of women is summed up in the FAO's *The State of Food and Agriculture 2010–2011, Women in Agriculture*:

- Women share a large portion of the farm work. Depending on the crop, their workload can fluctuate strongly.
- Women working in farming generally have less access to capital goods, such as land, equipment, seeds, as well as to education, financial resources and health care.
- Women's equality would have a profoundly positive effect on agricultural development and food security. If women were to have equal access to capital goods, they could achieve a 20–30 % rise in crop yields. This would help to reduce world hunger by 12–17 % (albeit in strictly caloric terms).
- Political intervention should focus primarily on:
  - eliminating discrimination against women with regard to agricultural resources, education, financial support, and jobs,
  - investments in farming equipment and infrastructure in order to reduce women's workload and enable them to focus more on other productive activities (also within the family),
  - promoting women's easier access to flexible, effective, and fair rural job markets.

Support for women during pregnancy and childbirth is undoubtedly a central issue when it comes to reducing maternal and child mortality. However, such measures are only sustainable when they are linked to the above-mentioned priorities and to the pillars of food security.

Box 6.1 Framework for Improving Maternal Health (Family Care International 2009; World Bank 2009)

- professional perinatal care,
- the availability of emergency medical treatment (EmONC, Emergency Obstetric Care) in the event of life-threatening complications,
- immediate postnatal care for mother and child,
- family planning and other health care aspects.

If these measures are implemented systematically, the benefits will soon start appearing. Sri Lanka has done an enormous job of fighting hunger and poverty on virtually all levels. Nearly all children receive vaccinations against measles, TB and polio. Ninety percent of households have access to clean water and 97 % of children go to school (UNICEF Annual Report 2007). Maternal mortality in the country went from 1,056 per 100,000 live births in 1947 to 24 in 1996 thanks to the strict adherence to the framework described in Box 6.1. In 1974, only 27 % or births were performed by a professional. In 1995, it was 89 %. Nonetheless, malnutrition is widespread in Sri Lanka. So although maternal and neonatal mortality have been decreasing, the basic problem of an insufficient diet with all of the consequences of hidden hunger still exists.

Sri Lanka is a good example of how maternal and child mortality can be drastically reduced when various measures are undertaken by the government. Vitamin A supplements have been distributed to 89 % of children from 6 to 59 months and 92 % of households use iodized salt. Yet 20 % of children still suffer from wasting and 17 % from stunting. The problem here also lies in the false interpretation of the situation with regard to nutrition, which is based on quantity. The improvement of food security, i.e., the implementation of all four pillars, is also in countries like Sri Lanka a challenge still, and one which must be overcome in the future. Doing so might help to make it possible for Sri Lanka to reach the MDG for child mortality. The child mortality rate in 1992 was 29/1,000, in 2000 it was 23/1,000 and by 2008 it had dropped even further to 17/1,000 (FAOSTAT 2010). That puts Sri Lanka on the same level as Mexico.

Model calculations for Afghanistan, the country with the highest maternal mortality rate in the world with 1,400–1,500 deaths per 100,000 live births, have shown that a strict adherence to the framework mentioned previously could help to prevent three out of four deaths occurring during pregnancy and birth. The costs of achieving this, according to the authors of the study, would be $200 per person per year (Carvalho et al. 2012). To be successful requires not only political will, but also acceptance of the framework within society, not to mention medical and family policies which must be implemented along with proper dietary practices.

A child's survival chances go up by 20 % when the mother controls the family budget (Walsh 1998). According to Walsh, the primary reasons for this are:

- Women are more centrally involved in the process of controlling food security and their children's diets than food manufacturers, the breadwinners in the family, those in the food processing industry or babysitters.
- Resources, including food, which are controlled by women in the family, are much more likely to be used for the benefit of the household and to satisfy the needs of the children.
- Within the household, it is more likely that the women control the food supplies and use these to feed the family, whereas the men are more occupied with earning and controlling the money. For the men, feeding the family is often one cost among many.
- Home-grown produce is often sold by the men in order to purchase non-food items.

Even if such generalizations are not always accurate, they do contain important arguments for placing control over what food the family buys and eats into the hands of the women.

Safeguarding Supply and Nutritiousness

First of all, there simply must be enough food for everybody. That does not necessarily mean, however, that everybody can afford to buy the food or that it is nutritious. How will the situation look in the years to come?

Figure 6.1 shows yield increases of staple food crops from 1961 to 2009 (FAOSTAT.fao.org 2009). Between 1961 and 1995, cereal production increased 2.5-fold and animal production (chickens) 3.5-fold. Between 1995 and 2009, however, cereal production increased by only 0.5 %, whereby yields from chicken farming rose to another 100 %. With regard to cereals it is clear that the rise in production which occurred until 1995 can hardly be repeated. In the case of meat production, it must be remembered that livestock farming consumes a large amount of resources and contributes to climate change.

Foley and Co-worker (2011) recalculated the crop yield development and arrived at a much different result. Yields of agricultural product groups including cereals, oilseed, fruit, and vegetables rose by 47 % between 1995 and 2005 (Food and Agriculture Organization 2011). However, if all crop yields in the USA are factored into the equation, then the increase is only 28 % (Food and Agriculture Organization 2011; Monfreda et al. 2008). If the figures are based on the increase in farmland, then the increase in crop yields falls to 20 %, a far cry from the often quoted 47 % (Foley et al. 2011). Hence the increases in agricultural production which occurred between 1965 and 1985 (56 %) were not continued afterwards, contrary to claims often made. Even the most optimistic interpretation of the data

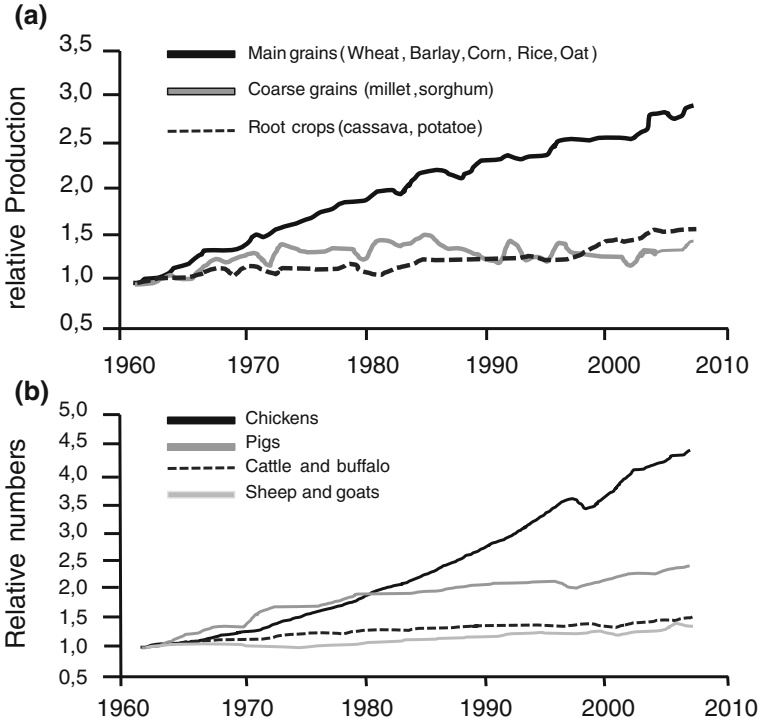

Fig. 6.1 Relative increases in the production of cereals and meat from 1961–2009 (FAOSTAT. fao. org 2009)

does not speak for an increase in yields by 70 % as proposed by the FAO at the World Summit on Food Security in 2009. Such a rise in yields would be another 40 % above the absolute gains of the last years (Tester and Langridge 2010). Sixty-two percent of harvested produce is allocated for human consumption and 35 % is used for animal feed. The remaining 3 % is (still) used for biofuels, seeds, and other industrial products.

The issue of higher crop yields must also take into account exactly where these gains should occur. The United States and European countries have achieved the highest gains in crop yields thanks to advanced technology and development, with 40 % being grown for human consumption. In Africa and Asia, where increases in crop yields are less feasible, 80 % is eaten by humans (Foley et al. 2011). Despite the enormous efforts of modern agriculture, every seventh person has an inadequate diet (based upon the required amount of energy of 2,100 kcal) and thus suffers from chronic undernourishment and the adverse effects described previously. Without having to look too far ahead into the future, it seems that this situation will worsen despite higher crop yields due to price speculation, biofuel production, and climate change (Godfray et al. 2010). The production of cereals, which are the dietary cornerstone in most developing countries, would need to double in order for the required amount of calories per person to become available.

The 'troublemakers' in this necessary development process, in addition to the ones mentioned above, are current trends in people's dietary habits. As income levels rise, people will become less dependent on cereals and will want to consume more meat and animal-based products. The desirable reduction in poverty is a double-edged sword since it will place a strain on the food resources currently available and cast a shadow of doubt on the doubling of grain production. This will only have a negative impact if food security is understood strictly in terms of quantity. In other words, it is sufficient when a person consumes 2,100 kcal a day, regardless of from what source. The result would inevitably be a further increase in hidden hunger.

The magical doubling of crop production, which does not result in a doubling of food thanks to the demand for biofuels, would entail a further problem. The agricultural sector is already primarily responsible for climate change, soil erosion, water use, and loss of biodiversity.

According to Foley's analysis (2011), the following goals should be reached by 2050: an increase in agricultural production, improvements in the distribution and availability of food, and more flexibility in the entire food industry. However, according to the author, these goals are just as illusory as the ability to reconcile them with environmental protection. Foley sums up by stating that the agricultural industry must do the following in its attempts to achieve its goals:

- reduce greenhouse gases which it produces by 80 %,
- halt the loss of biodiversity and wildlife habitats,
- reduce the use of water from sources which are not sustainable, particularly when that water is used for other purposes,
- lower the concentrations of chemicals and other agricultural runoff products in the water supply.

It is quite clear that these goals are overly ambitious. Greed, the relentless wasting of energy and other resources, such as water and land, deforestation, and a lack of appreciation for food—all these things are not likely to change anytime in the near future, not to mention other factors, such as dry periods, wars, and increasing poverty.

A further aspect which limits the availability of food yet which will not be elaborated on are the crop losses incurred before or after harvesting, especially in developing countries, as well as the throwing away of food in countries which simply have too much of it.

How Will Prices Develop in the Future?

Food prices on the commodities markets will remain at their high levels during the next few years. According to the FAO, the prices of rice, wheat, corn, and oilseed on the world commodities markets will respectively be 40, 27, 48, and 36 % higher in the period from 2015 to 2020 than they were between 1998 and 2003.

Short-term fluctuations must be differentiated from permanent changes. At the same time, a realistic scenario can only come to pass when such factors as climate change, water shortages, or extreme weather conditions are taken into account. Based on this, the OECD and the FAO have calculated the price increases which we can expect to see until the year 2017. According to their calculations, the prices of staple foods are expected to increase by 10–60 % versus those of 2008. Particularly affected will be oilseed and vegetable oils with a rise of 50–80 %, not least of all because of their relevance to biofuel production. The prices of wheat, rice, and other cereals are expected to rise by upto 40 %. Those who depend on these staple foods will find themselves in an increasingly difficult situation if the MDG 1, the reduction of poverty, is not achieved.

Price is generally determined by demand and this is precisely the dilemma which continues to unfold. The world's growing population and the rise in wealth (in some regions) are resulting in a greater demand for food, especially higher quality products, for instance meat and animal-based products. The politics of biofuel also have a considerable influence. If the price of crude oil increases, the demand for biofuels will also increase, resulting in a rise in food prices. As long as this link cannot be severed, it will remain impossible to prevent price shocks from (re-)occurring with all of their adverse effects in tow. When oil prices rise, the agricultural production costs also rise, again leading to an increase in food prices. Not least of all, climate change will also adversely affect food prices, most of all in countries which already suffer the burden of high prices for cereals. Particularly in countries where water scarcity and soil erosion are serious issues, it will hardly be feasible to produce cereals at a reasonable price. The result will be a higher dependency on grain imports and support from foreign organizations than ever before.

We can generally assume that food prices in future will be even more volatile and fluctuate more strongly than was previously the case. If extreme climatic conditions, such as dry periods or floods, become more common, this will quickly impact production and therefore prices, in particular those of staple foods.

On the basis of how the market for staple foods has developed over the past few years, Runge and Senauer (2007) have come to the conclusion that the number of people who cannot feed themselves adequately has increased by 16 million for every positive percentage point. Looking ahead, this will place the number of hungry persons in 2025 at 1.2 billion instead of the projected 625 million. In 2011, the figure was already over 1 billion, not least of all due to competition between staple food crops and non-food crops, which are one in the same plant. This rivalry is a very special and complex issue, yet in short it will lead to a worsening of the situation for the hungry. This is also not least of all because the commercialization of cereals for biofuel and animal feed production has given rise to new species which are not geared to the nutritional needs of human beings (Morris and Sands 2006). This phenomenon, which is known as the 'breeder's dilemma' is about the opportunity cost of cultivating cereal crops which do not conform to human beings' special dietary needs, but rather can bring higher yields and profits as a source of biofuel or animal feed and vice versa. Investing in human health is certainly the more expensive proposition, but ultimately it brings greater rewards and is more sustainable.

What do bigger crop yields bring, regardless of how much bigger they in fact are or how climate change will lower people's expectations about reaching the ambitious goals, when those who depend on the crops can no longer afford to buy the produce because it is too expensive?

In their report concerning the development of the agricultural industry between 2008 and 2017, the FAO and the OECD come to the conclusion that food prices will tend to rise, not fall in the future, barring a few isolated exceptions (see Fig. 6.2).

