Global food production systems: The need for embracing yield and quality

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Global population has reached 7.5 billion today, up from 2.5 billion in 1950, 3.7 billion in 1970 and 6.9 billion in 2010. According to The United Nation's projection, the world population could reach 9.15 billion in 2050. Thus, we expect an average annual increase of around 50 million with a total increase of 1.65 billion over the next 33 years, which is lower than the annual increase of 80 million occurred between 1970 and 2010. In order to feed this larger population, food production must increase substantially by 2050. For example, annual cereal production (*excluding the food grains used for biofuels*) will need to rise to about 3 billion tons from 2.6 billion tons today and annual meat production will need to reach 470 million tons rising from 320 million tons today (1). Despite the problems of food distribution and human access to food in various regions, the global agriculture, both food crops and animal, has thrived meeting such challenging demand for more food so far and will probably be able to produce the total quantity of food assumed as the projected need to feed the anticipated 9.15 billion population by 2050. Thus, the accomplishments in agricultural productivity through advancement of agricultural science and technology and their applications are very remarkable and encouraging.

Food quality is believed to be a combined outcome of the concentration and forms of various nutrients pertaining to density and physiologically bioactive forms of various nutrients in a food, freedom from toxic constituents like pathogens, mycotoxins, chemical contaminates, and toxic levels of essential and non-essential minerals or phytochemicals; and organoleptic quality pertaining to taste, flavor, aroma, appearance, mouth feel, storage stability (2). Generally, a good quality food represents a balanced-holistic picture of all these qualities attributes rather than placing more emphasis on one than another. Global agriculture has been very successful in feeding the ever increasing population by taping the physiological limits of crops, farm animals, and cultured fish by genetic manipulation and intensified use of various agricultural inputs. Geneticists and breeders have continuously uncovered the ways to conquer the bottlenecks to higher yields of food and feed crops, and levels of animal and fish production. However, we achieved these extraordinary goals often at the expense of nutrient density (3), the environment, and seldom plant and animal health and food safety (4). The increased of yields of food crops or production per animal is associated with an increased risk of plant or animal diseases. An inverse relationship of production per head with the health, ability to give birth, and life span of cattle and other farm animals is well-known (5). We also experienced various adverse environmental consequences of high input crop and animal production systems (6).

Despite the huge progress made in agricultural productivity during the last few decades, a key unresolved issue has been prevailing or even getting worse, is the suboptimum nutritional quality of our food systems and their consequential inability to support sound human health in our societies. Scientists have already realized the fact that our current food systems are not able to meet the nutritional needs of approximately 3 billion people around the world, which is 40% of the current global population. We also realize that human diets of poor nutritional quality now stands as the most important contributor to the global human disease load. Many countries around the globe by investing talents, energy, and capital, have modernized their agricultural production systems with a remarkable increase in food production along with a tremendous economic growth and far improved livelihood of their people. However, numerous public health issues related to poor nutrition have been remaining unresolved or even aggravated. Many intellectuals, engaged in research and development in food crop production, human nutrition, and food policy areas, believe that our burning need of increasing the yield of food crops has been achieved with a sacrifice of nutritionally rich and very diverse cropping systems. For example, Davis (7) found three kinds of evidence point toward declines of some nutrients in fruits and vegetables available in the United States and the United Kingdom: 1) early studies of fertilization found inverse relationships between crop yield and mineral concentrations; 2) three recent studies of historical food composition data found apparent median declines of 5% to 40% or more in some minerals in groups of vegetables and perhaps fruits; one study also evaluated vitamins and protein with similar results; and 3) recent side-by-side plantings of low- and high-yield cultivars of broccoli and grains found consistently negative correlations between yield and concentrations of minerals and protein. Likewise, Marles (8) carried out contemporaneous analyses of modern versus old varieties of vegetables, fruits, and grains grown side-by-side, and archived samples, and found lower mineral concentrations in varieties bred for higher yields where increased carbohydrate was not accompanied by proportional increases in minerals. Generally, such decline in nutrient concentration in food crops is perceived as the well-known environmental and/or genetic "dilution effect"; i.e., increased yield produced by high yielding crop varieties with irrigation, fertilizers, and other inputs used in commercial farming tend to dilute the concentrations of nutrients by their distribution in larger quantity of the biomass. High input farming gives higher economic yields; we get less expensive food; but often of lower nutritional quality.

