

# Food Security

## The Challenge of Nutrition in the New Century

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### ABSTRACT

*The exponential growth of the world population (according to the FAO projections, it is expected to reach 9 billion people in 2050) and the urbanization (which will bring more than 60% of the population to live in the cities at the same date), combined with the marked improvement of income conditions of large sections of the populations of countries such as China and India, will result in a strong increase in individual demand for animal products. It is becoming increasingly difficult to satisfy the rising global demand for food in a sustainable manner (the most recent estimates tell us that about one billion people go hungry or are malnourished). Furthermore, a great number of factors contribute to uncertainty about the world's ability to meet the food demand of an increasing population. For all that reasons, food security must be put on top of the policy agenda.*

*Keywords:* food security, right to food, malnutrition, hunger, human overpopulation, poverty, food safety, agricultural sustainability, health, animal footprint.

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“To halve, by the year 2015, the proportion of the world's people [...] who suffer from hunger and, by the same date, to halve the proportion of people who are unable to reach or to afford safe drinking water”. This was one of the goals of the *United Nations Millennium Declaration* adopted by the General Assembly of the United Nations in September 2000 (UN 2000). Unfortunately, the current situation shows how this ambitious aim is not reached. The right to food, enshrined in article 25 of the *Universal Declaration of Human Rights* proclaimed by the General Assembly of the United Nations (UN 1948) can be satisfied only if there are two essential requirements simultaneously secured, namely the permanent and unlimited access to food (*food security*) and the availability of adequate quality food (*food safety*). However, the availability of supplies and the improvement of food conditions for large sections of humanity are conditioned by the

ever-increasing global population and, consequently, by the steady increase in demand of food on one hand, and the decrease of soil available by agriculture and/or farming (due to soil consumption, erosion, land grabbing for industrial, mining, etc.) on the other.

Despite the possibility to eat food adequate either in quality or quantity may seem a simple concept, it cannot disregard to several key points, including the availability of food (i.e. permanent stock of food in sufficient quantity), access to food (i.e. have adequate economic resources to obtain food that meet the nutritional requirements) and its usage (i.e. processing the food in an appropriate manner following the basic nutritional and health principles, as well as placing water and adequate hygiene) (FAO 1996). Therefore, it is increasingly strongly-needed to find a new organizational model, different from the present, that makes possible to produce sufficient amounts of food (of adequate quality under the nutritional and health aspects) for the entire population. Unfortunately, this mission is not an easy task and the efforts of FAO to reduce the structural causes of hunger in the world have not achieved the expected results for several reasons. The causes that can contribute to exacerbate the increasingly rampant shortage of food are many, but they can be grouped in three main groups:

- *Immediate causes*, i.e. poor diet and disease. A poor diet may be due to insufficient breastfeeding, deficient meals, poor variety of food, low-energy and low in nutrients meals (food is too “watery”) and/or infrequent meals. Sick people tend to not eat much, absorb fewer nutrients, lose nutrients from the body and burn up nutrients in the body more quickly (for example in presence of fever).
- *Underlying causes*, i.e. family food shortages, inadequate care and feeding practices, especially of children and women, poor living conditions and poor health services. Family food shortages may be due to lack of money, low production of family food, poor food storage and preservation and/or poverty-stricken choices. Inadequate care and feeding practices accounts for the way families feed young children and encourage them to eat, the way families care for women (especially during pregnancy, childbirth and breastfeeding) and for sick and old people, the way food is prepared and the level of hygiene in the home and/or the ways families prevent and treat illnesses at home and use health facilities. Lastly, poor living conditions (such as insufficient water, inadequate sanitation and overcrowded housing) and poor health services, comprising shortages of medicines and skilled health staff, increase the risk of disease and/or inadequate environmental sanitation services increase the risk of food-borne infections.

- *Basic causes*, because for each underlying cause there are “deeper” causes, such as widespread poverty and lack of employment opportunities, unequal distribution and control of resources at community, district, country and international levels, the low status and education of women, population pressures, environmental damage, political unrest and conflict, lack of health, education, and other social services and/or discrimination.