This pertains in particular to staple foods which are the basis of poor people's diets, for instance cereals and oils. The inhabitants of the poor countries of today will want to increase the meat content of their diets once prosperity and productivity levels have risen (provided a new generation can bring more productivity to the respective country). Even when the forecasted price increases are minimal, higher cereal prices will undermine any hopes of achieving diet diversity. The connection between quantity and the availability of quality has thus far not been drawn and assessments of the status of hunger continue to be based exclusively on available calories. Cereal prices will most likely remain at their peak levels since 2008/2011, while oil prices will be even higher (OECD/FAO 2008). So it appears that we have the same situation as before. The diets of the poor will remain unbalanced and hidden hunger will continue to be 'inherited' by future generations. With the exception of the third pillar, nutritiousness, nothing seems likely to change.

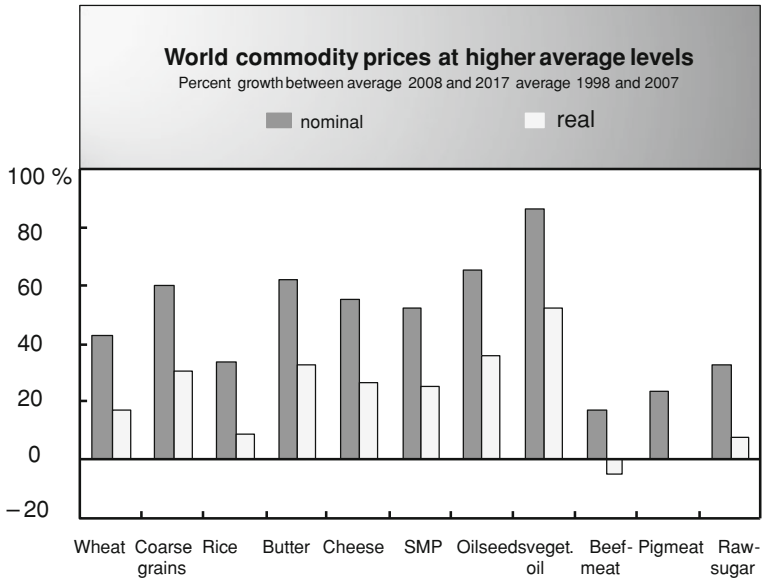

Fig. 6.2 Development of the average prices of foods (SMP: milk products) from 2008 to 2017 in percentage points compared to 1998–2007 (OECD/FAO 2011)

Conclusion

The road out of the hunger crisis is rocky and full of hurdles, assuming that one even exists. In addition to real options, such as strengthening the position of women, there are models and projections for escaping hunger which are not utilized for a wide variety of reasons. Affordable food items, which also keep under extreme conditions and are not subject to price fluctuations, are every bit as illusory as the eradication of hunger. The hunger carousel will continue to spin and it is only by means of short, mid, and long-term strategies that the passengers who are trapped onboard can be freed.

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Strategies to Combat Hidden Hunger

7

Let us remind ourselves at this point once again: The discussion regarding a rise in the production of staple foods is focused on providing sustenance, in other words calories, and not high-quality, nutritious food for the world's growing population. The goal is to avoid potential famines. The guiding principle is that no person should starve. Persons whose hunger is satisfied in this manner still find themselves in a state of undernourishment and susceptible or 'sensitive' to starvation in the words of the FAO, the WHO and other organizations. Sensitive means that a sudden drop in calories could lead to death by starvation.

Starvation in this context means that children die from harmless infections or from childhood illnesses, such as measles, which become too serious for the children to cope with. Starvation also means that the body's reserves are completely depleted and, along with a lack of bodily fluids, food can no longer be properly digested. This is a sort of wasting away which even the most well-intentioned dietary intervention can no longer stop. Such measures are often a more or less brief interruption of a chronic state of undernourishment. The dilemma faced by victims of hidden hunger is slowly being understood. Three years ago, UNICEF identified and documented micronutrient deficiency as being the central issue with regard to the hunger carousel (UNICEF 2009).

The impact of such policies can be demonstrated on board the hunger carousel, as well as the necessary relief measures.

Figure 7.1 shows the impact of hidden hunger on the passengers on board the hunger carousel. We tend to notice people who are starving, visibly emaciated, or show symptoms of a severe vitamin deficiency. We see them as candidates for acute dietary intervention. Those who suffer from the effects of hidden hunger remain in the background since their symptoms, including frequent illness, physical, and mental handicaps, or 'mere' poverty, and lack of education are not seen as being associated with hidden hunger. This is a general fact and not exclusively a developing world problem. It is often just a case of the severity of hidden hunger and thus of the effects. How severe these are to what extent the lives of those who are afflicted by hidden hunger are impacted cannot be estimated. Hidden hunger and its adverse health effects lie tucked away in places where they are least expected.

H. K. Biesalski, *Hidden Hunger*, DOI: 10.1007/978-3-642-33950-9_7,

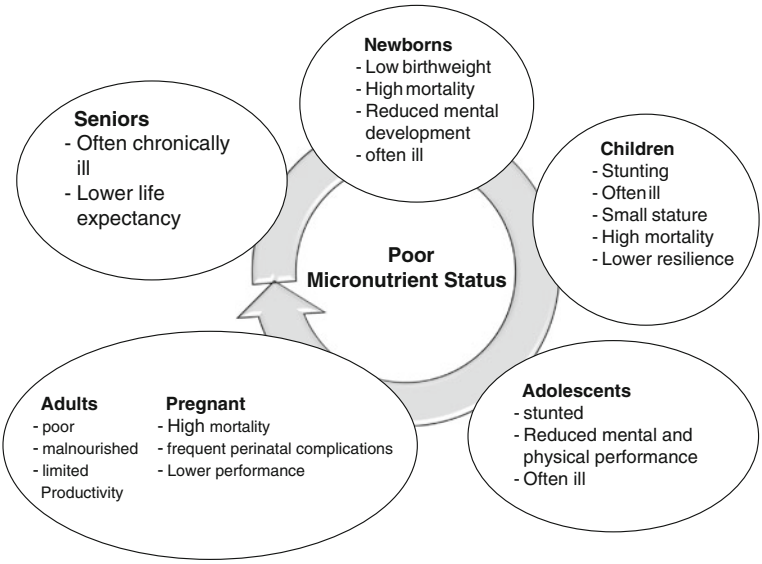

Fig. 7.1 The carousel of hidden hunger (UNICEF 2009)

If dietary intervention is not systematically undertaken at some point within the vicious circle, then the circle begins again at that point with even less of a chance of preventing the complications associated with hidden hunger. Unlike the hunger carousel, which is visible for all to see, the hidden hunger carousel, as the term indicates, is concealed behind the former. If a concerted effort is made to alleviate hidden hunger, many of the related developmental disorders and illnesses will vanish.

The fight against hidden hunger must not be carried out on isolated fronts, but rather attack the circle in its entirety. The goal of all relief efforts must be a healthy and appropriate diet for those who currently suffer from hidden hunger in all age groups. This will ultimately lead to an increase in performance and productivity. The fruits of increased productivity must be reaped solely by those who carried out the necessary labor. This is the gauntlet which has been thrown down to politicians from the regional to the international level, as well as to everyone with regard to their dietary habits since food is a valuable resource and must be treated as such—in every respect. This is the only way to pave the way out of poverty for the poor and to create a framework for reducing hunger and hidden hunger.

Acute Crisis Intervention: Supplements

In the case of hidden hunger, acute crisis intervention means administering specific micronutrient supplements to alleviate a deficiency. Such intervention requires that the deficiency has been diagnosed or is at least highly probable and that an

improvement in one's health status can be achieved by means of supplementation. This is particularly the case with regard to the micronutrients vitamin A, zinc, and iron. Concerning the latter, however, malaria incidence must be taken into account beforehand.

Malnutrition and economic development are closely tied together. In light of this fact, the recommendations proposed by the Copenhagen Consensus (2008) are to be understood as a vital means of increasing productivity with the help, for instance, of vitamin A and zinc supplements.

The considerations by the members of the Copenhagen Consensus are based upon studies which have shown that administering protein and micronutrient supplements to malnourished children helps to improve not only physical and mental development, but also their level of productivity. The latter can be observed from the disparity in the average income of adults who, as children, received supplements versus those who did not. A cost-benefit analysis was conducted at the same time to determine what the potential success of implementing these measures would be.

For that reason, a catalog of criteria was assembled which should help to make improvements in the health and productivity of hungry persons more effective. The disability-adjusted life years, or disease-adjusted life years (DALY) values are incorporated into this. These are the years of productivity which are lost due to premature death or disability in relation to life expectancy. It is possible to project the degree to which the DALY values can be reduced by implementing the measures to reduce hidden hunger. Recommendations are made based on the relative costs of the various measures and their potential to reduce the DALY values. This is admittedly a very bureaucratic approach which pits finances against benefits. If intervention is not found to help reduce the DALY values or sufficiently increase productivity relative to what it costs, then it no longer becomes an option. The fact that the particular deficiency is often not questioned, for example if a person suffers only from a vitamin A deficiency or from a lack of iron, or indeed a number of other vital nutrients as well, may be tied to certain (economic) constraints which measures which are aimed at intervention are subject to. For the individuals concerned, it matters more to them if their situation will improve or not and less if their productivity will have a measurable impact on the economy. This issue is undoubtedly relevant to fighting poverty, yet it must not be misunderstood as being a long-term or sustainable approach to the problem. The Copenhagen Consensus also issued a statement declaring supplements to be a form of crisis management and not a long-term solution to hidden hunger.

The participants of the Copenhagen Consensus 2004, the most highly renowned economists, were determined to define criteria by which the economic power of poorer countries could be strengthened. Their proposals, which were amended in 2008 and 2012, can be interpreted as a combination of immediate and mid-term solutions.

The result is a catalog of measures (see Box 7.1), whereby half of the first ten of which are related to nutrition. Without a doubt, the criteria contained in the Doha Development Agenda, which were established by members of the WHO in Qatar

in 2001 and which have so far failed to be implemented due to resistance by industrialized nations, are designed to improve the position of developing countries in the global marketplace. Fulfilling these criteria is indeed a prerequisite for developing countries to make economic progress and comply with the demands of the Copenhagen Consensus.

Box 7.1 Copenhagen Consensus (2008)

1. Micronutrient supplements for children (vitamin A and zinc)
2. The Doha development agenda
3. Micronutrient fortification (iron and salt iodization)
4. Expanded immunization coverage for children (e.g., measles, tetanus)
5. Biofortification
6. Deworming and other nutrition programs at school
7. Lowering the price of schooling
8. Increase and improve girls' schooling
9. Community-based nutrition promotion
10. Provide support for women's reproductive role.

Why are vitamin A and zinc supplements at the top of the list? This is because vitamin A and zinc cannot be obtained from food in adequate amounts by those who desperately need these micronutrients quickly enough. Achieving this is a necessary precondition for eliminating hidden hunger worldwide. By means of vitamin A and zinc supplements, the under-four mortality rate can be dramatically reduced by between 20 and 40 %. It is also possible to achieve a 70 % reduction in blindness and an estimated 30 % reduction in diarrhea among children. At the same time, supplements can help to break the vicious circle described earlier and improve children's at-home care. Similarly, improving mothers' iron status can help to reduce maternal mortality.

The effectiveness of vitamin A supplements can be seen from the figures which were recently obtained as the result of a nationwide supplementation program in India. The is a significant correlation between the reduction in mortality among children between the ages of 5 months and 6 years and the pervasiveness of supplement programs (Semba et al. 2010).

Should one wish to consider to what extent intervention in the case of a vitamin A deficiency is economically 'sensible', the figures indicate that preventing death through vitamin A is relatively 'cheap' compared with preventing death by other means (see Table 7.1). Oral rehydration therapy (ORT), which alleviates diarrhea caused by a zinc deficiency, is the most expensive form of intervention.

The third point on the Copenhagen Consensus' agenda is micronutrient fortification of staple foods, such as iron and salt iodization in combination with vitamin A supplements. Such emergency treatment could be applied to target and fight hidden hunger. In the long run, however, food products which naturally contain essential micronutrients must be made available to the poor as the

Table 7.1 Costs of intervention (to prevent fatalities) (WHO 2008)

Vitamin A supplements	$23
TB treatment	$50
Malaria treatment	$145
Measles vaccination	$243
ORT for diarrhea (children)	$3,401

Copenhagen Consensus also demands. This can be achieved by means of genetically modified foods, such as golden rice, and particularly through biofortification, involving the cultivation of varieties which have a high concentration of specific micronutrients. In both cases, the first steps have been taken and appear thus far to be very promising. An example of this success is the significant improvement in the bioavailability of β-carotene in golden rice, which has essentially turned golden rice into a sound source of pro-vitamin A. In addition, there are also a number of varieties of rice on the market which have been cultivated to contain more β-carotene.

The Copenhagen Consensus 2012 Expert Panel took a strong stand on hidden hunger and believes that fighting malnourishment should be the top priority for policy-makers and philanthropists, as is evident in the summary given by the Nobel laureate economist Vernon L. Smith:

> One of the most compelling investments is to get nutrients to the world's undernourished. The benefits from doing so—in terms of increased health, schooling, and productivity—are tremendous. (Vernon Smith 2012).

