FACTORS AFFECTING FOOD SECURITY

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Abstract: *Consumption patterns are constantly shifting towards higher value- added products. There have been positive changes in the fight against global hunger, but despite progress, the world is still a long way from a sustainable food security system. The extreme climate is increasing production risk and placing a growing burden on farmers. Climate change poses a threat to the food supply of both rural and urban populations. Extreme climate events also have a negative impact on agricultural production in the long run, as exposure to risk and increasing uncertainty affect the introduction of effective economic innovations. Sustainable agriculture is essential to safeguard the future. At the same time, the growing population must continue to be provided with the proper quantity and quality of food without further destroying the environment and biodiversity. This endeavour is a huge challenge for scientists, producers, policy makers and consumers. There is no simple or easy solution to feeding the expected 9 billion people sustainably, especially if consumption patterns follow the current unsustainable trend. Sustainable food production can only be achieved by reducing greenhouse gas emissions and water consumption. We must avoid further loss of biodiversity, not only because biodiversity provides many of the public goods on which humanity relies, but also because we have no right to deprive future generations of the goods provided by nature. Together, these challenges raise a critical issue that needs to be addressed. The solution of this issue requires a social revolution that breaks down barriers to the flow of information between the science of food production and agriculture. The goal is not only to maximise productivity, but also to optimise the results of production, environmental protection and social justice (the equality of food distribution) in a much more complex way.*

Keywords: *food security; climate change, population; food prices; sustainable agriculture.*

JEL Classification: *Q11; Q15; Q18; Q25; Q53; Q54.*

1. Introduction

Currently, one of the key challenges is to increase global food production to achieve food security across all regions. Most agricultural surveys and research efforts focus on crop production, however, these analyses do not take into account the temporal instability of yields or the variability of grain production over the years (Gilbert, 2010). As the population continues to show a strong upward trend, agricultural production must also keep pace with it. Over the next 40 years, agricultural output will increase by approx. 60% in order to provide humanity with adequate quantity and quality of food (Fróna, 2018). The challenge for professionals and scientists is to achieve these emissions in a sustainable way without further destroying current biodiversity. Weather is also a significant risk factor, especially due to increasingly extreme weather anomalies. According to various relevant studies, strong population growth is expected within 30 years, after which the rate of population growth will significantly slow down (Hofstra and Vermeulen, 2016). According to Röös et. al. 2017 the world population will be approximately 9-11 billion by 2050 (Röös et al., 2017), but this total population will be disproportionately distributed among each geographical region, as a significant part of the population will be concentrated in urbanised regions. Thanks to scientific and technological innovations, Malthus 'prediction of 1798 has not yet come true, as increasing food production is still able to meet the food needs of a growing population In order to prove Malthus' even more distant findings for the future false, we need to make a very serious effort, especially in the field of crop and livestock production (Smith, 2015). Increasing production must be achieved without further environmental damage. Enhancing sustainable agriculture can be a way to ensure the required level of production while mitigating environmental impacts. Increasing sustainable agricultural intensity goes beyond the cumulated production and environmental performance (Hunter et al., 2017).

2. Literature

75% of the world's poorest people live in rural areas, where agriculture is still the most important source of livelihood (Fróna et al., 2019). Nevertheless, on average, more than 20% of the population in rural areas suffer from food security problems. Demand for high-fiber foods, feeds and crops is constantly increasing, putting increasing pressure on already exploited arable land and freshwater supplies. The size and proportion of land used to produce food and feed is highly dependent on the evolution of global food consumption habits and the average yields to be obtained. The production of raw materials for the increasingly widespread western diet in the world (with high consumption of meat, milk, and eggs) poses serious environmental challenges (Fróna et al., 2019). Continuous technical and technological development will continue to contribute to the improvement of the conditions mentioned above, to the mitigation and elimination of difficulties. At the same time, it is important to emphasise that the lack of a suitably qualified and knowledgeable workforce in many parts of the world is a serious obstacle to the introduction of technological innovations and increasing the efficiency of productive activities (Dajnoki and Kun, 2016, Herman et al., 2018, Fróna and Kőmíves, 2019). The growing population must strive for sustainable food consumption, as social, environmental and health impacts are also very important in this regard. Current global trends in food consumption cannot be analysed sustainably in terms of public health, environmental impacts, or socioeconomic costs (Blanchard et al., 2017). The change in consumption structure is caused by the increase in the number of workers earning higher and higher incomes in low- and middle-income countries (Popp et al., 2017). Changes in consumption habits have

