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Food production is a precondition for a good quality of human life[*]

Abstract

Persistent organic polluters, to which certain pesticides belong, are organic substances that are practically not degraded by chemical, photolytic or biological activity. They are often characterized by low water solubility, and high solubility in fat, which leads to their accumulation in fat tissues of living organisms. Their presence in the living environment is only small; however they persist to exist over a long period of time. They are transmitted by water and air to the place where they were not used. Given the fact that they are included in the food chain their accumulation occurs so that they can be found in a human organism too.

In addition to pesticides that are used for protection of plants against attacks of causes of diseases, pest insects and weed plants that are used for a specific purpose, there is also a category of non-intentionally emitted chemicals that include numerous chemical substances, some of the most important being:

- polyhlorinated dibenzo-p-dioxines (PCDD) and dibenzofurans (PCDF), i. e. dioxins and furans
- polycyclic aromatic hydrocarbons (PAH)
- polychlorinated biphenyls (PCB)
- hexachlorbenzen (HCB)

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Most polluters get to the organism of humans and domestic animals causing various, not yet sufficiently known effects. On the other hand, the population is unaware to which degree they take such substances in their organism. The whole population of a country is subjected to such an exposure. Therefore it is the obligation of the states and their bodies to use legal regulations and their supervision to strictly prescribe and control the condition of poisonous matters that can be found in the products that are food for people and domestic animals, and the pollution of which may occur during the process of production, transport or keeping. The main products that are used as food should be subjected to constant monitoring, and the data of such analyses should be available to the broadest public.

Fundamental problems of food production

Many nations and countries have based their life and development on science. Chaotic processes are increasingly being curbed. Skillful and rational use of scientific resources should in fact suppress the blind forces of nature. That is a fundamental task and idea bringing together nations of the world. Yet, we live in a world of numerous and intensified contradictions: famine on the one hand, and a wealth of means to fight it back on the other. That is the constellation of human societies today.

Current human population has been estimated at 6.5 billion and the number is expected to grow to 8 and 9 billion in the years 2030 and 2050 (Anonymous, 2006). Mankind, which had doubled in size every 50,000 years during its initial million years, is now being doubled every 40-50 years. The world today has a population of 1-1.5 billion hungry or undernourished people. It means that there are more starving people on Earth today than the entire human population had members at the end of the 19th century. Providing sufficient food over the next 50 years will therefore prove to be probably no less of a task than the building of entire civiliation up to the present moment. The alarming division of our world into a third that has plenty of food and two thirds with meagre food resources or facing starvation is an ongoing challenge to humankind. The crucial issue is how to come out of poverty that brings about undernourishment and starvation. The first and most essential precondition for that is to have a policy of development of agricultural production in all countries struggling against starvation. It is their duty to invest all efforts to secure enough food for their population. The international community also has a duty to assist such efforts of developing nations as a shared humanistic goal. In those countries, land reclamation is one of the main possibilities that agricultural expansion can rely on. Arable land in developing regions of the world could be expanded by as much as 20%. This especially applies to large areas of Africa and South America, where conversion into land for cultivation is possible with relatively small investments. Of Earth's total surface, merely 10.6% is currently cultivated. In some continents and regions of the world, especially in developing regions, only a fraction of land is currently used for agricultural purposes, e. g. 3.9% in Australia and New Zealand, 5.2% in Africa, and 4.4% in South America. Considering total surface, Europe has the highest acrage under crops (32.1%) with Asia following (18.9%). Looking at the world globally, only 44% of the land suitable for crop growing is currently being used and cultivated at present.

One of several issues related to providing sufficient food is the problem of insufficient diversity of plant species used for nutrition. It has been estimated that of a total of 350.000-300.000 species known to grow on Earth, some 10.000-50.000 are edible, but only about 5.000 are really being used for human consumption in practice, while three edible plant species, namely maize, wheat and rice, cover as much as 60% of human needs in calories and proteins. An enormous nutritive potential of that unexploited plant diversity therefore still remains to be used by future generations on our planet.