From the 16 items which were found by the group to be worthy of investment in 2012, the first and most desirable one is bundled micronutrient interventions to fight hunger and improve education. By doing so, the group has distanced itself from supplements containing only vitamin A and zinc. This does not imply, however, that these should be discontinued in the future. Rather it is apparent that a combination involving other micronutrients is more effective. To provide a child with micronutrient supplements and food, treatment for worms and diarrhea, and special care programs would only cost $100.

Therapy During the 1,000-Day Window

It has been repeatedly mentioned that the so-called 1,000-day window is the critical period regarding the adverse effects of malnourishment (see Chap. 3). That is why special attention is paid to this time period when intervention therapy is administered. Naturally, the best therapy would be a balanced diet, which (still) fails for a variety of reasons mentioned at length in the previous chapters. During the first stage of life, the 2012 UNICEF report recommends the following measures and mentions the benefits of doing so:

- *Early breast feeding*. Breast feeding within the first hour after birth reduces the risk of neonatal mortality by 20 %. Worldwide, more than 40 % of all newborn infants are not breastfed during the first hour.

- *Exclusive breast-feeding*. Less than 40 % of all infants worldwide are breastfed for less than six months. A child who is not breast-fed has a 14-times greater risk of not surviving its first six months than one who is exclusively breast-fed.
- *Continued breast-feeding*. In developing countries, three out of four children are breast-fed during the first year, but only one out of two children is breast-fed during the second year.
- *Baby food*. Giving a child baby food during the first two years ensures that the child receives an adequate diet and, therefore, is most effective for preventing stunting and promoting the child's healthy development.
- *Micronutrients*. Vitamin A is recommended. One in three children does not receive vitamin A supplements twice a year.

With regard to the hunger carousel, improving a person's micronutrient status by means of micronutrient supplements as a form of crisis intervention at the outset of the 1,000-day window appears to be the best approach. The recommendation to breast feed is certainly sensible, yet it does not take into account two important aspects: There is insufficient scientific data regarding the concentration of micronutrients in breast milk during the baby's first six months, particularly when the mother is malnourished. This is especially critical when the intervals between births are short, as is common in Asia and Africa. In 25 % of cases in Europe, the concentration of vitamin A in mothers' breast milk was at a critically low level (Strobel et al. 2007). This can be the result of a multiple birth or short periods in between births. Expecting mothers who have a balanced diet and come from a higher social class in Germany were observed to have vitamin A concentrations in their blood which can be classified as being borderline deficient (<1.4 umol/l), whereas in the blood of the umbilical cord, the amount was clearly deficient (<0.7 umol/l) in 27 % of cases (Schulz et al. 2007). The retinol levels in the colostrum were found to be significantly lower among mothers who had given birth to twins than among women who had not undergone a multiple birth (2.35 and 4.15 umol/l respectively). A plausible explanation for the alarmingly low concentration of vitamin A in these women's breast milk is an unbalanced diet (e.g., lacking meat, particularly liver). The intake of pro-vitamin A by eating fruits and vegetables is apparently insufficient for maintaining an adequate vitamin A status. What the vitamin A status of children whose mothers are substantially malnourished is during their first six months can hardly imagined. The same applies to the other micronutrients. More specifically, young girls who are malnourished and could potentially become pregnant should receive micronutrient supplements. Such measures should always be coupled with education about nutrition. A number of studies were conducted which involved administering supplements of folic acid and iron, or a placebo to expectant mothers at various intervals. The results were then compared in meta-analyses. As heterogeneous as they were, the results do, however, open the door to new questions and approaches. A meta-analysis which comprised 17 studies tested whether the administering of bundled micronutrient supplements versus iron and folic acid to expectant mothers was beneficial (Haider et al. 2011). In both cases, a significant reduction in anemia during the third trimester was observed. This confirms the results of other studies,

which showed that anemia could be reduced among women with multimicronutrient supplements. However, there was still a not inconsequential number of women (25–35 %) whose anemia could not be cured. There are apparently other dietary factors which play a part in anemia and could not be compensated for by means of supplements.

The children of women in the multimicronutrient group did however have a much lower tendency to be underweight than those of women in the folic acid and iron group. Especially important with regard to this result is the fact that this primarily applied to women whose BMI was >22, in other words, whose diets seemed to be adequate. And yet, it should be clear from the previous chapters that this fact does not necessarily mean that the micronutrient status of the mothers was sufficient. This could explain the effect of the bundled micronutrient supplements. An observation of the children throughout the entire 1,000-day window was only carried out in one study (Huy and Le Hop 2009). In the study, pregnant women in two different districts in Vietnam were given either multimicronutrient supplements plus antenatal classes (MMN+A), or multimicronutrient supplements (MMN) or folic acid and iron (FI) without antenatal classes. Dietary counseling was provided to all three groups. In the two groups which had been given multimicronutrient supplements, the birth weight of the children was significantly higher (MMN 166 g; MMN + A 105 g) than in the folic acid and iron group. The children in the MMN groups were also taller at the end of their second year (MMN 82.66 cm; MMN + A 83.61 cm; FI 81.64 cm). The percentage of children with stunting was also 10 % lower in both MMN than in the FI group (20 versus 30 %). The number of children with anemia was only half as high in the MMN groups (43) than in the FI group (95).

This study illustrates two important aspects. Providing MMN to expectant mothers results in a better micronutrient status for their children and, thus, a better development, although not in every case, as the stunting figures show. This fact, together with the high anemia rate, indicates that the children's diets were inadequate during their first two years. Bundled micronutrient supplements are, therefore, only a partial solution. Hidden hunger must be treated before conception so that both mother and child are well-supplied with micronutrients during pregnancy and lactation. The fact that breastfeeding is beneficial to babies' diets, also as a dietary supplement, even after their first six months, requires no further explanation.

Box 7.2 Long-term Studies into Intervention: INCAP and CSRP

Both of these studies illustrate the importance of ensuring that children are adequately nourished from the very beginning in order to ensure that they will experience a normal development beyond the 1,000-day window. They have been going on for many years and have provided a great deal of insight into the causes and effects of malnutrition, which, in turn, has been useful in developing new intervention techniques. Since data is continuously being

collected from the children taking part (and has already appeared in more than 30 publications), many conclusions can by drawn concerning the impact of nutrition on a person's development. The Institute of Nutrition of Central America and Panama, or INCAP, which began already in 1949 (Scrimshaw 2010), observed during long-term studies involving supplements that the major factor restricting growth is the amount of protein consumed during childhood. The Collaborative Research Support Program, CRSP, tested without the use of supplements over the period of a year if insufficient energy intake is the primary limiting factor regarding growth and development. The CRSP applied a classical, quantity-based approach, which primarily assessed foodstuffs based upon their calorie content. However, the intake of micronutrients was also captured in the findings.

The INCAP study, which was conducted mainly from 1969 to 1977 with a series of follow-up studies from 1988 to 2007, examined the impact of a marginal case of malnourishment on development, both during childhood and later in adulthood. The scientist who initiated the study, Moises Béhar, wanted to test the impact of malnourishment on children's physical development. In order to also be able to observe the cognitive impact, Josquin Cravioto, a renowned expert in this field, was added to the team.

Together, the CRSP study, which involved children in Kenya, Egypt, and Mexico, and the INCAP study are two of the most comprehensive studies to have dealt with these issues.

So what answers did the study deliver concerning how stunting among children could be explained and how this affects further development, including cognitive ability? Neither the protein supplements administered in the INCAP study, nor the calories obtained in the CRSP study were able to prevent children from being stunted. Thus, the authors of the INCAP study believe that neither an increase in protein nor a relatively higher consumption of calories can substantially reduce the risk of stunting. In the CRSP study, 65 % of calories consumed by the children were derived, on average, from corn, wheat and rice. The INCAP study did not capture any such data. The majority of children who participated in the CRSP study did not obtain adequate amounts of micronutrients. In all three countries of the CRSP study, between 38 and 45 % of the children suffered from iron deficiency anemia. INCAP also estimates a similar figure, due to the high percentage of corn in the children's daily diets, although this issue was not specifically examined in the study. Other micronutrients were found to be at critical levels (Mexico: vitamin B12, 44 %; vitamin E, 85 %; zinc, 57 %; Egypt: vitamin B2, 52 %; vitamin C, 63 %; vitamin A, 20 %; vitamin E, 92 %; iron, 88 %; zinc, 25 %; Kenya: vitamin B2, 20 %; vitamin E, 22 %; iron, 65 %; zinc, 10 %) The amount of animal-based products, such as meat, eggs, and dairy products, which are sources of the above-mentioned vitamins, made up between 11 and 15 % of people's diets in all three countries. It is, therefore, not surprising that the children's micronutrient intake was

insufficient. Children's growth rates in Kenya and Mexico correlated directly with the amount of animal-derived foods consumed. Lindsay Allen (1995), one of the directors of the CRSP study, came to the conclusion that stunting and developmental handicaps suffered by children in Guatemala and in the three countries in the study are caused to a greater extent by a lack of micronutrients than by a lack of energy or protein. More precisely, she believes that it is the key micronutrients in hidden hunger—iron, zinc, and vitamin A—which have a significant impact on physical development.

INCAP and CRSP have reconfirmed that growth during a baby's first 1,000 days is decisive and that a child's height at the end of his or her second year has a direct impact on his or her height as an adult. As previously described, this fact has implications for a society's labor force and future development.

Improving the Quality of Food (Nutritiousness)

Creating new sources of micronutrients can only be, at best, a mid-term solution since only very few micronutrients can be replaced by others. On a long-term basis, people's nutritional requirements can only be satisfied by dietary means, in other words with food, whose components can, by all means, be fortified with vitamins, minerals, etc.

The most sustainable way to improve the nutritiousness of food is to raise the diet diversity score by increasing the assortment of foodstuffs available. To accomplish this requires not only the necessary financial means, but also basic dietary knowledge. There is no miracle cure. Each food product must be put to the test to examine how it satisfies a person's dietary requirements. Based upon the results, recommendations can then be made for combining various foods to achieve the nutritional target.

Recognizing Malnutrition: Case Study Indonesia

According to a survey which was conducted among 68,000 households in Indonesia in 2008, the average person consumes 102 kg of rice per year. Rice thus accounts for 60 % of the daily caloric intake of 2,450 kcal. On the basis of linear programming, the amount of micronutrients was able to be determined (Jati et al. 2012). The typical diet of children between the ages of two and five is illustrated in Table 7.2. The table does not account for differences in social class.

Based on these data, the foods necessary to provide sufficient amounts of vitamin A, zinc, and iron can be ascertained. At the same time, it can be determined how much of these micronutrients are necessary to meet the recommended intake (see Fig. 7.2). Using special algorithms, the data which has been collected from nationwide dietary studies can be used to assess the amount of micronutrients consumed from each of the food groups which contain those particular

Table 7.2 Dietary breakdown for children ages 2–5 (Jati et al. 2012)

Food	g/day	kcal
Rice	225	790
Vegetables/beans	44	33
Meat/chicken	40	104
Fish	24	27
Eggs	60	82
Fruits	40	34
Total		1,070

micronutrients. Dietary models containing locally produced food items can be compiled and thus contribute to improving the micronutrient status of the population.

On the basis of such analyses, it is not only possible to determine the degree of micronutrient deficiency within a given population, but it is also possible to present recommendations for targeting and removing such deficiencies. Much has already been accomplished, for instance, by substituting one portion of white rice

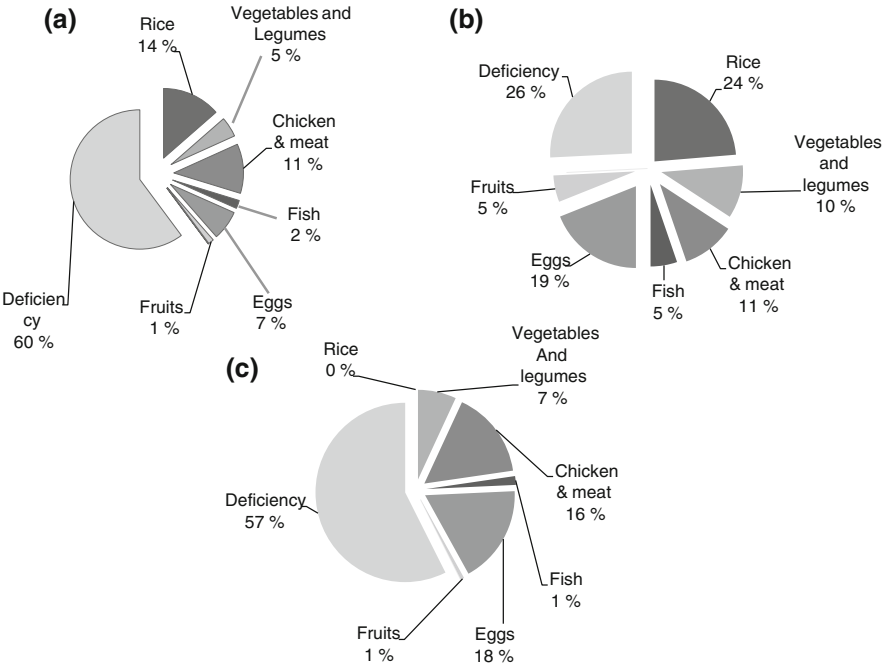

Fig. 7.2 Average diet of children and its content of iron (**a**), zinc (**b**) and vitamin A (**c**) in % of RNI. The depiction of the individual food groups allows nutritional gaps discovered during treatment to be filled

with sweet potatoes or more nutritious, colored varieties. Spinach and fruit, as well as palm oil can also make valuable contributions to diet optimization. The great advantage of such analyses and recommendations is the fact that not only more traditional foods and those which are only available in certain regions are taken into account, but also those which are affordable.