primarily led to increasing consumption of meat, dairy products, and fruit and vegetables. It is particularly interesting that the seasonal consumption of fruits and vegetables has completely disappeared. Currently, one person eats an average of 42 kilograms of meat per year, which is expected to rise to 52 kilograms by 2050, and an additional 1.5 billion new consumers are expected to enter the market. The growing share of poultry meat among other types of meat should be mentioned here (Gergely et al., 2019). Due to changing eating habits, an increasing number of people are consuming chicken because it can be produced relatively quickly and relatively cheaply, and is not banned by any religion.
There is a uniform view in research that population growth is a major driver of global challenges. Food crop, fodder crop and energy crop production compete for land use. Furthermore, urbanisation is taking an increasing amount of agricultural land and putting pressure on current land use and biodiversity. It is estimated that growing food demand will require an additional 320-850 million hectares of agricultural land by 2050 (Oliver and Gregory, 2015). Demand for agricultural land is influenced by future food consumption habits, which is mainly influenced by socio-economic aspects of development. Depending on these changes, due to improving welfare, consumption will shift to animal-based food sources by 2050, which is not an appropriate trend (Blum, 2005). So the strong population growth is one of the key driver forces of global problems.

3. Results and discussion

3.1. Reasons behind changes in eating habits

Consumption patterns are constantly shifting towards higher value-added products, i.e. are animal products and dairy products, the production of which will increase the demand for fodder plants. The process is well illustrated by the fact that, between 1960 and 2010, the global per capita index of arable land fell from 0.45 hectares to 0.25 hectares and is expected to decline further by 2050 to a level of 0.2 ha (FAO, 2018). 66% of agricultural land is currently used by livestock in the European Union. This rate is 40% globally and is expected to increase further by 2050 (FAO, 2018). According to this data, dietary change will have a more significant impact on land use than population growth itself. Recognising the social needs and attitudes of consumer behaviour, a number of research studies analysing changes in food consumption habits have emerged that focus on exploring the routine nature of consumer habits and the profile of the institutions and infrastructure surrounding them(Jackson et al., 2009, Warde, 2005, Delormier et al., 2009).

3.2. The relationship between nutrients and hidden hunger

There have been positive changes in the process of fighting global hunger, but despite progress, the world is still a long way from a sustainable food security system. Obesity is a phenomenon that coexists with famine and malnutrition. Nearly 800 million people are chronically malnourished in terms of energy intake, while 2 billion people suffer from micronutrient deficiencies and 1.9 billion people are overweight or obese(McGuire, 2015). People with hidden hunger usually consume high-calorie but low-nutrient foods. Consumption of these inadequately nutritious foods often leads to obesity. This fact also demonstrates that hunger and obesity coexist globally. Therefore, it is interesting to note that a person may be malnourished (in terms of micronutrients) even with excessive calorie intake. People suffering from this form of malnourishment do not consume enough vitamins, minerals and trace elements. It is a great challenge for the future to produce not only the right quantity, but also the right quality food. To summarise the above written facts, three phenomena appear as contradictions but in parallel with each other: malnutrition, overnutrition, and hidden hunger. These three forms of nutritional problems are also referred to as the "triple burden" of malnutrition (Hengeveld et al., 2018). This triple effect contributes to decreased physical and cognitive human development, decreased fertility, susceptibility to infectious and chronic diseases, as well as aging (Fróna and Harangi-Rákos, 2019). Micronutrient deficiency is a global phenomenon that may affect certain social groups the most. Reducing various forms of malnutrition requires better food policies and targeted nutrition interventions. In Africa and Asia, the urban population is growing at a rapid rate, which may lead to a further decline in per capita nutrients (Trimmer and Guest, 2018).

3.3. Climate change and water resources

Currently, 97.5% of the Earth's water supply is salt water and only 2.5% is fresh water. 69% of freshwater is found in the form of glaciers and permanent snow, 30.7% in the form of groundwater, and only 0.3% in the form of lakes and rivers (Popp et al., 2014). In terms of availability, there are some similarities between freshwater resources and cultivable soil. If both factors are considered globally, they are available in sufficient quantities, but their distribution is very uneven. This is also illustrated by the fact that there are huge differences between countries in the same regions, but even within the same countries. Water demand is expected to increase by 100% by 2050, due to population growth, urbanisation and the consequences of climate change. As the urban population grows, household and industrial water consumption is expected to double (EASAC, 2017). Due to increasing food production, water resources in rivers and groundwater are used primarily to irrigate agricultural crops. Most irrigation systems tend to provide more water to plants than they actually need (Lane et al., 2017). Improving living standards, changing food consumption preferences and increasing demand for goods are generating higher water consumption. However, more than 650 million people, especially in sub-Saharan Africa, do not have access to good quality drinking water. The current situation is further exacerbated by the fact that 2.4 billion people live without modern wastewater treatment (WHO, 2015). The United Nations places special emphasis on the issue of wastewater treatment, which is properly illustrated by the fact that Element 6 of the Sustainable Development Goals (SDGs) is the availability of clean and healthy water. Ensuring the proper management and sustainable management of water resources is essential for present and future generations.