The most vulnerable period during lifetime for stunting and undernutrition is early childhood, as a result of the high nutritional requirements relative to body size. Frequent acute infections aggravate the problem by further increasing nutrient demands or gastrointestinal losses. The prevalence of severe wasting is usually the highest in the first two years of life, and it declines thereafter. The prevalence of stunting has been shown to increase progressively until reaching a plateau around 24 months (Victore et al. 2010).

In 2005, about 36 million (6.5%) children less than 5 years-old who were living in developing countries had moderate wasting, and another 19 million (3.5%) had severe wasting or severe protein-energy malnutrition (Black et al. 2008). Approximately, 69% of severely wasted children lived in Asia, 29% in Africa, and 2% in Latin America. This is part of the reason why 99% of deaths in children younger than 5 years old occur in those continents (Black et al. 2008). This prevalence varies substantially within countries and is highest for the poorest segments of the population. In 2010, there were 171 million (26.7%) stunted children worldwide, of whom 97.5% lived in developing countries (de Onis et al. 2012). Although this represented a relative decrease of 33% since 1990, when the percentage was 39.7%, stunting remains a public health problem in many developing countries. The relative decrease between 1990 and 2010 has been remarkable in Asia (43%, from 48.6% to 27.6%) and Latin America (43%, from 23.7% to 13.5%), but in Africa the decrease was only 5% (from 40.3% to 38.2%). Undernutrition often starts during pregnancy as a result of dietary deficiencies and concurrent increases in nutrition requirements of the pregnant woman. Low birth weight infants secondary to intrauterine growth restriction (at term babies who weighed less than 2500 g) represent around 11% of all live births each year in developing countries, that is 12.8 million in 2004 (Black et al. 2008).

The result of the many aspects that are the basis of food shortages is represented by *hunger*, defined as a recurrent, involuntary lack of access to food. Hunger may produce malnutrition over time (Dietz and Trowbridge 1990). Hunger is ongoing. Hunger is involuntary. Hunger is lack of access to food. In other words, food may be available, but some people are not billion get it. These people are “the hungry”. In a healthy person, being

hungry for a day does not cause malnutrition (bad nutrition or poor health). Lack of food over time affects physical and mental health to produce malnutrition. In many cases, “the hungry” are undernourished so they do not have all of the food that they need to be healthy. They may lack calories (energy), and/or protein, and/or micronutrients (vitamins and minerals). Long-term exposure to poor nutrition may cause alterations capable of causing irreversible damage and thus are unrecoverable.

All of this screeches significantly with what should be the concept of right to food and adequate nutrition, which defines the optimal dietary intake of individuals and/or populations and, therefore, is a tangible expression of body response to a correct nutritional pattern. The accuracy of the diet at all stages of life is the essential requirement for the maintenance of health. Considering the definition of the latter, in all its aspects, given by the World Health Organization (WHO 1946), nutrition must be able to ensure the performance of the genetic growth potential, the physical effectiveness and psychic and, yet finally, the extension of life expectancy. Moreover, the extreme conflict that occurs in sections of the world population, where hunger is present in a highly radicalized way and coexists in a totally antithetical and contradictory with the concept (never as today so utopic) of ideal nutrition that should be one inalienable standards of human health, requires a global commitment to reduce disparities and to defeat starvation, too often intertwined with poverty and other socio-political issues.

As just seen, the maintenance of health status, in nutritional terms, is equivalent to the structural and functional integrity maintained through the exchange of energy and nutrients with the environment. However, this is not always possible due to a devastating vicious circle that involves food shortages, food poverty and food deprivation. Food shortages are regional and involve many people who are affected by lack of available food. They are frequently caused by natural disasters, such as droughts, hurricanes, earthquakes and floods, but they can also be caused by regional conflicts. Food poverty occurs at a household level (food poverty can occur even when food is available in a region) when the household does not have resources to bring food into the home. Household poverty frequently occurs in times of economic hardship, such as low employment opportunities or illness of individuals of working age. It also occurs when people do not own land to farm for household gardens. In areas where HIV/AIDS is prevalent, food poverty is a common problem. Lastly, food deprivation is an individual’s lack of food that can be relative. For example, if everyone in the household eats the same amount of food, some individuals may not have enough food. Also, distribution of food by type in a household may

leave some individuals with a less nutritious diet. The most terrible aspect is that food shortages (regional) may contribute to food poverty (household) and food deprivation (individual), while food deprivation for an individual may reduce his/her productivity, contributing to food poverty for a household.