UNICEF and the World Bank, in cooperation with important organizations in the field of food security, including USAID, GAIN, the Micronutrient Forum, and the Flour Fortification Institute, published a World Report which states that certain micronutrient supplements should be considered as a means of achieving the MDGs (SUN 2010). Table 7.3 shows the different micronutrients and their role in the MDGs.

Systematic supplementation in countries affected by hidden hunger can lead to an accelerated strive toward reaching the MDGs. The question is whether this approach will enable mothers to get off the hunger carousel and secure a better prospect for themselves and their children. As mentioned previously, the occurrence or rather the diagnosis of an isolated micronutrient deficit is an indicator of a

Table 7.3 Requirements for food security (SUN 2010)

Millennium development goal	Role of micronutrients
MDG 1: The eradication of extreme poverty and hunger	Iron can eliminate anemia, and increase productivity and income Salt iodization reduces the risk of iodine deficiency, increases the prospects of receiving an education, pursuing a career and earning a decent income Zinc reduces the risk of stunting and its adverse effects
MDG 2: Primary school education for all	Salt iodization improves cognitive development Iron improves cognitive development among children Zinc reduces illness and therefore absenteeism at school Vitamin A prevents blindness Folic acid prevents developmental disorders
MDG 3: Gender equality/ strengthening the role of women	Iron increases productivity among women The treatment of malnutrition among women has a greater effect than among men: an improved micronutrient status can help to neutralize inequality with regard to access to adequate and nutritious food
MDG 4: A reduction in the infant mortality rate	Vitamin A significantly increases a child's chances of survival Zinc reduces cases of diarrhea, one of the main causes of child mortality Salt iodization reduces iodine deficiency and thus the occurrence of birth complications, stillbirths, and neonatal deaths
MDG 5: An improvement in mothers' state of health	Iron increases a mother's chances of survival Salt iodization minimizes the effects of iodine deficiency, including miscarriage, stillbirth and congenital mental handicaps and deafness

generally inadequate diet. Therefore, further deficits, which receive even less attention as a result of the focus given to the diagnosed deficiency, still lurk in the background, resulting in health complications and reduced labor capacity.

The risk involved in the supplementing of individual vitamins and minerals is that other contributing factors to hidden hunger, i.e., other micronutrient deficiencies, may be overlooked. For that reason, more bundled micronutrient supplements are being called for (Semba et al. 2011). These can take the form of a powder to fortify one's daily diet or to complement so-called ready-to-use therapeutic foods (RUTFs), or energy-dense, micronutrient-enriched pastes which can be produced locally. Doing so requires more cooperation and diligence on the part of the victims as opposed to programs whereby, for instance, high concentrations of vitamin A are administered twice a year.

The governments of Japan and Canada in cooperation with the World Bank and USAID started an initiative in 2010 to promote scientifically proven supplementation programs. Among these were:

- periodic vitamin A supplements,
- zinc supplements in cases of diarrhea,
- micronutrient powder to fortify meals,
- iron-folic acid supplements for expectant mothers,
- salt or oil iodization,
- iron fortification of staple foods.

Those who initiated these recommendations were well aware of the fact that they do not solve the problem completely and therefore put forth proposals for further action.

Mid-Term Solutions

Sustainable, mid-term solutions are those which more or less compensate for micronutrient deficiencies. These include RUTFs, RUSFs (ready-to-use supplementary foods), micronutrient supplements, such as sprinkles, or enriched foodstuffs by means of cultivation or genetic modification, e.g., corn, rice, sweet potatoes, or oil.

Fortified Food Products

Most products which are enriched with micronutrients are staple foods, such as flour, sugar, salt, or oil, in order to reach as many people as possible. The most well-known example is iodized salt, which is the standard salt in many regions and is even required by law in some countries. In the United States and Canada, as well as a few other nations, folic acid is added to flour and milk is enriched with vitamin D.

Nutrient enrichment of food of which roughly the same amount is consumed daily is a sensible measure. One important condition is that neither the taste, nor the appearance, nor the price is affected in the process. The latter is often the most uncertain factor, the reason why many sensible projects, such as the enrichment of oil with vitamin A, have failed. For that reason, it must be considered if an alternative exists which naturally contains the respective micronutrient, for instance using palm oil, which contains vitamin A, instead of vegetable oil.

Since deficits occur at varying degrees in different countries, different foods are enriched or perhaps none are enriched at all in the respective countries. The most widespread form of nutrient fortification is salt iodization. In light of the fact that hidden hunger is a problem in developing countries, test fortification schemes have been conducted in individual regions, including adding vitamin A to vegetable oil and sugar, iron to fruit juice, rice and sugar, and zinc to fruit juice, rice, and cheese. In industrialized countries, especially the USA and Canada, milk and dairy products are enriched with vitamin D and folic acid is added to flour. The latter has contributed to a significant reduction (50–80 %, depending on the region) in so-called neural tube defects, involving an opening in the spinal cord or brain, among newborn infants (Lindzon and O′Connor 2007). In the case of iodine, vitamin D, and folic acid, we are dealing with worldwide deficits. The same applies to iron, however since this deficiency usually affects females, a general enrichment of food with iron has not been recommended. There are a number of other nutrient-enriched foods which are available in certain regions, such as vitamin A-enriched mustard in India. However, such products are not affordable for the poorer members of society, with the exception of iodized salt, or many people are not aware that such fortified products are available. On the other hand, there are indeed regions which have reported success in fighting hidden hunger by means of nutrient enrichment. A ready-made mixture of iron and vitamin A was added to the portion of rice eaten by children ages 36–66 months over a period of 24 weeks. In comparison to the group of children which had received rice without any nutrient additives, a significant reduction in anemia, yet not in vitamin A deficiency, was observed (Varma et al. 2007). The enrichment of cooking oil with vitamin A over a period of 18 months led to a clear reduction in the prevalence of vitamin A deficiency (<10 %), while the standard practice of administering a vitamin A capsule showed no significant effect. The rate of occurrence remained at 30 % (Mason et al. 2011). There is a well-known problem inherent in the latter practice. The explanation could be poor bioavailability since fat is lacking, or perhaps intestinal parasites and diarrhea prevent the vitamin from being absorbed. Enriching foods, on the other hand, involves a continuous administering of vitamin A in small doses, yet dissolved in oil.

A study involving cornmeal showed that when it was enriched with vitamin A, B1, B2, and B6, a substantial improvement in vitamin A status was experienced by 21 mildly malnourished children, in comparison to 23 mildly malnourished children who consumed normal cornmeal used for making porridge by adding milk or water (Nesamvuni et al. 2005). Children in both groups experienced the same

increase in height and weight over the entire time period of the study. This was especially the case with severely malnourished children. The study worked with very small collectives and also did not account for illnesses which require more vitamin A, which means that the results are not particularly reliable. The authors do point out, however, another issue regarding enriched foodstuffs. Many of the children between the ages of 12–18 months were breastfed. Thus, the amount of cornmeal porridge which they ate varied greatly. As the frequency of breastfeeding decreased, the children were given more cornmeal and other low-vitamin A foods. When the porridge is prepared by means of cooking or simmering for up to 30 min, half of the vitamin A which was added (1,700 IU in 150 g) is destroyed.

Nevertheless, there are a number of foodstuffs, in addition to salt and flour, which have been tested and found to be ideal candidates for nutrient enrichment (see Table 7.4).

Nutrient-enriched oil promises to be a booming business. Cargill, a major American food manufacturer, has begun to enrich oil made from soybeans, sunflowers, cotton, mustard, and peanuts with micronutrients, especially vitamin A. It is hardly available for the poorer members of society, however, because it is relatively expensive. What is more, oils which are refined are more expensive and lose important substances, such as fat-soluble vitamins in the process. Nonrefined palm oil retains its pro-vitamin A and vitamin C and is an important source of vitamin A and E for the poor, provided the price remains stable. When foods are biofortified, with the noble purpose of reducing micronutrient deficits, it must nonetheless be asked which corporate interests are behind the initiative, which traditional foodstuffs are being sidelined ,and what sustainable contribution is really being made to food security.

Enriched foods can be a valuable solution if they are available to everyone, including the poor, and particularly to children aged 6 months and older. The problem lies in overseeing the distribution so that it is uniform and widespread. In addition, price stability can hardly be guaranteed. The persons who own the mills where food is enriched also want to survive and are dependent upon the price of raw materials.

Table 7.4 Fortification of food with micronutrients

Food	Enrichment
Rice	Vitamin A, E, B1, B12, niacin, folic acid, zinc, iron, selenium
Oil	Vitamin A (perhaps vitamin D and E)
Sugar	Vitamin A, iron, zinc
Fish sauce	Iron (Vietnam)
Soy sauce	Iron (China)

Ready-to-Use Therapeutic/Supplementary Food

RUSFs were designed to ensure that children suffering from chronic malnourishment received enough micronutrients and protein. Mixtures of special micronutrient supplements called sprinkles are then added to these. Sprinkles are also added to food in the form of small globules and provide a multitude of vitamins and minerals.

It was observed in a comprehensive meta-analysis that this form of intervention helps to reduce the prevalence of anemia among children under the age of two by up to 50 % (De Regil et al. 2011). As mentioned earlier, anemia is not only symptomatic of an iron deficiency, but it is also an indicator of a more or less extreme case of malnutrition.

RUSFs have many important benefits, which make them suitable even under adverse conditions. They need not be kept cool and kept even in high temperatures. They also need not be mixed with water and this reduces the risk of bacterial contamination. Hence, they are effective on a mid-term basis for preventing severe malnutrition.

RUTFs are also specially designed to treat acute and severe malnutrition among children. An intervention study which was conducted in 12 villages in Niger clearly illustrates the previously described causes of malnutrition and the difficulties involved in treating the ensuing health complications (Isanaka et al. 2009). The control group contained six of the villages. In the other six, a three-month supplementation program using RUTFs was carried out, as well as follow-ups which monitored weight and height. 11 % of the children were found to be severely malnourished, whereby the figures reach a peak around the time just before the millet harvests in August, when supplies are just about empty.

The supplements lead to a rapid growth in weight versus height (WHZ) in comparison to the control group. At the beginning of the study, the degree of wasting in the control group increased significantly (i.e., a higher z-score), whereas in the test group there was little change and less severity if a change did in fact occur. This illustrates the success of intervention in cases of mild malnutrition (z-score < -1.5). At the same time, however, there was no apparent difference in the morbidity rate for malaria, diarrhea, and respiratory infections. In the test group, seven children died, whereas 18 children died in the control group.

A look at the figures for growth as an indicator for stunting shows the limits of supplementation. All children were clearly stunted (z-score > -2.0) at the outset of the study. The children's growth in the test group was only marginally improved through dietary intervention. This demonstrates the fact that this form of intervention is too late (i.e., after their second year) to be of any benefit to many children and is also ineffective in preventing stunting related to chronic malnutrition during early development. The authors of the study (De Regil et al. 2011) come to the conclusion that this form of intervention can lead children who suffer from mild malnutrition to gain weight, yet it cannot shield them from the causes nor prevent them from suffering the later effects of chronic malnutrition.

In a follow-up study (Isanaka et al. 2010), the authors assessed the success of Plumpy Nut, an enriched peanut butter paste, as an RUTF versus an RUSF, which is not intended to be an emergency measure, but rather a supplement to one's daily diet. In comparison to RUTF, RUSF only contains half the amount of calories, yet it has a higher concentration of micronutrients per 500 kcal. RUSF are also not intended to replace meals, but rather to fortify them. RUFS was administered over a six-month period, clearly longer than that of RUTF (four months). This may explain why in the RUSF group the stunting rate among children was 19 % lower than in the RUTF group and why the mortality rate in the RUSF group (10 from 747 children) was also clearly lower than in the RUTF group (25 from 856 children).

Conclusion

RUTF and RUSF are important forms of treatment, both as an emergency measure in cases of severe malnutrition, as well as chronic undernourishment. As a form of treatment for chronic undernourishment, they should be a mid-term solution administered in combination with other dietary improvement measures. It is especially important that mothers receive dietary counseling in addition to efforts to improve the availability of different foods. It has been proven in our own studies aimed at improving nutrition that this approach, which goes above and beyond the sole use of RUFS, is both effective and sustainable (Purwestry et al. 2012). The goal of dietary intervention must be the eventual replacement of RUFS with normal, nutritionally adequate food. To achieve this requires knowledge of nutrition, which is often absent among women and must therefore be communicated.

Ways of Getting Off the Hunger Carousel

If the aim is to enable those who are currently on board the hunger carousel to get off once and for all, then this can only be achieved when an entire generation is not hampered by malnutrition and when other supportive measures are undertaken (health care, hygiene, education, minimum wage) in order to lay the foundation for a healthy and productive society. Since such relief measures are often undertaken piecemeal, success is usually short-lived. Even if the maternal and child mortality rates are able to be reduced, a large assembly of vulnerable individuals still remains on board the hunger carousel.

Stunting as a sign of early childhood chronic malnutrition and as a basis for a person's entire development must be attacked at the roots, i.e., during the 1,000-day window.

There are essentially two basic approaches for enabling individuals to leave the hunger carousel forever:

- preventing chronic malnutrition among mothers and their children during the 1,000-day window,
- dietary intervention or the continuation of preventative measures beyond the 1,000-day window.

Prevention

Save the Children compiled a list of measures which should help to lower not only child mortality, but also the rate of stunting in particular.