The law of demand and supply has a crucial role regarding human nutrition. There is not a country in the world that is able to provide all foodstuffs required by its population in a course of several years. Human population is expanding continually and there is a growing gap between its needs and available food supplies. Food production worldwide is organized in different regions, but their agricultural outputs often do not stand in correlation with the size of local population. Many countries are unable to produce adequate amounts of food for their inhabitants. Such countries are generally in need of food imports from other regions or countries, which are not always possible for a variety of economic, political or other reasons. For example, Asia's population accounts for 56.9% of total world population, but only 33.6% of the world agricultural output. The situation is similar in Africa and Latin America. In those countries, there is a realistic expectation that many inhabitants would suffer food shortage unless this proportion has changed.

Food production and means of its expansion are in the hands of private capital, which is motivated by profit-making. Consequently, areas with unfavourable soil properties, and requiring larger investments, have less been used for agricultural production. It is generally soils of better texture and chemical properties (such as chernozem, red and yellow tropical soils, terra rosa and alluvial soils) that are more intensively used for agricultural purposes, but even that utilization is only at a level of some 50%.

Soils fit for agricultural production are rather limited on a world scale. To understand the existing limits of land use, one should first consider the fact that only 11% of the world's 13 billion hectares can be readily used for agricultural production. Of that total surface, around 28% is exposed to excessive drought, some 23% to harmful chemicals, 22% of soils are too shallow, 10% are excessively moist or waterlogged, while 6% of the soils are locked in permanent ice and cold. It means that a mere 1.5 billion hectares of soil is currently at man's disposal to organize food production that would meet the world's growing demands.

Harmful organisms, pesticides and food production

Therefrom springs another global problem–the fact that food producers strive to achieve ever increasing yields on a limited resource of soils with generally favourable characteristics. In an effort to provide sufficient food for the expanding human population, man has created new plant varieties and hybrids, and is using growing amounts of mineral fertilizers, and more pesticides to protect plants from phytopathogenic organisms, insect pests and weeds. New cultivars and hybrids are generally more susceptible to many unfavourable factors, especially to agents of various diseases, insect pests and weeds.

Living organisms on our planet are plentiful and diverse. The total number of species has been estimated at 80-100 million, and only a fraction (2-5%) of that biological diversity has been studied and described in detail (UNESCO, 1994). Around 67.000 species of harmful organisms are believed to infest cultivated plants worldwide. Of that number, some 900 species are insects and mites, some 50.000 species are pathogenic microorganisms and around 8.000 species are weeds. In countries practicing highly intensive farming, phytopathogenic microorganisms, insect pests and weeds are believed to reduce yields by as much as 30%, while the reduction in countries with extensive farming exceeds 50%. According to different sources, phytopathogenic microorganisms, insect pests and weeds cause annual losses in harvest that could otherwise feed half a billion people worldwide. Viewed from a different angle, we might say that the man takes for himself what harmful biological agents have left behind, or that one in three food producers works for the pests. Considering a most propitious effect vs. investment relationship, the control of biological organisms appears to be the method that secures maximum effect at minimum cost.

It has been estimated that some 500 billion dollars are lost each year to various harmful organisms that infest plants (agents of plant diseases, insect pests and weeds) (Oerke et al., 1994). Our own estimates (Janjić, 1994) for the territory of Serbia and the Republic of Srpska are that agents of plant diseases, insect pests and weeds reduce yields by 2.670.000 tonnes annually. In the U. S. alone, these harmful organisms cause 9.1 billion dollars of annual losses. The use of pesticides throughout the world builds up a cost of some 26 billion dollars. This was the reason for creating transgenic plants – mostly plants tolerant to those harmful organisms – in an effort to cut down huge yield losses and at the same time reduce the use of pesticides (Phipps and Park, 2002).

Besides their great importance in plant production, pesticides can also gravely affect the environment (Richardson, 1991). Ecotoxicological implications are especially threatening because of a diversity of their molecular structures and mostly unselective activity to harmful and beneficial organisms alike.

However, it is believed today that giving up pesticides might cause as much as two thirds of overall plant production to be lost, which would result in unprecedented devastation and starvation across the world (Spurrier, 1985). Pesticides may accumulate in the environment, in soils, waters, air, plants and animals, and products made from them, they may cause acute or chronic poisoning of nontarget species or expansion of secondary plant pests, or their use may result in outbreaks and development of resistance in populations of various pest organisms (Janjić, 2005).

Pesticides persist in soils for as long as several years, and they can also pollute underground waters. In the U. S., for example, 67 pesticides have been detected in underground waters in 33 of states, while 17 compounds were found in amounts exceeding permitted levels in 17 states (Parsons and Witt, 1988).