Climate change is a global phenomenon, but developing countries are at greater risk. The problems caused by urbanisation, increasing water scarcity and technological backwardness are the main challenges that need to be addressed. Rural areas must have access to basic services of the 21st century, such as utilities, health care, electricity, education, and so on. This is important for improving the living conditions of the population (Diaz and Moore, 2017). It is estimated that climate change has already reduced global yields of maize by 3.8% and that of wheat by 5.5%. Predictions and research suggest that further declines in productivity are expected as temperature changes exceed critical physiological thresholds (Lobell et al., 2011). The extreme climate increases production risk and places a growing burden on farmers' livelihoods. Climate change poses a threat to the food supply of both rural and urban populations. Extreme climate events have a negative impact in the long run, as exposure to risk and increasing uncertainty affect the introduction of effective economic innovations. Consequently, the number of low-risk, but relatively lower-return activities will increase (Lesk et al., 2016). Risk mitigation is also of paramount importance because farms are capital-deficient in many countries around the world (Fenyves et al., 2019a, Fenyves et al., 2019b). Agricultural activity contributes to global warming. Agricultural CO2 emissions in 2010 were 5.2–5.8 gigatonnes of CO2 equivalent per year, accounting for 10–12% of global anthropogenic emissions (Diaz and Moore, 2017). Processes related to agriculture with the highest CO2 emissions include fermentation, use of organic manure and fertilisers, and the combustion of biomass. Given the need to further increase agricultural production, emissions of harmful substances are also expected to increase. The main source of emission growth is the use of traditional agricultural techniques (as opposed to precision farming), which can result in further severe damage to the ecosystem, such as further water and soil pollution (Fróna et al., 2019). Changes in the environment can exacerbate malnutrition by limiting the ability to produce food products. Extreme weather events (such as droughts and floods) can contribute to volatile changes in food prices, which, in extreme cases, can cause serious problems in the form of riots or further increases in famine (Godfray, 2014). Sustainable food security solutions require the gradual development of innovation that covers the entire food chain. Openness to a commitment to innovation can introduce new perspectives and approaches to agriculture that can help solve the sector's problems. The development of human capital in agriculture is also important, as the success of the application of innovations depends to a large extent on the effectiveness of human activities (Pretty et al., 2010).

3.4. The issue of food and oil prices

Changes in food prices fundamentally affect the quantity and quality of food available to people. In developing countries, where much of household income is spent on food, changes in food prices are a critical factor. Relatively moderate price changes in these areas can also have a significant impact on food security. In recent decades, food prices were fluctuating. Market developments require the collective cooperation of the countries concerned in order to mitigate the adverse effects of price changes. Swinnen and Squicciarini (2012) drew attention to the contradictory messages of the parties involved in the food safety debate. These messages do not always correctly provide the true cause of high or even low food prices (Swinnen and Squicciarini, 2012). Not only price level but also greater variability may be a cause for concern (Calvo-Gonzalez et al., 2010). As noted by Baffes and Haniotis (2016), reversing the declining trend in food prices until 2000 has already had an impact on food security in developing countries (Baffes and Haniotis, 2016). According to Timmer (2008), the main sources of the recovery between 2000 and 2007 were increased inventories induced by global economic growth, the devaluation of the dollar, as well as changes in inventories and the utilisation rate (Timmer, 2008). In addition, adverse events, plant diseases and trade policy changes also had an impact on the aforementioned events, such as the growing demand for biofuels (where food crops, especially maize in particular, provide the raw material) (Baffes and Haniotis, 2016). According to a study by UNCTAD, agricultural prices are inherently more sensitive to fluctuations. These effects will require a more effective risk-sharing mechanism between markets, which may be able to strengthen the safety net for changes in food prices. Increased price volatility has a detrimental effect on developing countries due to the high proportion of low-income rural households, which often rely heavily on self-produced inventories (IMF and UNCTAD, 2011).