The exponential growth of the world population, which now has reached nearly 7 billion people, continues at a dizzying pace so that, according to the most accurate projections, it is expected to exceed 8 billion people in 2030 and then reach 9 billion in 2050. Although these are projections for the future, if the fertility rate remains unchanged from the current one, it will be observed a substantial demographic stability in Europe and North America, and a substantial increase in Asian populations, India and especially Africa. Population growth does not only lead to an increasing demand for food, especially in countries in transition and in the least developed countries, but also to changes in the required quality of the food; the progressive urbanization, which will bring, in 2030, more than 60% of the population to live in the cities, combined with the marked improvement of income conditions of large sections of the populations of countries such as China and India, will result in a strong increase in individual demand for animal products. Anyway, it is now known that meat consumption is linearly related to average income. These data are confirmed by the observations of FAO, which noted that developing countries have had, in the last forty years of the twentieth century, a significant increase in both average daily availability of energy (from 2000 to 2500 kcal/day for individual) and food of animal origin (about 2-3 times) and predicted a further increase in the following years. Recently, the same FAO data predicted a doubling of animal food consumption by 2050, whereas the daily individual consumption of plant foods (grains, fruits and vegetables) should remain almost stable. Even fish production, which currently amounts to 130 million tons, might duplicate in the next forty years (Godfray et al. 2010).

In this scenery, food security is not an exclusive problem of developing countries, but has become a critical challenge for all humanity, because it is increasingly clearer that the food availability is related to life expectancy. As can be seen from the data shown in *Table 1*, life expectancy increased as availability of food, up to around 3200 kcal/person/day. These are averaged data and do not account for other factors that affect life expectancy, such as availability of antibiotics and vaccines in the 1900s. Moreover, some individuals in earlier times lived longer and everyone did not have the same diet or physical work level. But these data are nevertheless significant.

Table 1. – Life expectancy, year – kcal/person/day.

COUNTRY	1750	1850	1950	2000
UK	37 – 2170	40 – 2360	69 – 3230	78 – 3220
France	26 – 1657	42 – 2480	67 – 2785	79 – 3512

To date, the most recent estimates tell us that about one billion people (15% of the global population) go hungry or are malnourished. In fact, the global distribution of the availability of calories per capita is very varied, with peaks higher than 3400 kcal/day for North America and Europe and with values of less than 2000 to 1800 kcal/day for the countries of central Africa (FAO 2009). The direct consequence is that people in Africa have less energy and less protein available to them than people in North America and Europe. Individuals in parts of Africa and Asia may not meet their caloric needs if their jobs require manual labor, if they have special health needs, if the food does not reach them, or if the food they receive is less nutritious than other food. Moreover, if protein requirements are about 56 g/day (0.8 g protein/kg body weight/day), people in all regions may have the amount of protein they need. However, in reality protein intake goes hand in hand to caloric intake, with very different values between the countries of North America and Europe and African (*tab. 2*). Meat consumption is linearly related to the average income per inhabitant (Speedy 2003): from the examination of the trend of the individual average consumption since 1980, it can be expected, for the next 20 years, a considerable increase in demand for such food in emerging countries, China and India in particular, with annual quantities for individual that will go up to 37 kg of meat and 66 kilograms of dairy products already by 2030, in contrast to what will happen in developed countries where the individual consumption of such products will remain substantially constant (FAO 2002).

Table 2. – Food balance sheet.