The Republic of Srpska and Serbia have an advantage in this respect of using 10-20 times lower amounts of pesticides, compared to agricultural regions in developed countries, and their history of use of agrochemicals has been such over a long period of time.

In order to suppress the large existing number of harmful organisms that infest plants, enormous amounts of pesticides are being used around the world, especially in developed countries. Since 1945, when the world pesticide output was estimated at around 100.000 tonnes, it has risen to a current level of over 2.000.000 tonnes. Today's pesticide industry is based on over 1.000 chemical compounds incorporated in close to 100.000 products. Apart from being highly important for plant production, pesticides may also cause serious environmental impact. The world, and developed countries in particular, faced this problem in its most acute form in the last decades of the 20th century. Pesticides are able to disturb the biological balance in a variety of ways, to cause environmental degradation, to have direct or indirect toxic effects on people and animals, and to become incorporated in the food chain in their intact form or as metabolites. Damage caused in this way would then reflect on other living beings that are in a constant ecological interrelation. Food pollution is not strictly limited to pesticides used in all technological stages of production, processing and storage of raw materials and final products, it also includes the impact of many other compounds that are used to increase agricultural output, such as mineral fertilizers or antibiotics, or to improve product quality, such as various additives. Food pollution is worsened also by many compounds spontaneously reaching agricultural areas by polluting air, soil, atmosphere, surface and underground waters (polychlorinated dioxins, polycyclic aromatic carbohydrates, polychlorinated biphenyls and hexachlorbenzene, and other spontaneously emitted compounds). Some 90% of all pollutants getting into human organism today are believed to be consumed with food.

Potential threats to human health, especially in developed countries, increase with the development of technologies and application of different compounds in food production and processing. Acknowledging the gravity of the situation, many countries have either banned or limited the production of nearly two thirds of all known pesticides. As many as 834 active ingredients are expected to become subject to revision. The European Commision in charge of pesticide registration has estimated that over 500 active ingredients of pesticides (around 60% of total number) will not meet the standards prescribed for registration. According to EU estimates, pesticide manufacturers may be expected to withdraw some 230 active ingredients by choice.

Many countries have also initiated what is now known as organic food production, a technology that is pesticide-free or involves only a most limited use of selected pesticides. However, areas in which food is produced without any pesticides are merely symbolic. Yields in such areas are considerably lower, and production costs many times higher. Such production, at this level of development, can therefore hardly help solve the problem of starvation or inadequate nourishment in developing countries. Due to their limited amounts and high prices, such products are mostly used by people in wealthy nations with high living standards.

Genetically modified plants

In some countries, cultivation of transgenic plants has also been introduced. But their cultivation is motivated by greater profits, and the benefits restricted to food industries without sharing them with impoverished population.

All genetic manipulation belongs to the scientific area known as genetic engineering (Lindsey, 1992). Nature has willed it that cross fertilization of same species individuals should produce fertile offspring. Crossbreeding is not possible between individuals of different species. Methods of molecular genetics enable combination of features of different species standing at evolution distance. Gene transfer is not restrictive, they can be transferred among plants, bacteria, fungi and animals. A certain gene with defined characteristics may become incorporated in an organism without producing a new organism but modifying its characteristics as determined by that particular gene.

It was some two decades ago that DNA fragments were successfully transferred for the first time into plant cells *in vitro* (Herrera-Estella et al., 1983), and we already have on the markets today transgenic soybean, rice, maize, cotton, tomato and other crops cultivated in a number of countries. Plants developed this way are mostly tolerant to total herbicides, agents of various diseases and insect pests.

Genetic engineering, above all its potential risks, have provoked major disputes in the international scientific community (Wolfenbarger and Phifer, 2000). This has resulted in a significant lack of confidence in the boundless possibilities of genetic engineering (Talpin, 1998). This lack of confidence ranges from concerns over improperly conducted research and unpredictable developments to fears from total manipulation of nature and implying threats to man through products of genetic engineering (McHugen, 2000).

Public concerns have also been raised considerably over developments in genetic engineering.

In the Republic of Srpska, cultivation of genetically modified or transgenic plants is banned, as it is in other European Union countries. However, developing and growing genetically modified plants is allowed in the U. S. and some other countries, and such practice has marked the last decade of the 20th century and the beginning of 21st century in terms of rapid increase in GMO acreage (Tab. 1).