- iron and folic acid supplements for mothers
- consistent breastfeeding during the first six months and beyond as an additional source of nutrition after weaning

Breastfeeding is without doubt one of the foremost methods for reducing child mortality. If all children were to be breastfed for their first 6 months, the number of children who die each year in developing countries would decrease by 1 million. If newborns were provided with other necessities, such as additional breastfeeding after the first six months, vitamin A and zinc supplements, multimicronutrient powder, as well as clean water and proper hygiene, the lives of a further 1.2 million children could be spared (Save the Children Nutrition 2012).

The assumption that breast milk can supply a baby with all of the necessary micronutrients may be true if the mother herself is adequately nourished, but it is more than doubtful if this is not the case. To date, there have been nearly no studies to compare the micronutrient content of breast milk from well nourished and malnourished mothers. The only isolated studies which have so far provided data involve vitamin A, E, pro-vitamin A, B12, zinc, copper, and iron.

In a study involving 102 nursing mothers from the United States, it was thus revealed that the concentration of zinc in breast milk decreases during lactation from 500 μg/100 g at the beginning to 290 μg/100 g when the breast milk is mature (Feeley et al. 1983). Iron and copper concentrations, however, only decrease during lactation by nearly 20 %. Another study involving 59 women from Vietnam, whose daily iron and zinc intake—primarily from plant-based sources—was 10 mg each and hence under the recommended amount of 30 and 15 mg respectively, revealed that 39 % of these women were anemic, while 55 % had a low plasma zinc level, and that the concentrations of these elements in their breast milk were clearly below those of healthy American mothers six to twelve months after birth. The iron concentrations among the Vietnamese women were 43 μg/100 g versus 76 μg/100 g among the American women, whereas zinc concentrations were 56 μg/100 g versus 290 μg/100 g (Nakamori et al. 2009).

With regard to vitamin A in particular, a number of intervention studies have been conducted to test whether or not supplementation immediately after delivery results in a rise in the amount of vitamin A in the breast milk and the curing of the mother's vitamin A deficiency. In a study involving Nepalese women with varying degrees of vitamin A deficiency, it was observed that both one-off vitamin A

supplements (60,000 RE) and daily pro-vitamin A supplements (7.8 mg/day for the first nine months after birth) did not yield any positive results. The concentration of vitamin A in the breast milk did in fact rise significantly (three months after birth) in comparison to the control group, yet it had dropped again to the same level as that of the control group by month six. In contrast, the pro-vitamin A group experienced no change in vitamin A concentrations in the breast milk during the first six months, yet a sharp rise in vitamin A concentrations occurred after nine months compared with the control group (Rice et al. 1999). Since the women had very little vitamin A stored in the liver, there was apparently not enough of the vitamin to be distributed to the breast milk. The facts of the case also illustrate that since the vitamin A values of the breast milk rapidly declined, the initial supplements were already 'exhausted'.

Ninty expectant mothers from Tanzania were put into groups of three and were given either pro-vitamin A-rich palm oil or sunflower oil (which contains little pro-vitamin A) or green leafy vegetables beginning in the third trimester. Approximately 60 % of the women had vitamin A values which, according to the WHO, are indicative of a vitamin A deficiency. The results indicate that a significant increase in the pro-vitamin A concentration in the mother's breast milk could be achieved by consuming red palm oil. The effect on the vitamin A concentration, on the other hand, was minimal. The drop in the vitamin A concentration in the breast milk which occurred in the group which had not received red palm oil did not occur in the group which had been given supplements (Lietz et al. 2001). The issues involved in providing mothers and their children with adequate amounts of vitamins throughout the 1,000-day window are discussed on page nn.

If a mother's diet is inadequate during pregnancy or if she becomes pregnant in short intervals, the risk is high that the baby will develop a micronutrient deficiency during the time until it is weaned if it is fed exclusively breast milk. If the mother is suspected to suffer from malnutrition, then the better choice would be for her to take bundled micronutrient supplements instead of single vitamin A and iron supplements, naturally under the condition that an adequate diet for her is not feasible.

Intervention

Early prevention should ensure a newborn's survival and guarantee that the child enjoys an adequate diet to enable it to experience normal development. Chronic malnutrition must be prevented with sustainable measures. In addition to the criteria for food security, other factors which promote malnutrition must also be taken into account.

So-called multisector design projects, which comprise various subprojects to capture data concerning childhood development, provide valuable input as to how intervention can be optimized. These include:

- Food security within the household
  - dietary adequacy month by month;
  - food processing;
  - number of meals;
  - diet diversity score.
- Childcare
  - breastfeeding;
  - medical treatment in case of fever or coughing;
  - vitamin A supplements.
- Monitoring for infectious diseases
  - use of insecticide-impregnated mosquito nets (to prevent malaria);
  - availability of clean water;
  - access to clean sanitary facilities;
  - monitoring for diarrhea;
  - measles vaccination.

These measures were applied in 8,652 households (70 % of which had an income of <$1/day; average size 5.9 persons; 95 % rural; 16 % with a school diploma) in nine African countries over a period of 3 years. In the end, data from 2,700 households was able to be evaluated. Improvements were observed in all three sectors, meaning that substantial improvements were achieved regarding food security and diet diversity. Regarding childcare, improvements in all three areas were observed, as well. Yet, improvements in the monitoring of infectious diseases were not observed to the same degree as in the other sectors. The unchanged prevalence of diarrhea is an indicator of the still relatively poor hygiene. The height of 1,096 children was measured at the end of year three. After income and demographic variables were factored in, the prevalence of stunting was 43 % lower than the initial values. By applying the above-mentioned measures, stunting was able to be significantly reduced and this underlines the value of multisector projects, and also illustrates how comprehensive this form of intervention must be. Despite the success of such projects, however, the prevalence of stunting continues to increase in the countries where the studies took place (see Fig. 7.3).

The yearly progression of the stunting rate can be viewed as a seismograph with regard to food security. The rate among African children has been steadily rising since 1985 and currently stands at 40 %. In order to ensure that children undergo normal physical and mental development, widespread intervention programs must be initiated immediately.

In nine African countries, a multisectoral design program was implemented over a period of 3 years (Remans et al. 2011). The program involved a total of 1,100 children from 2,600 households. The above-mentioned measures were carried out with the result that the stunting rate had diminished by 43 % after 3 years. These children now have a much better chance of developing normally even if food should become scare once again.

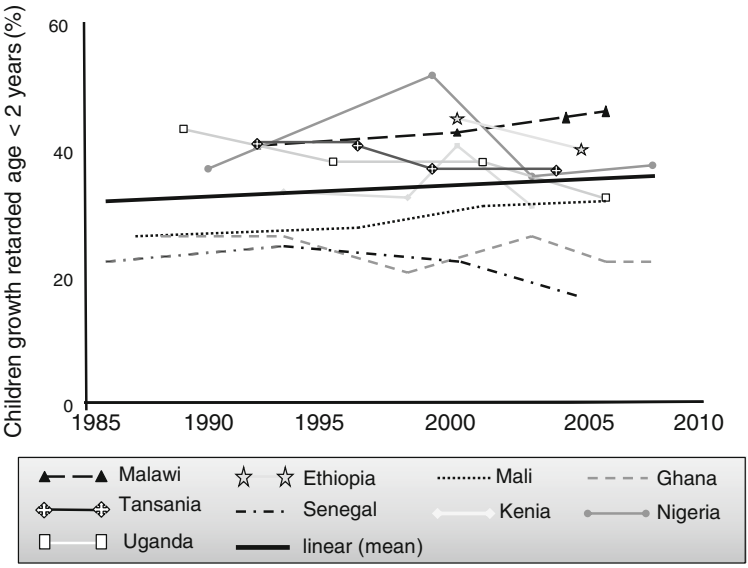

Fig. 7.3 Stunting rate (in %) among children under the age of two in different African countries from 1985 to 2008. The graph shows a clear upward trend (Remans et al. 2011)

Modern Biotechnology

The techniques which have been made possible by modern agro-biotechnology, as well as those which are still in the pipeline, can help to combat hidden hunger, provided they do not rest on the traditional quantity-based view of nutrition. Efforts to produce seeds which require less water and can withstand heat better are without a doubt essential contributions to improving agricultural production, especially since they attempt to work around the climatic changes which are currently taking place, and have already led to improvements in areas affected by water scarcity. However, it still remains to be seen how rising income levels among farmers will ultimately play a part in combatting hidden hunger.

Genetically Modified Food

Rice is one of the most heavily consumed staple foods. In addition to iron and zinc, it also contains vitamin E, folic acid, and pro-vitamin A, albeit in a biologically suboptimal distribution. The concentration of these vitamins in the grain is very low, whereas they are present in much larger quantities in the green leaves of the plant. Thus,they help to shield the plant from oxygen and the damaging effects of UV rays from the sun (which both produce free radicals). However, in the

endosperm, the edible grain of the plant, pro-vitamin A is missing entirely since it can be neither produced nor stored there. Apparently, it is not needed by the grain. By means of genetic modification, the expression of two enzymes, phytoene synthase and a carotene desaturase, is induced, producing lycopene, the red pigment found in tomatoes. Golden rice, however, is yellow due to the fact that it does, in fact, store pro-vitamin A. The reason for this is that the metabolic process for creating pro-vitamin A in the rice plant does not only take place in the leaves (Sachub et al. 2005). The expression of the available enzymes is too low under natural conditions in order to create sufficient amounts of pro-vitamin A, since it is apparently not required by the plant.

The situation is quite a different one regarding carrots, which are well-known as being one of the best sources of pro-vitamin A. Pro-vitamin A is hardly necessary as an antioxidant in this case since carrots grow under the soil and are hardly in contact with UV light. Nevertheless, a mutation which took place in the sixteenth century (either in Ireland or the Netherlands) led to the production of β-carotene. So what happens to the pro-vitamin, which the carrot apparently does not need? It is packed up into small 'garbage bags' made of cellulose. Since the human digestive system cannot open these bags, it can hardly absorb any of the pro-vitamin A from raw carrots. Golden rice is an important and sustainable source of vitamin A, particularly in poor countries. New varieties have significantly higher concentrations than the first-generation varieties and can play a vital role in reducing malnutrition, especially because they possess a high level of bioavailability. In addition, the production of vitamin A from pro-vitamin A is more effective than when pro-vitamin A is taken from other sources (Tang et al. 2009).

It is, however, not the only food crop which has been genetically modified nor should it be the only one in order to provide essential micronutrients to more people (Bouis et al. 2003). Attempts are currently being undertaken to modify the essential fat content and the concentration of vital amino acids, which are either lacking or are contained in only small amounts in oilseed, such as methionine.

One of the most controversial questions in this context is how the poor will benefit from this development. This issue touches upon the cultivation and dietary implications for women and children, as well as the fact that the natural genetic code is being altered. If one weighs the cost of modifying the genetic code against the benefits, then Qaim and his colleagues (Stein et al. 2006) estimate that in India alone, where 71,500 children die annually due to vitamin A deficiency, between 5,500 (conservative estimate) and 39,700 children (optimistic estimate) can be saved with second-generation golden rice (Stein et al. 2006). With regard to improving food security, in particular for the poor, this can certainly be achieved for vitamin A provided that the costs of procuring and cultivating golden rice crops do not vary from those of the traditional varieties. It is of no benefit to small-scale farmers whatsoever if the diet diversity of their families is restricted due to eating more expensive rice. Hence, the vitamin A deficiency would be effectively fought at the expense of preserving other deficiencies.

In 2008, GM cereals were grown on 300 million acres in 25 countries, 15 of which are developing countries (Fedoroff et al. 2010). When it comes to hidden

hunger, genetic modification must also be discussed as a viable option. Syngenta, a British-based seed manufacturer which owns the rights to golden rice, wants to distribute the rice to subsistence farmers in Africa at no additional cost, yet it intends to maintain ownership of all commercial rights to the plant. The International Rice Research Institute wants to introduce golden rice to Asia by the end of 2012.

As long as there are no real alternative sources of vitamin A available, golden rice and other similar agro-biotechnological innovations are big steps toward eliminating micronutrient deficiencies, such as vitamin A. If the price of red palm oil were to be kept more stable, and if the oil were available to more of the population, then it would be a much better and cheaper source. However, as long as we are prepared to burn this nutritionally valuable oil as fuel, we must be prepared to fall back on golden rice and to discuss the value of other genetically modified foods.

Considering the fact that golden rice took more than 15 years to come to market, GM foods are indeed an option for combatting hidden hunger, yet they are hardly a once-and-for-all solution to the problem.

Unfortunately, the object of GM is first and foremost to increase the quantity, not the quality of crops. The cultivation of insect and herbicide resistant varieties is at the forefront of research. Although GM varieties of cereals can close the gap left by crops which require a lot of water or are destroyed by blight, this ultimately solves only part of the problem of chronic malnutrition.

Biofortification

The aim of biofortification is to increase the micronutrient density of staple foods through cultivation in order to improve nutrition. By carefully selecting varieties containing a higher micronutrient density, it should be possible to raise more nutrient-rich crops in poorer regions, as well. There are varieties of rice, for instance, which contain particularly high concentrations of bioavailable iron (Haas et al. 2005). The micronutrients which have been targeted to be enhanced in staple foods by means of biofortification are pro-vitamin A in cassava, corn and sweet potatoes, and iron and zinc in beans, rice and wheat (see Table 7.5).