COUNTRY	kcal/person/day	g protein/person/day
Africa	2434	51.3
Asia	2713	71.0
Europe	3250	97.1
Oceania	2991	94.1
Central America	2953	80.5
South America	2838	75.8
North America	3713	113.0

Over the past 50 years, the green revolution and the development of agro-livestock sciences has guaranteed an adequate level of food production to the planet: in the face of a greater availability of food (increased by 20% per person), it is recorded a fall in their price which reached 50% in the middle of the first decade of this century (Hazell and Wood 2008). However, there are still big differences between the countries in their ability either to feed themselves or to protect the productive capacity of its long-term natural resources (Hazell and Wood 2008). For example, in the last 4-5 years, the price of cereals, in particular, is practically doubled, either as a result of speculative phenomena or for the increase of their demand for the production of energy from biomass.

The significant increase in food prices in 2008, revived again with greater force in 2010 and has reduced the purchasing power of cereals, particularly rice, wheat, and seeds for cultivation in the fields, causing social tensions often escalated into riots in some emerging or developing countries. The need to increase world production of plant and animal food will have to deal with the limited availability of natural resources, particularly land and water (Reilly and Willenbockel 2010). The total area of the Earth is about 13 billion hectares, of which less than 40% is used for agriculture. Currently, only 11.5% of the Earth's surface is arable, while 26% is classified as grasslands. The latter usually has the surface of vulnerable soil unsuitable to its transformation into arable land, but it is widely used for sheep-farming and thus ensures a considerable production of food of animal origin, without interfering with crop production (Godfray et al. 2010).

In the future, to meet the needs of the increased population, the area of arable land is expected to increase; unfortunately, the area used for farming has already reached the limit of that potential (Avery 2001). Furthermore, various human activities, such as urbanization, industrialization and production of bio-energy, constantly subtract large areas intended to food production, even for the lack of a precise land use planning policy, in particular as regards the most fertile lands. If the sustainability of agriculture has become a global concern, the crucial question is: how will agriculture ensure food to humanity in the coming decades? The challenge is dramatic, but some of the solutions currently under consideration aim at an economic model capable of ensuring environmental sustainability and acceptable living conditions for the entire population and the priority to invest limited resources (especially water and earth) for the production of food, to the detriment of energy production, urbanization and alternative uses. Whatever the proposed solution to try to solve the problem of food security, this must necessarily take into consideration the fact that our planet does

not have the reserves of land necessary for the expansion of agriculture. At this time, since the majority of public opinion in the developed countries believe that conventional farming is less secure than the biological one, there is a strong propensity to conversion of lands from first to second. However, organic farming is less productive than conventional farming, either for crop (Emmens 2003; Ryan et al. 2004) or for animal production (Sundrum 2001; de Boer 2003). Furthermore, there is no scientific evidence demonstrating that the consumption of organic food has beneficial effects on human health (Williams 2002; Magkos et al. 2003; Dangour et al. 2010). Consequently, if, in hypothesis, all conventional farms were immediately transformed into organic companies, arable land area to produce the same amount of food required at present should be increased by 2.6 times (up to 1.5 to 4 billion hectares) (Avery 2001). Similarly, if a tendency to favor organic farming will remain unchanged and the population increase will continue as estimated, in 2025 organic farming will require a quadruple area of arable land, that simply we do not have. Consequently, the only realistic option to meet human needs is an increased efficiency of agricultural and livestock production systems and improvement of their environmental sustainability (Pretty 2008; Godfray et al. 2010).

The need to make major improvements to the livestock sector is due to the fact that livestock compete for crops but provide a buffer against grain shortages. In simple numeric terms, livestock actually detract more from total food supply than they provide. Livestock now consume more human edible protein than they produce. In fact, livestock consume 77 million tons of protein contained in feedstuff that could potentially be used for human nutrition, whereas only 58 million tons of protein are contained in food products that livestock supply. In terms of dietary energy, the relative loss is much higher. This is a result of the recent trend towards more concentrate-based diets for pigs and poultry, with nutritional requirements more similar to humans than ruminants. This simple comparison obscures the fact that proteins contained in animal products have higher nutritive values than those in the feed provided to animals. Moreover, it does not capture the fact that livestock and their feed also make a contribution to food security targets by providing a buffer in national and international food supplies that can be drawn upon in case of food shortages. However, as the livestock sector moves away from using feed and other resources that have no or little alternative value, towards using crops and other high value inputs, it enters into competition with food and other uses of commodities and land. While it is probably true that livestock do not detract food from those who currently go hungry, it raises overall demand and prices for crops and agricultural inputs. These various aspects of livestock's