Changes in oil prices (and changes in energy prices in general) can be a critical factor in other prices. The impact of oil prices is twofold: first, high oil prices increase demand for alternative energy sources such as biofuels. These changes, in turn, increase the demand for raw materials, which can change the distribution between food, feed, and fuel. The second impact is that higher oil prices lead to higher production costs, which reduces food supply stability in the long run (Hochman et al., 2014). The Worldbank (2016) estimates that energy costs typically account for 10% of agricultural production, which means that agriculture and related sectors are extremely energy-intensive. In developing countries, production technologies and transportation are inefficient. For this reason, changes in energy prices can have serious consequences. Several studies have shown a stronger impact of energy prices on agricultural prices (Kristoufek et al., 2012, Kristoufek et al., 2013, Gilbert, 2010). These studies confirmed the link between energy and the agricultural market after the global economic and financial crisis. The obtained results clearly supported the possible non-linear effects, the increased transmission mechanism, and the long-term relationships (cointegration). At the same time, the root of the price increase is the basic market mechanisms, such as supply and demand. As Timmer (2008) noted, the long-term question is how supply will be able to keep pace with demand generated by rapid economic growth. As research results are often lagging behind in this area, the only chance to increase yields is the emergence of new agricultural technologies. The most effective solution against high food prices may be to increase agricultural production within a sustainable framework. The combined effects of climate change and water scarcity call for a quick and effective solution to the problem. Public opinion is often concerned with global warming, but the long-term consequences are not yet reflected in our everyday thinking or in widespread growth models. Macroeconomic models have an infinite time horizon and are modeled on non-limiting variables of capital factors, at least in terms of production factors, while real resources are very finite. The three factors of growth function are technology, capital goods, and labor. It is worth considering that, with the current or even a reduced amount of capital, growth is possibly only by means of technological development, i.e. the improvement of productivity, without further compromising nature's carrying capacity. For this reason, innovative innovations must be applied at all stages of production. Due to the growing demand for energy and food, it has become clear that greenhouse gas emissions, especially that of carbon dioxide, have an impact on the global climate. There is a growing demand for arable land where food production, fodder production, energy crops and urbanisation compete. These problems are exacerbated by the gradual depletion of soil productivity, which is also greatly affected by climate change (erosion, water scarcity, increase in soil salinity, etc.). Land use changes can damage biodiversity and increase greenhouse gas emissions. According to the scientific elite of global climate change, increasing global levels of greenhouse gases are leading to a general global warming trend, although the main question is still how anthropogenic activity is contributing to this tendency. What can we do to prevent this threat from escalating further, what can we do to end hunger and malnutrition? Is there enough arable land and water to feed the Earth's population? The answer to this phenomenon may be that it depends on how we manage these remaining resources. Technological innovations can enable humanity to increase food production in a sustainable way to meet reasonable needs. Finally, the issue of food security affects both people and the finite resources. There is no simple or easy solution to sustainably feed the projected 9 billion people, especially if consumption patterns follow the current unsustainable trend. Hopefully, scientific and technological innovation will help overcome this challenge. Sustainable food production can only be achieved by reducing greenhouse gas emissions and water use. We must avoid further loss of biodiversity, not only because biodiversity provides many of the public goods on which humanity relies, but also because we have no right to deprive future generations of the goods provided by nature. Together, these challenges represent a critical issue to be addressed. Its solution requires a social revolution that breaks down barriers to the flow of information between food production science and agriculture. The aim is not only to maximise productivity, but also to optimise the results of production, environmental protection and social justice (equity in food distribution) in a much more complex way.

4. In conclusion

Sustainable agriculture is essential for safeguarding the future. Considering the environmental load, agriculture is one of the most environmentally damaging activities. At the same time, providing the growing population with adequate quantity and quality of food, in a way that no longer destroys the environment and

biodiversity, poses a huge challenge for researchers, producers, policy makers and consumers. Growing populations and changing food consumption habits (growing demand for higher value-added foods) in developing countries are expected to increase food demand by 60% by 2050. Sustainable production of food for human consumption requires new technology that allows for more efficient use of limited resources such as soil, water and fertiliser. Traditional agricultural production cannot be economically or environmentally sustainable.
A fundamental transformation of food production is needed to preserve the ecological conditions of the planet and avoid health risks. The key to the solution is so diverse that it is essential to integrate and innovate the relevant disciplines. These include, for example, molecular biology, food science, medicine, agronomy, ecology, soil science, IT, and natural biology. Long-term, interdisciplinary human health studies need to be further integrated to achieve higher standards and compatibility of sustainable food production. Global food security requires further industrial and scientific revolution. It is also important to note that there is a growing demand for arable land for which food production, feed production, energy crops and urbanisation compete with each other. These problems are exacerbated by the gradual decline in soil productivity, which is also greatly affected by climate change (erosion, water scarcity, increase in soil salinity, etc.). Land use change can damage biodiversity and increase greenhouse gas emissions. According to the scientific elite of global climate change, increasing global levels of greenhouse gases are leading to a general global warming trend, although the main question is still how anthropogenic activity is contributing to this. What can we do to prevent this threat from escalating further, what can we do to end hunger and malnutrition? Is there enough arable land and water to feed the Earth’s population? The answer to this phenomenon may be that it depends on how we manage these remaining resources. Technological innovations can enable humanity to increase food production in a sustainable way to meet reasonable needs. Hopefully, scientific and technological innovations will help to overcome these challenges.

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