When looking at Table 7.5, to which certainly other foods can be added in the meanwhile or are in the pipeline at large corporate laboratories, it is necessary to differentiate between two important aspects: modifications which are designed for rich nations and to increase prevention and longevity and those which are specifically designed to combat hidden hunger. The former involves modifying the fat content to create healthy fatty acids (e.g., oleic acid, omega-3 fatty acids, gamma-linolenic acid), which promise to protect against vascular diseases and dementia, as well as to promote brain development during childhood. To promise the people living in poor countries that they will protect their health by consuming healthier types of oil, which have no additional health value aside from the fatty acids, is not

Table 7.5 Examples of enriched food products (Johns and Eyzaguirre 2006)

Food	Nutrient	Method
Corn	Lysine, tryptophan pro-vitamin A phytate reduction	Cultivation
Potatoes	Protein methionine	GMO
Rice	Protein pro-vitamin A iron	GMO GMO cultivation/GMO
Soybeans	Omega-3 fatty acids methionine vitamin E	GMO GMO GMO
Sunflowers	Oleic acid docosapentaenoic acid	Cultivation/GMO GMO
Sweet potatoes	Pro-vitamin A	Cultivation
Tomatoes	Gamma-linolenic acid folic acid lycopene pro-vitamin A flavonoids	GMO

a lucrative proposition since most people living in these countries can hardly afford to buy them. Once again we have the situation in which a food product is manufactured in a country with widespread nutritional problems for the export market. The biofortification of vitamin A, iron or zinc, on the other hand, is especially beneficial to the poor rural population, yet it largely depends upon the price. In 100 g of sweet potatoes, there are approximately 12–14 g of pro-vitamin A, in addition to minimal amounts of zinc and iron. 100 g of sweet potatoes are thus enough to meet the recommended daily allowance of vitamin A, whereby less than 100 g would suffice to eliminate a deficit.

According to Howard Bouis, the founder of the HarvestPlus program which focuses on biofortification, $80 million would be enough to provide vitamin A supplements to 80 million Asian children over a 2-year period, or to supply a third of the population of South Asia with iron over 2 years, as well. The same amount of money would also be enough to enrich staple foods with vital micronutrients by means of biofortification for the entire world population (Bouis et al. 2003).

The loss of diet diversity due to poverty and ignorance is causing nutritional deficits, which lead to health disorders in both rich and poor countries alike. While primarily mothers and their children are affected by malnutrition and its adverse health effects in poor countries, the one-sided diets of many people living in rich countries is causing a worldwide rise in obesity, diabetes, and heart disease. Nutritionally enhanced food products (e.g., iodine, iron, folic acid, and vitamin D) do help to reduce dietary gaps in industrialized nations. However, they cannot

replace a healthy diet which provides all of the essential micronutrients in adequate amounts. The same applies to poor countries, even if the elimination of the well known and very serious deficiencies by means of enhanced food is certainly more effective.

Conclusion

The concept of fortifying food products, regardless of the technique, focuses first of all on benefitting individuals whose diets are made up primarily of staple foods (i.e., cereals). This is certainly the correct approach, however it does not account for the fact that a number of other micronutrients are often lacking in addition to those missing nutrients which are added to enhanced food crops and which account for numerous disorders, such as anemia, night blindness, and diarrhea. However, it is undoubtedly an important approach for lowering the child and maternal mortality rates and can perhaps also help to increase productivity. Despite these efforts, it remains uncertain whether or not the passengers will remain on board the hunger carousel. If the assessment of a deficiency is wholly dependent on the appearance of clinical symptoms, then the treatment of such symptoms must not overshadow other underlying causes of illnesses and developmental disorders. To do so would be to merely shift hidden hunger to another group of micronutrients.

In addition, focusing on fortified foodstuffs as a solution to the problem can result in other vital factors, such as the importance of a proper diet, micronutrient density and diet diversity are left by the wayside, both on a local level (e.g., subsistence farmers who believe that fortified foods full his and his family's nutritional requirements, as well as at the local markets) and in domestic food markets. A fact which must also be remembered (and is often overlooked) is that the occurrence of a particular deficiency, whether vitamin A or iron or any other, is an indicator that those foods which contain the respective micronutrient in larger amounts are not being eaten regularly. Thus, all other micronutrients which these foods contain rich amounts of are also lacking. As important as the various techniques for fortifying food with specific micronutrients may be, this can also lead to a new form of hidden hunger when nutrition is not viewed from a holistic point of view.

Effectiveness of the Measures

Availability

In light of the requirements of food security for less-developed and more highly developed countries, various methods were compared and the promises of the agricultural industry critically examined (Dibden et al. 2011).

For instance, is domestic production sufficient or do foods need to be imported to meet the demand? Is production sustainable enough in light of climate change

and the water supply? Does the distribution system also accompany rural inhabitants and the poor?

The Promise of Agro-Biotechnology

Agro-biotechnology has announced the dawn of a Green Revolution with

- higher crop yields,
- cereals which are better adapted to their environment,
- less use of fertilizer.

Critique

- To date, only herbicide and pesticide-resistant varieties are available.
- Higher crop yields and better adaptability to dry spells and heat still remain only promises.
- More resistant varieties of weeds grow in large numbers following reductions in the use of chemicals.
- Both biodiversity as a whole and indigenous plant species are lost.

Access

An important issue is whether or not the groups which depend on the food in question can afford to purchase it. Can the minimum dietary requirement of 2,100 kcal/day, which is needed to enjoy an active and productive lifestyle, be secured?

The Promise of Agro-Biotechnology

- Higher yields lead to lower prices.

Critique

- Inequalities are ignored.
- Corporate control raises the seed prices.
- The seeds cannot be produced by the farmers themselves.
- Small-scale farmers have no access to the necessary technology.

Nutritiousness

Does agricultural production provide for a healthy and balanced diet according to the various nutritional requirements, as well as ensure diet diversity at all times? Are the foods processed and stored in a reliable manner?

The Promise of Agro-Biotechnology

- Fortified cereals, e.g., golden rice, are designed to meet the dietary needs of people in developing countries.

Critique

- There have so far been no apparent nutritional benefits.

- Both the need for a balanced diet, as well as the socioeconomic barriers which the poor face in achieving a better diet are ignored.

That critique more or less sums up the situation regarding the silver-tongued promises made by the agricultural industry, which will not solve the problem of hidden hunger anytime soon. So what happens next?

Sustainable Dietary Strategies for the Future

The Bretton Woods Agreement, which established the International Monetary Fund (IMF), is one of the principal underlying causes for today's hunger crises. The agreement set up regulatory mechanisms aimed at protecting the agricultural interests, and hence the profits of the founding nations. Developing countries which wanted to join the World Trade Organization (WTO) had to submit to structural stipulations set up by the organization. The guiding principle behind this, which was the brainchild of the World Bank, was that countries with high foreign debts could raise income through free trade in order to pay them off.

The structural stipulations included more specifically:

- the stopping of land reforms (e.g., Indonesia),
- no government regulation of land distribution,
- an increase in the utilization of agricultural technology,
- the ceasing of government farming subsidies,
- the bolstering of livestock breeding for the export market,
- the bolstering of fodder crops for the export market,
- the bolstering of other export crops, such as flowers and exotic fruits.

Regarding the effects of these structural stipulations, the sociologist and Right Livelihood Award laureate (2009) Walden Bello is of the opinion that the holdings of small-scale farmers were more thoroughly ravaged by these measures than by any other force, social, or otherwise (Bello 2009).

The end result is that small-scale farmers in developing countries produce for export markets exclusively, in other words neither to feed their families nor for sale at local markets. The losers of this deal are the small-scale farmers and their families, as well as the poor who are dependent on locally grown produce.

The so-called 'liberalizing' of the market brings profit to the rich countries and more poverty to the poor ones. We can hardly talk of globalization as a market-place in which people from around trade and are treated fairly, at least not as long as those who are too weak to assert themselves or to compete are left along the wayside.

In the end, developing countries' foreign debts have only increased and, as a result, so too has the number of poor and undernourished persons. The neoliberal concept of free markets for developing nations to help them increase productivity and pay off their debts is an inhumane idea. Inhumane because it rests completely on cold, hard economic principles, and ignores the circumstances under which people had lived for a very long time.

The liberalizing of trade bypasses the agricultural infrastructure and markets of developing economies. 90 % of all farms comprise less than 2 ha of land. Among these are 35 million small farms in Africa and 200 million rice farms in Asia (McIntyre 2009). These farms would be enough to produce not only enough staple foods, but also fruits and vegetables for the farmers' own needs and, ideally, for the local markets. Due to the forced low import duties and large quantities of subsidized imported foods (primarily cereals), small-scale farmers stand no chance of feeding themselves or of earning money with produce to help secure the family's financial situation. Our endeavors to combat the problem are nothing but a compensation for governments' errant policies guided in the manner of Don Quixote by our own ignorance.

The traditional small farmer is only able to provide for himself and his family by allocating a portion of the crops for the family's needs and by selling the rest of the produce in order to buy seed and groceries. This presupposes the fact that the farmer has both the land and able-bodied family members who can contribute to crop production. If this is not the case, for instance when children die or are physically weakened due to malnutrition, then the farmer finds himself trapped in the vicious circle of hunger. Even a well-intentioned grain donation is not of much help in such a situation.

The production of export crops as stipulated by the structural framework of the WTO has also forced small-scale farmers to gear production toward this market with all of its implications: The goods must be fresh, they must be delivered, they are subject to strict regulations (best before dates, EU norms etc.) and they are also subject to unforeseeable price fluctuations on the markets. Regardless of these stipulations, the farmers do not have enough land to produce for the export market and, if they are fortunate enough to make a profit, still produce for their own families. Thus, the foundation of food security is missing and it should be no surprise that 75 % of the poor live in rural areas. Of these, according to a report by the UN, 50 % are small-scale farmers, 20 % are landless farmers and 10 % are shepherds. The fact that nearly half of the world's population makes a living from agriculture becomes alarming when the possibilities to provide for oneself and one's family through agricultural production are becoming less and less. In comparison, roughly 4 % of the population in Germany (530,000 full-time jobs) and 5 % of the European population are employed in the agricultural sector (IAASTD 2008).

Two very different models stand in opposition to one another and their antagonism only worsens the plight of small-scale farmers: on the one hand a high-tech and highly productive agricultural industry in developed economies and small-scale and much less productive farms. Only 2 % of the 1.3 billion small-scale farmers worldwide own a tractor, 20 % employ the use of animals, while the other 80 % must do all the work by hand. This requires able-bodied women and children. Depending on the region, up to 70 % of farms are run entirely by women. When it comes to the world's hungry population, it is primarily about these farmers, male and female. They should at least be allowed to have the means to feed their families and pay for health care and education. Then the next generation

of rural farmers can experience the plus side of globalization and not only be left with the short end of the stick.

Subsistence Farming

Subsistence farming is a type of agricultural production which primarily serves to fulfill the dietary requirements of the producers and is independent of the national and international food markets. Farmers and their families should therefore be shielded largely from price fluctuations and be able to secure enough food and quality of life for themselves. This may sound somewhat utopian and unrealistic, however it is the only truly sustainable way for many people to maintain a diet and survive.

The majority of hungry and undernourished persons live off the land. They are small-scale farmers, who can hardly make a profit with their tiny plots of land. Hence, they and their families have to live off their own produce. Yet this is by no means a given and there are a few essential conditions which must be met:

- Subsistence farmers need to fulfill their families' dietary needs, both in terms of quantity and quality. What diet diversity means specifically must be defined for a particular region in terms of quality and quantity based on the (traditional) food products available.
- Subsistence farmers need their own, clearly defined plot, which is suitable to the production of various crops (depending on the climate and soil).
- The primary goal must be to adapt production to the surrounding conditions in order to optimize yields, both from the point of view of quantity and quality, not to increase crop yields at all costs.
- Grasslands as grazing grounds for livestock would be a vital factor in improving nutrition.

There are more than enough models which describe how subsistence farming should be established. Many plans have already been implemented. One of the pioneers is Via Campesina, an organization which was founded in Indonesia in 1993 to represent the interests of small-scale farmers. Via Campesina introduced and promotes the concept of 'food sovereignty', which is a policy framework for food security for peasant farmers and other groups. Not only does food sovereignty stipulate the right of all individuals to an adequate and nutritious diet, but it also the right of each person and nation to grow and harvest crops. This means that every nation on earth and thus every farmer must be literally given the freedom to produce their own food.

Some tenets which are directed at national governments, as well as international trade organizations (Engel 2002) are:

- that the production of healthy, nutritious foodstuffs, which takes into account the natural and social surroundings, must be given top priority regarding government subsidies, that food is produced primarily for the family, and local, and domestic markets,

- that farmers are paid fairly for their produce,
- that surpluses are avoided by means of regulation,
- that every country must have a means of protecting itself against cheap imports so that increases in domestic staple food prices do not hurt local farmers,
- that every kind of export subsidy and measure which lowers export prices to below production costs is forbidden.

Attempts to transform peasant farms into industrial enterprises and incorporate them into the world agricultural industry have in grand style with devastating consequences—devastating because of the stagnation and general mood of resignation which they have triggered. This is not least of all visible from the fact that the target of reducing poverty and halving the number of hungry and undernourished persons by 2015 will not be achieved, but rather the reverse trend can be observed.

The reason is not that peasant farmers in many developing countries were unable or unwilling to increase their productivity. Rather the explanation lies in the fact that peasant farmers are confronted with national and international policies which oppose their interests and foil their ideas, such as land grabbing, price dumping and biofuel production. There is a certain mystique surrounding the 'pastoral lifestyle' which we are encouraged to believe yet which in no way reflects the hard reality of life and work for the peasants we can only see through a glass darkly. Poverty and hunger, coupled with helplessness, put the brakes on every initiative to change the status quo. We can hardly blame the people living in regions rife with malnutrition when they sit and stare at the ground with their hands folded because there is often not much else that they can do.