importance feed into national decision-making for the sector. The different policy targets of food supply, poverty reduction, food safety and environmental sustainability take on different levels of importance depending on factors such as stage of development, per capita income and general policy orientation of a country. In the least developed countries with large smallholder sectors, concerns of small producers weigh heavily, along with those of providing cheap supplies to urban consumers. In higher income countries, consumer concerns for food and environmental safety usually override producer interests, even though governments continue to support and protect domestic production for a variety of reasons. There is a stark contrast between the rather modest economic contribution of the livestock sector and its important social, environmental and health dimensions. It is against this background that livestock-environment interactions need to be seen and improved (FAO 2006). As it regards the environmental sustainability of the livestock sector, it is proven that the livestock business has a significant influence on the environmental balances, both locally and globally, affecting many aspects that include, among others, the quality of air and water, soil, biodiversity and landscape quality. At the present day, such influence is quite relevant, but will be further increased as a result of the growing worldwide demand for animal products. To the concept of environmental sustainability, it has long since been attributed an important role in livestock, because a careful management of livestock provides improved animal welfare conditions and, consequently, the production of healthy animal food and of excellent nutritional quality, in compliance with the directions advocated by the right to food.

Today, however, in addition to the fulfillment of the right to food, progresses also a new urgency, intrinsically linked to the relationship between farming systems and climate change, desertification and exploitation of resources, human and/or natural that are ascribable to the breeding of animal. This concern is one of the main cornerstones around which revolves the attention of those who must deal with improving livestock processes, since animal husbandry practices, which are not properly managed and organized, can disrupt the delicate balance between livestock and environment that is present since thousands of years, with possible negative repercussions, some immediate, other slower onset, but no less serious and dangerous. However, whilst approaching the livestock-environment problem, is important to remember that livestock activities always play an essential role towards the environment and how agriculture is the instrument of choice in the fight against the depletion and environmental degradation. The interactions between livestock and the environment are not always and only negative, but in some cases also extremely positive; we can just think

of the advantage given by the use of livestock manure as organic fertilizer or the importance of the workforce of animals, still an essential aid in many areas of the world.

In conclusion, food security cannot disregard from increased production of food, which, however, must be obtained through farming practices that protect the environment. This ambitious goal requires the cooperation of many sectors, all highly interconnected, ranging from the sustainable livestock to nutrition. The challenges to guarantee the right to food regarding the production of an adequate amount of food of animal origin, as they are essential for proper human diet, the limited use of the surfaces less suitable for agriculture, in order to preserve biodiversity, the increased yields of crop farming and animals, especially in emerging countries (through the adoption of more efficient production systems) and land use balanced between agriculture destined for food production and alternative activities (such as, for example, energy, urbanization, industry, etc.). In this context, both the study of factors influencing animal footprint and the development of appropriate technologies to reduce the environmental impact of animal husbandry and which also ensure greater efficiency in production, will be among the main topics of research in field of animal sciences and biotechnologies. However, attention must also be paid to animal welfare, ensuring healthier and more efficient stocks. These objectives will have to find the cultural, political, social and infrastructure to enable a capillary transfer of such technologies, especially in emerging countries, at an acceptable cost. There will also be implemented other support measures for a balanced use of the land with the best integration between livestock and crop production in every geographic area, to guarantee sustainability in the long run. It remains also essential to the training program and nutrition education and health, in order to improve the conditions of nutrition and living standards of populations, on one hand by reducing the excesses of food and other stimulating a conscious and responsible use of the people. Only in this way the food security ceases to be a mere concept solipsistic and becomes something concrete and real, even in those geographical areas that are daily deprived of the possibility and the right to food.

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