The World Health Organization estimated that at least 2 billion people world-wide suffer from one or more micronutrient deficiencies (9), a major public health problem in many countries. According to World Health Organization (10), nearly 3.7 billion people around the globe are iron deficient with 2 billion of these iron deficient individuals, being severely iron deficient, are indeed anemic. The clinical symptoms of iron deficiency in humans include anemia, fatigue, dizziness, reduced intellectual progress and reduced work capacity. It is also estimated that 2 billion people globally are at high risk of iodine deficiency. Humans often suffer from iodine deficiency when the soil is poor in iodine (places far away from seas), causing a low concentration in the regional food products with consequential insufficient iodine intake. In iodine deficient individuals, insufficient production thyroid hormones results in a series of functional and developmental abnormalities, collectively referred to as iodine deficiency disorders (IDD). The IDD includes mental developmental problems in children, impaired reproductive functions, and low intelligence level. In pregnant mother, the iodine deficiency causes impaired synthesis of thyroid hormones by the mother and the fetus. An insufficient supply of thyroid hormones to the developing brain may result in brain damage and irreversible mental retardation. As many as 35% of all 1-5 years old children suffer from zinc or iron deficiencies. Clinical symptoms of Zn deficiency in humans include diarrhea, pneumonia in infants and growth retardation in children. Vitamin A deficiency is prevalent in 190 million preschool aged children and 19 million pregnant women (11). About 800 million people worldwide are believed to be deficient in selenium (12). "Keshan" disease is a well-known example of an endemic cardiomyopathy that has been observed in children, adolescents and pregnant women in

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the “Keshan” region of China, a place where selenium levels in soil and food are extremely low. Typical manifestations “Keshan” disease due to selenium deficiency are fatigue after even mild exercise, cardiac arrhythmia and palpitations, loss of appetite, cardiac insufficiency, cardiomegaly and congestive heart failure. In many areas of the world, poor quality diets and associated micronutrient deficiencies are more widespread problems than low energy intake with catastrophic human health consequences. For example, 19% of all deaths before the age of 5 years could be attributed to combined vitamin-A, zinc, iron and/or iodine deficiency. There are three approaches for the amelioration of micronutrient deficiency, namely dietary micronutrient supplementation, diet diversification from various regions, and biofortification of food and feed crops. Bio fortification of food and feed crops can be achieved genetically and agronomically. A number of projects for genetic biofortification of rice, wheat, maize, cassava and sweet potato and few other crops are being implemented globally. These projects already offered few cultivars. For example, vitamin-A rich orange-flesh sweet potato and both vitamin A and iron rich ‘Golden Rice’. Agronomic biofortification involves application of micronutrient fertilizers to crops grown on deficient soils. A good success has been achieved with selenium biofortification in Finland and zinc biofortification of rice and wheat in India and of wheat in Turkey. An integrated approach involving human and animal nutrition experts and agricultural scientists (plant breeders and agronomists) is essential combat human micronutrient deficiencies.

Food processing industries are integral part of the industries producing food crops, meat, milk, egg and fish. They succeed and sustain on each other. With growing economy and urbanization, more people are choosing urban life style driving an increased demand for processed foods. It is an everlasting research process to inventing the appropriate ways of producing good tasting processed foods at a low cost with longer shelf life and more importantly minimizing loss of nutritional quality during processing and storage. This very important area requires blending of the knowledge base of “Food Science” with skills of “Food Technology”.

I am confident the *Applied Food Science Journal* will play a significant role to carry scientific information for generations and make significant contributions to the advancement of both food production and processing sciences, and contribute to elimination of human hunger, improvement of human nutritional and health status, and building healthier productive societies. With continued interest and contributions from the authors and supports from the team of reviewers, editors and support staff, I am very optimistic that the *Applied Food Science Journal* has started a glorious journey with this inaugural issue.

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