Table 1. Transgenic crops acreage worldwide (James, 2003)

Year	1996	1997	1998	1999	2000	2001	2002	2003
Millions ha	1.7	11.0	27.8	39.9	44.2	52.6	58.7	67.7

In the 1996-2003 period, the acreage under transgenic crops rose over 40 times. Today, of the overall 30 million hectares of soybean in the U. S., nearly all (>97.0%) are transgenic crops. Other important crops, apart from soybean, include rapeseed oil (>3.6 million hectars), maize (>6.4 million hectars) and cotton (>4.1 million hectars).

The European Union has hundreds of laws regulating the area of biotechnology, and a bulk of them refer to transgenic plants (Hodgson, 1992). Many countries have legislation on transgenic plants. Two directives have been adopted in the European Union that are focusing exclusively on transgenic plant research. Directive 90/219 EEC (Anonymous, 1990 a) covers the research work involving transgenic plants in laboratories, controlled environment chambers (growth chambers) and glasshouses, while Directive 90/220 EEC (Anonymous, 1990 b) regulates research of genetically modified organisms in natural environments, i. e. in the field.

Growing genetically modified plants in the field has quickly become an international issue that many countries have tried to benefit from. The technology was swiftly transferred from leading technological nations to developing countries (Leguizamon, 2001). It is precisely what the developed countries had expected most benefits from, but potential problems as well (Dale et al., 1993).

As the knowledge of effects of genetically transformed plants on the environment, and especially on people and beneficial organisms, is still insufficient, these plants are not grown in our country and their imports are not allowed (Malidža et al., 2006).

Plants and energy production

There is one other problem associated with food that has become a global concern – the problem of energy resources. The existing crude oil and coal resources worldwide are sufficient for smooth development in this century. The attempt to produce nuclear fuel is associated with a number of ecological and many other far-reaching consequences for the life on our planet, and this resource is now less at the focus of attention in some countries and a minor contributor to their overall energy sheet of balance. Today, the energy problem is tackled through plant production because plants are the only organisms capable of converting sunlight (a virtually unlimited but insufficiently utilized resource, accounting for merely 2%) into organic compounds for energy supply that is needed to keep civilization going. The United States already plans to allocate 36% of its maize output for producing ethanol. In 2015, it plans to use around 110 million tonnes of maize to produce about 45 billion litres of ethanol, while China will allocate 7.8 million tonnes of maize for the production of 3.8 billion litres of ethanol (OECD-FAO, 2007). Brazil will at the same time produce nearly 45 billion litres of ethanol from some 500 million tonnes of sugar cane. There is also a visible growth in rapeseed oil production worldwide to get biodiesel. Food production thus becomes even more complicated as the limited agricultural areas are being increasingly converted to land that is used for large-scale energy production, rather than for producing plants for human and animal nutrition. Plant production is therefore considered to be precarious in the midst of these most complex relations in the history of human civilization. It is an unequivocal fact that the relations between developed and developing nations concerning food production are becoming acute and increasingly complicated. There is already an available technological potential that some experts have estimated capable of securing three times as much food as it is produced today. Regardless of ideological, economic, cultural and other differences, mankind is able to build a global policy and prioritize new values for its future development concerning food production both in terms of amounts and quality of food, which should prevent starvation, and death from starvation, which has never abandoned our species and is regrettably more widespread now than it has ever been in our history.

Conclusion

The growth of civilization is inevitably associated with changes, which have assumed a global character in the past century, some of them involving nearly all developed countries, while starvation and poverty have crippled poor and undeveloped countries. This century is therefore expected to bring an even greater divergence of the quality of food in developed countries and its shortage in impoverished countreis. That divergence has already demonstrated its long-term consequences, but failure to deal with the problem more efficiently and quickly in the future is bound to have disastrous consequences on the development of mankind and its civilization. In that context, many of the values to be fostered in the 21st century will lose their very foundation if a huge proportion of human population should suffer from such poor living conditions. It is my opinion therefore that the worth of a science is measured by the benefits it creates for its people and all of humanity. Those values and scientific truths are therefore inseparable from life itself and can only be respected and developed while at the same time respecting and abiding by the crucial principles of development of human civilization.

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