While in developing countries the potential to produce food which satisfies basic dietary requirements in accordance with the concept of food sovereignty does exist and could indeed contribute to reducing poverty and hunger, the globalized agricultural industry is geared toward making profits and not toward bolstering food security.

Unlike the agricultural industry, nutrition science, which concerns itself with many of the issues at hand, does not have an international lobby and therefore does not have a real voice. It would be an absurdity when the majority of nutrition scientists around the world, who work on developing healthier forms of nourishment by means of phytochemicals, nutrigenomics, or modified fruits and vegetables, did not address the issue of food security and how it can be achieved. Of what benefit is it to an Ethiopian farmer, who can expect to live roughly 46 years, when oils enriched with omega-3 fatty acids, which are believed on the basis of insufficient data to prolong life expectancy by preventing arteriosclerosis, are offered at the local market? It is more than ironic that such products are sponsored by the EU and produced on land where vegetable crops or indigenous oilseed could have been cultivated. Barring a very few exceptions, the agricultural, nutrition science, and health care sector have remained completely isolated from each other and have not engaged in collaboration with regard to research and knowledge transfer to this very day.

The primarily profit-oriented agricultural sector has so far devoted little resources to the issue of quality, i.e., which vital micronutrients are contained in the different crops which it produces. The reasons for this are politics, the lure of higher profits by increasing production and, quite simply, ignorance. When calls are made once again to move in the direction of higher crop yields to feed the growing population in the coming years, heeding the calls means taking two steps back. When one views the results of the Green Revolution, which brought about an explosion in rice and wheat harvests, from the point of view of those who depend on these staple crops, then one hardly notices any real progress. As mentioned previously, rice and wheat contain protein plus a very few essential micronutrients. The fact that within a few years after the first shots of the Green Revolution were fired, the calories available in Asia increased in some regions by more than 25 %, led many to celebrate an apparent victory in the war on hidden hunger. Unfortunately, what many people overlooked is the fact that the consumption of more calories alone does indeed supply more energy, but it is no replacement for high-quality, nutritious food.

The advancement of subsistence farming means giving peasants the possibility to live, look forward to and shape their future with dignity.

The Future of Food Security

In the wake of the Green Revolution with the introduction of chemical and mechanical technologies, the amount of calories available to each person has increased significantly (see Table 7.6).

At the same time, the Green Revolution helped to give rise to a powerful agricultural industry, which still generates revenue from a valuable 'raw material'—food, primarily cereals. The food business is not geared toward the end users of the products, but rather toward the world markets and profit. The world's population is continuing to rise and is creating for itself the challenge of feeding further billions of people who will join its ranks, particularly in Asia. By 2050, the number of calories per capita will sink to below 2,200 kcal in some countries if nothing decisive is done. This does not even take into account the impact of climate change, biofuels and the forces connected to the hunger carousel.

Table 7.6 Availability of dietary energy (WHO 2010a, b)

	1970	2000
Global average	2,410	2,800
Industrialized countries	3,130	3,230
Southeast Asia	2,010	2,920
Africa	2,100	2,190

By concentrating on calories and not on quality, the Green Revolution succeeded in reducing the number of undernourished people worldwide, yet it ignored the problem of hidden hunger and probably even worsened it. The situation is reminiscent of the euphoria which was rife when biofuels were first introduced. There were promises of unlimited resources, jobs for the poor and a reduction in hunger and poverty.

Despite all of its apparent advantages, the Green Revolution also led to a move toward the new monocultures in Asia since these were believed to be more lucrative. Thus, crop rotation was abandoned (Graham et al. 2007). In India, the Green Revolution has led to a 25 % increase in crop yields, yet the situation regarding child mortality and malnutrition has remained largely unchanged (Bamji 2007). In light of all that has been said about the problem of hidden hunger, this can hardly be surprising.

There have been no such increases in production in Africa. The reason for this is two-fold. During the 1960s, many African countries became independent, making it necessary to reorganize their farming industries. More serious, however, was the fact that many traditional food crops in many regions throughout the continent, such as corn, cassava and millet, did not have a lobby to promote the development of related, yet higher-yield varieties. Sub-Saharan Africa is the only region in the world where the number of people living in poverty has increased by more than 50 % (Kates and Dasgupta 2007).

The development of high-yield varieties began in 1944 as the American agricultural scientist Norman Borlaug, the father of the Green Revolution, initiated a project to increase wheat production with funding from the Rockefeller Foundation. In 1965, these varieties were introduced to Pakistan and India, resulting in a doubling of wheat production from 4.6 to 8.4 million tons within a 5-year period. This impressive development in yields must not detract from the fact that India is still among the countries with the highest under-five mortality rate, as well as the highest number of malnourished children. The simple formula

$$\text{worldwide production} = \text{land} \times \text{yield}$$

still holds true today. The motivating factor behind higher crop yields is primarily profit and has less to do with concerns about feeding the population. The trade regulations set up by the USA and the EU in order to preserve growth-oriented developments will not be elaborated upon at this juncture. However, in a nutshell, it can be said that these measures have ultimately led to the Green Revolution being relativized in many countries where poverty has increased.

The progression of the Green Revolution is, on the one hand, the foundation for a booming agricultural industry, as well as a source of quick profit through speculation and, on the other hand, it has apparently contributed to reducing world hunger. At the same time, however, crop yields after 1970 have triggered numerous hunger crises, for instance in Indonesia in 2003 and globally in 2008 due to higher rice and wheat prices. These price hikes do, however, have a profound impact on what people eat and, thus, how they develop, in particular children

under the age of five. With every percentage point that food prices increase by, another 1,000 children under the age of five die.

The Green Revolution has so far ignored one essential aspect—people's true dietary needs. A dialog with nutrition scientists concerning the quality of food products as a basic requirement for human development has hitherto not taken place. The impetus for such an exchange has also been largely absent in the nutrition science camp. Researchers have been much too enthralled by molecular methodology as to devote their attention to such mundane issue as food security. As a result, a quantity-oriented gauge was established by the agricultural industry: the daily amount of calories required in order to ensure a person's normal development and performance.

2,200 kcal is the minimum amount required by a person to survive. In purely mathematical terms, 2,800 kcal are available to each person today. Without an increase in crop production in the future, only 2,200 kcal will be available to each person in 2050. Normal Bolaug took up the issue of a quantity-based view of nutrition in a *Science* editorial (2007) entitled "Feeding a Hungry World":

> For the foreseeable future, plants—especially the cereals—will continue to supply much of our increased food demand, both for direct human consumption and as livestock feed to satisfy the rapidly growing demand for meat in the newly industrializing countries. The demand for cereals will probably grow by 50 % over the next 20 years, and even larger harvests will be needed if more grain is diverted to produce biofuels. (Borlaug 2007)

It has been amply demonstrated that precisely this approach is merely a partial solution to the problem, yet one which is still promoted. Nutrition and diet diversity go hand-in-hand within the context of food security. Then, and only then, can a safe assessment of who has enough to eat and who does not be carried out. A focused evaluation of locally available foods with regard to their micronutrient density would be much more effective than numerous other measures in helping to optimize the diets of both rural and urban populations.

Figure 7.4 recapitulates the problems described at length earlier. The extremely poor (i.e., those earning <$1.25/day), as well as the very poor (<$2.00/day) have no chance to defeat hidden hunger. The former draw at least 90 % of their diets from rice (or other cereals), while the latter draw 85 % from these sources.

Table 7.7 illustrates the difficulty involved in even remotely fulfilling the RNI for certain micronutrients when income levels decrease, a situation which is particularly critical for pregnant women.

Depending on the variety, beans can supply up to 50 % of the RNI for folic acid, iron, and zinc. There is a wide plethora of local varieties.

Although the values may vary depending on the region, Table 7.8 shows one solid fact. The composition of an adequate diet requires knowledge of nutrition, arising either from tradition and empirical knowledge or from counseling. However, micronutrient deficiencies can only be sustainably eliminated once other foodstuffs, which are currently only available to those with higher-incomes (see Fig. 7.4) are available to all. It is precisely these food products which can close the gaps created by the missing micronutrients, which, in turn, are representative of

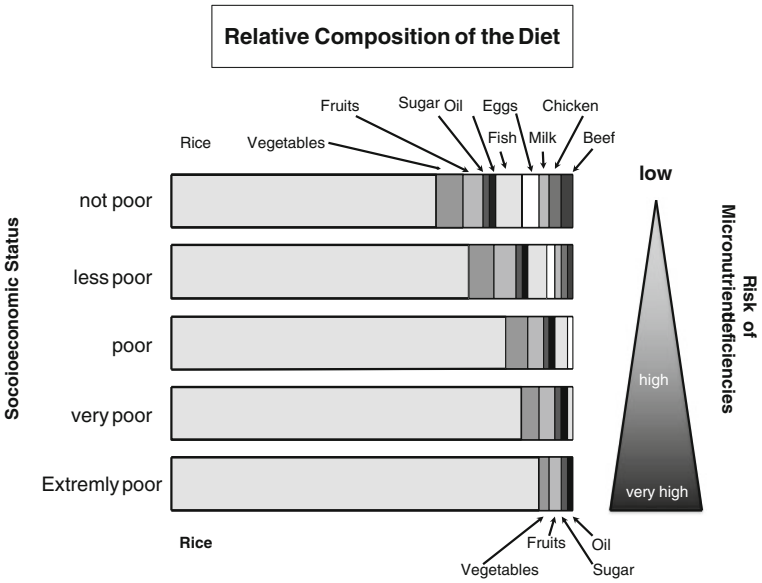

Fig. 7.4 Distribution of the various food groups in relation to income and the risk of malnutrition. (Semba et al. 2011)

Table 7.7 RNI for pregnant women

First trimester	Protein	Vitamin A	Iron	Folic acid	Zinc	Calcium	Vitamin E
Recommended amount	60 g	800 µg	30 mg	600 µg	11 mg	1,000 mg	75 mg
% RNI per 100 g food							
Rice	0	0	1	2	4	0	0
Cassava (root)	2	0	1	5	3	2	0
Millet	6	0	2	14	8	0	0
Meat (chicken)	37	0	3	1	14	1	3
Mung beans	40	2	22	104	24	13	7
Soybeans (green)	18	2	13	28	13	4	78
Cabbage	3	1	1	10	2	4	2
Tomatoes	2	18	1	3	2	1	7
Green leafy vegetables	6	106	5	30–77	11	18	58
Moringa leaves	7	146	11	49	5	10	65
Amaranth	9	160	6	31	6	32	17
Jute leaves	10	198	12	21	0	36	36
Solanaceae (nightshade)	8	101	13	10	9	21	28
African leafy vegetables	8	193	6	27	3	54	101

Table 7.8 Available food types containing micronutrients in developing countries and their typical relationships to hidden hunger

Micronutrient	Food type	Quantity RE/100 g conversion rate 1:6
Vitamin A	Beef liver	8,000
	Chicken liver	4,000
	Eggs (yolk)	200
Pro-vitamin A	Sweet potatoes	1,000
	Carrots	850
	Bell pepper	250
	Squash	200
	Mango	200
	Melon	150
	Papaya	100
	Green leafy vegetables	300
		mg/100 g
Iron (animal derived)	Poultry	7
	Beef liver	6
	Beef	4
	Mutton	3
Iron (plant derived)	Millet	1–20
	Soybeans	5
	Buckwheat flour	4–15
	Beans	2–8
Zinc	Meat/meat products	2–7
	Quinoa	5
	Buckwheat flour	3
	Barley	2

average values modified according to Johns and Eyzaguirre 2006

hidden hunger and which are indicative of a range of dietary deficits. Taking into account the 'special' foods which are distinguished by the amounts of vitamin A, iron, and zinc which they contain, it is quite clear that a combination of these, together with the staple foods, are sufficient to guarantee a person an adequate diet.

Local nutrition campaigns can provide counseling based upon a combination of different food types, thus helping to improve diet diversity. To do so requires knowledge of the nutritional make-up of the different food types, as well as the

taking into account of food prices, including those of fortified foods. The result would be a sensible dietary mix with the maximum micronutrient density.

Unlike the situation in rich countries, fruits and vegetables have a more prominent role in the diets of hungry people in developing countries and are a means of minimizing the effects of hidden hunger. There is a highly significant link between the availability of vegetables and both wasting and mortality among under-five year olds (Keatinge et al. 2011). Countries in which vegetables are the scarcest, such as Niger, Mali, Tanzania (<120 g/pers), have a much higher child mortality rate (230/1,000) than those with more than 150 g per person. Yet availability does not necessarily mean that the people have access to the respective foods, as Fig. 7.4 clearly illustrates. The availability of certain foods could be utilized to eliminate micronutrient deficiencies in combination with nutritionally fortified foods and supplements, both on a short-term as well as a long-term basis.

In other words, it is a question of diet diversity and micronutrient density when it comes to fighting hidden hunger and its effects, not simply 'counting calories'. This can be based upon a pre-defined selection of foods providing a mathematical model in the spirit of food security. This is the only way to develop long-term strategies, which are circumspect and take into account all influencing factors and can also be implemented by the victims themselves.

What is needed is a second Green Revolution with the four pillars of food security as its goal and not simply higher crop yields. The problem of hidden hunger and child mortality can be solved step by step. Nutrition scientists must also adopt a new paradigm and reconsider what their real mission is. It is not enough to vainly observe the building blocks of nutrition through a microscope and to rattle on about the wonders of GM foods.

Hidden hunger lies at the very heart of nutrition science, yet it has so far been neglected. We concern ourselves with hypothetical contaminants in food products or the potential risks of smoking whilst taking vitamin pills. It has been calculated that 0.018 smokers in 1,000 might harm their health through the use of vitamin pills. This statistic pales in comparison to the 250 children in 1,000 in South East Asia who die from a lack of vitamin A, iron and zinc before reaching the age of five. Malnutrition is first and foremost a result of poverty. Any analysis of treatment of malnutrition must take this fact into consideration.

The fact that poverty is on the rise in industrialized countries and that children are the primary victims of this development is an issue, which is often overlooked. The fact that being poor means having a poor diet and little diet diversity means that children who live in the land of plenty also suffer from malnutrition—a fact that only seems to interest a very few people. In any case, there have been no studies to date to monitor the diets of children whose parents receive welfare benefits, particularly single parents.

Both the quality and the quantity of food in one's diet are both determining factors when it comes to physical and mental development. Humans' dependency on essential micronutrients and our inability to specifically target these in our diet has turned us de facto into omnivores. Climate change and increasing aridness most probably altered the lives of our ancestors three to four million years ago in

the forests of East Africa. These changes made it necessary to search for new means of sustenance. They apparently learned to fear the hunger they felt more and more often.

Their tastes led them to go from being strictly frugivores (eaters of sweets) to consumers of other foods including meat. This shift profoundly influenced humans' evolution. The brain developed in accordance with the micronutrients found in these new foods (e.g. omega-3 fatty acids found in fish) as did the body (e.g. protein found in meat). They became hunters in order to secure a supply of meat during their wanderings over many generations. Apparently, this lifestyle was beneficial to our ancestors and they prospered and developed, yet there were certain to have been periods of food scarcity. Such a period sparked a development which began only 10,000 years ago. Early humans learned to produce food and store it and thus prevent such agonizing periods of food scarcity. Due to their early development, humans laid the groundwork for the modern-day dilemma of hidden hunger.

What appears to be an advantage actually conceals a dilemma for the human race. When one or more vital micronutrients are missing from our diets, our development is stunted. We enter into the vicious circle of hunger without perhaps even realizing it.

The 55 most important aid organizations, in cooperation with representatives of the WHO, the World Bank and other government organizations, have calculated the costs of eradicating worldwide hunger on the basis of scientifically sound intervention studies (SUN 2010). Unlike the Copenhagen Consensus, productivity was not the most important aspect, but rather empirical data collected from various measures applied within the context of scientific studies. The recommendations are aimed at children under the age of two since this is the period during which the hunger circle must be broken if the children are to have any prospect of a normal future away from the hunger carousel.

Advancement of Healthy Dietary Practices ($2.9 billion)

- breastfeeding;
- additional feeding of children after 6 months;
- improvements in hygiene including washing one's hands.

Improvements in Vitamin and Mineral Intake ($1.5 billion)

- periodic vitamin A supplements;
- therapeutic administering of zinc in cases of diarrhea;
- micronutrient powder (sprinkles);
- deworming (to reduce the loss of nutrients);
- iron and folic acid supplements for expectant mothers and to treat anemia;
- iodized oil if iodized salt is not available.

Administration of Micronutrients Through Food Enrichment ($1 billion)

- salt iodization;
- iron fortification of staple foods.

Therapeutic Feeding of Malnourished Children with Ready-to-Use Therapeutic Foods/RUTFs ($6.2 billion)

- prevention or treatment of moderate undernourishment;
- treatment of severe undernourishment (and malnourishment) with RUTFs.

Most of these measures are related to improving micronutrient status where it is necessary and, barring the last point, increasing caloric intake. This approach, should it be implemented, is a mid-term solution. In the long run, the poor can only truly be helped by supporting peasant farmers and initiatives for women. Women must not only be able to feed their families, either with home-grown produce or from their personal income, but they must also be put in a position to free themselves from poverty and from the powerful force of the hunger carousel.

Outlook

In conclusion, the ultimate question is "What happens now and what can be done?" I ask myself, as others are also asking themselves, why so little is known about hidden hunger in all its complexity and with all of its adverse effects. What has gone wrong? Naturally, there are well-known reasons for the problem, such as consumer behavior in rich countries and the discount shopping mentality, or the common expectation to have all varieties of food from all over the world throughout the entire year. To do so at this point would be redundant. This has all been said before and nothing has changed. It might be the case, however, that the different facets of the problem have not been explained to consumers in a manner which helps them to understand and connect the dots. In fact, such dialogue has not even been possible between agriculturalists and dieticians.

In a report by Olivier De Schutter, the UN Special Rapporteur on the Right to Food, he writes

> The right to food cannot be reduced to a right not to starve. It is an inclusive right to an adequate diet providing all the nutritional elements an individual requires to live a healthy and active life, and the means to access them. States have a duty to protect the right to an adequate diet, in particular, by regulating the food system, and to fulfil the right to adequate food by proactively strengthening people's access to resources, allowing them to have adequate diets. […] Agrifood companies also have a responsibility to respect the right to adequate food. They must avoid infringing upon this right, and seek to prevent any adverse impact their activities might have on the enjoyment of this right. […]
>
> The world is now paying a high price for having focused almost exclusively on increasing production over the past half-century. Undernutrition remains considerable, largely because agrifood systems have not contributed to the alleviation of rural poverty. […] Like undernutrition, micronutrient deficiency or "hidden hunger" is a violation of a child's right to a standard of living adequate for the child's physical and mental development […]. States, therefore, have a duty to support exclusive breastfeeding for six months and continued breastfeeding, combined with adequate complementary foods, until the second birthday of the child; and to establish food systems that can ensure each individual's access not only to sufficient caloric intake, but also to sufficiently diverse diets, providing the full range of micronutrients required (UN Report, 26 Dec. 2011).

If we took the rights of every individual to an adequate diet as seriously as we take the issue of human rights, and if we proclaimed these as loudly and as often as we rightly do with regard to human rights, then the first big step toward making a change would be taken. That is my wish and my motivation for writing this book.

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The Four Horsemen of the Apocalypse

Unseen Death

It is written in the Book of Revelation that the end of the world, the apocalypse, will be announced by four men on horseback. Albrecht Dürer portrayed the horsemen of the apocalypse as inescapable powers in a 1498 woodcut. In it, Death rides on an emaciated horse, holding a trident in his scrawny hands; he gores whatever life he can, his frame is mere skin and bones. Beside him sits a well-attired bon vivant on a dark horse, holding the reigns in his left hand and a scale in his right. The darkness of the horse, according to historical tradition, stands for the brute force of hunger. The scale is symbolic of inflation; if our daily bread becomes unpayable, we will be trampled down by hunger and death.

The nutrition expert Hans Konrad Biesalski, professor and managing director of the Institute of Biological Chemistry and Nutritional Science at the University of Hohenheim, instead of *Hidden Hunger* could just as well have entitled his book *Unseen Death*.

Despite its depressing theme, Dürer's dismal woodcut became one of the brilliant Nuremberger's most popular works. Having been ill at ease when the Turks besieged Vienna in 1529, even Martin Luther was inspired by Dürer's spirited and moving interpretation of the Book of Revelation. The first horseman sitting atop a white horse was previously believed to be Jesus, the King of Kings. According to Luther's interpretation, however, the proud horseman stands for war, the bringer of death by tyranny.

Hans Konrad Biesalski knows that wars cause hunger today as they have always done in the past and, in his view, we are faced today with "an economy that places profit above the moral imperative". In his book, Biesalski quotes the Nobel laureate economist Amartya Sen. Sen, a philosopher from West Bengal in India who today studies the problems of poverty and how they are addressed by welfare economics at Harvard, says, "Hunger crises have less to do with the availability of food than with the ratio of the purchasing power of those who buy foodstuffs versus that of those who sell it."

Poverty and hunger are apparently bound together like Siamese twins. Moreover, nothing else bears witness as strongly to humanity's dependency on the right amount of rainfall, the ideal temperature between scorching heat and

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destructive iciness, the quality of the soil as does the sheer necessity of cultivating crops and raising livestock.

Climate, economic power and economic potential, the building up in times of peace, and the destruction in times of war—these are the factors which have formed Europe's history. The history of the western world and beyond has always been an account of hunger versus satiety, scarcity versus decadence, and even the promise of abundance in boom times.

Starting in the early 1950s, hunger evolved into an Asian, African and South American phenomenon. Images of famine, particularly in Africa, have been published in newspapers and broadcast on television. Pop stars call to action with concerts, they urge society to make donations.

Europeans and Americans Respond Generously

As truly pleasing and commendable as these donations are, they cannot prevent the next famine or the one after that. Ultimately, the combined force of the North's development money is an almost innocuous remedy for the hunger which prevails in the South.

There are Questions Which Must be Asked

Why do we not scream out whenever we hear, see and read how large expanses of agricultural land are being reserved to grow oil-rich crops for the production of gasoline and diesel fuels, or fuel in general, and that this is deemed an example of sustainability by politicians?

Why do we not find it to be abhorrent when we discover that Danes, Americans, Swedes, and Germans are buying up valuable farmland in Africa and South America in order to maximize the profits from specialized and exportable crops? This is arable land that is lost to the locals.

How can we tolerate that food has become an object of price speculation on the commodities markets, and in mutual funds and hedge funds?

Why do we want to close our eyes to the fact that our economic policies in the west, our attitudes to trade, do not serve to relieve developing economies of their distress on a long-term basis, but rather to intensify the adversity?

A total of 3 billion people suffer from hidden hunger. They are chronically undernourished, face a constant threat of illness and death. They are the first victims of a hunger crisis or they perish slowly from disease and die early.

From our happy little island, we regard 'food' from the point of view of the well-fed. We speak of weight-loss diets, protein-rich diets, bourgeois farming life and petty, minute details. Food is for us a way of life, the outward expression of a certain attitude. *Show me what you eat for breakfast and I will tell you who you are*.

For genteel-minded fellow citizens from New York to Berlin, to be hungry is a duty to be performed religious, health, or intellectual reasons. Fasting as a means of self-purification. Fasting is thus a voluntary exercise: a small salad with a few tidbits of choice beef.

We regard sustenance and nutrition from our well-composed, urbane perspective and we know very well that whenever we hear the catchwords 'factory farming', 'GM food', 'chemical fertilizers', 'monocropping', 'the agricultural industry', and so on that we are obliged to feel a cold shiver of revulsion.

Food as a lifestyle product—the lovely farm in the Black Forest, the organic farmers' market. And what is more, you will live to be 100 if you only eat 'white meat'. It requires courage to stand in opposition to such unquestionably politically correct Zeitgeist and stand behind a different, and God only knows how crucial, paradigm.

With the comprehensive inquisitiveness of a citizen of the world, Hans Konrad Biesalski describes in *Hidden Hunger* that large element of humanity which suffers under the yoke of hunger like never before. Alongside those who have starved and are starving to death, he introduces us to the millions of people whose stomachs are full but are nevertheless malnourished. Rice, corn, and cereals are the 'Big Three' when it comes to food. Yet, they alone are not enough to supply what is needed for a healthy, long life.

Not enough nutrients and vitamins, a lop-sided diet despite bread, creamed rice, and corn tortillas—petite mothers give birth to small babies. Frail young boys and girls grow up into permanently enfeebled men and women. If food prices were to rise now, many more thousands would die.

This is enough food to feed everybody, according to Biesalski. In the end, what he is demanding from the peoples of the Earth is good governance and farsightedness when it comes to allocating resources, especially food. Research and modern insights, he believes, can benefit the hungry and the malnourished.

Whoever automatically thinks of evil and sorcery when the latest developments in the food sector, agricultural research, and perhaps even medicine are announced may have a romantically idealist view of the world, yet he or she remains idle when it comes to finding out more and helping farmers in places like Kenya or Brazil, helping villagers in India and ultimately, lending support to the millions of men, women, and children in need around the world.

Hidden hunger appears in Victorian London in Charles Dickens' novels. Right there in the middle of the city, it tucks itself away in the back alleyways just meters away from the noble houses of the bourgeoise and the stately palaces of the rich. Nowadays, Salman Rushdie describes similar scenes in Calcutta and Mumbai. The two parallel worlds, where the haves and the have nots live side-by-side, are still there.

In the end, change can only come about with wise policy making and when 'I' is replaced by 'we'. In chapter 6 of the Book of Revelation, it is written "I looked, and there before me was a black horse! Its rider was holding a pair of scales in his hand." The country/western singer Johnny Cash refers to the horsemen of the

apocalypse in his 2002 song *The Man Comes Around*:

Voices calling, voices crying

Some are born and some are dying

Biesalski tells us that we must hear these voices, although he admits that we only perceive hidden hunger when thousands of voices join in and cry in unison and when the images of famine victims are splashed across the primetime news. With regards to poverty, our self-aggrandizing globalized economy has only made matters, according to Biesalski.

Do We Hear the Voices?

Biesalski believes that in our collective consciousness, the poor are on the fringe. Perhaps, Johnny Cash was too optimistic in his depiction. He sang

Hear the trumpets, hear the pipers

One hundred million angels singin' …

The publicist Helmut Ahrens has written biographies of Theodor Fontane, Johann Nestroy, Ludwig Thoma, and Tania Blixen. He is also the author of works on contemporary English history and is a journalist and chairman of the board of trustees of the Hildegard von Bingen Prize for publishing.

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