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AGRICULTURAL INPUTS AND FOOD SECURITY

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Abstract: *Food security is a broad interdisciplinary process with multi-sectoral implications that go beyond the food production, supply and procurement needs. Ensuring consumption availabilities has lately gained particular importance due to the evolution of the prices of production factors. The analysis of annual indices for energy, agriculture and food processing shows that energy prices (coal, crude oil and natural gas) have registered spectacular increases. The common responses to problems related to the scarcity of resources include higher prices, while the common responses to the management of resources involve their more efficient use, introducing alternatives and recovery of resource after use, involvement of public factors in supporting agricultural production.*

Key words: *food security, agricultural inputs*

JEL Classification: Q12, Q18

INTRODUCTION

Food production stability has a multidimensional character. Food system productivity is closely linked to economic and social conditions, as well as to the climatic factor. As it results from the conclusions of specialist studies, the impact of changes in climate variables on crop yields is different by crop species and regions, so that it is quite difficult to reach an understanding of the influence of annual inter-climatic variations on crop yields in different regions. When there is a dynamic balance between the environmental and management factors, stable crop yields can be obtained. In this sense, the evolution of the consumption of fertilizers and pesticides as well as of their prices are of crucial importance in reaching food security.

MATERIAL AND METHOD

Various sources from literature have been studied, such as: forecasts of potential world nitrogen, phosphorus and potassium balances, demand projections based on agronomic considerations (for example, cultivated area and fertilizer application rate), market feedback, estimates of industrial associations, growth models, econometric models and other assessments by experts. The evolution of annual indices for energy, agriculture and food processing on the global market, the fertilizer consumption, the evolution of prices and price indices of the agricultural production means, of agricultural products on the European market and in Romania were also analyzed.

The data sources come from FAO, World Bank, Eurostat and national statistics.

RESULTS AND DISCUSSIONS

The green revolution led to high productivity of crops by the increase of cultivated areas, use of high-yielding hybrid seeds, excessive use of inorganic fertilizers and pesticides, emergence of new irrigation equipment and methods and agricultural machinery.

There have been many challenges since the phosphorus, nitrogen and potassium began to be used on farmland. Phosphorus is a non-renewable resource, like oil. Various studies state that at the current extraction rates, the global commercial reserves of phosphate will be exhausted in the next 50-100 years, and the remaining potential reserves are of lower quality or more expensive to extract (Dana Cordel et al.).

The use of phosphorus fertilizers becomes increasingly efficient, mainly in Europe. According to the European Fertilizer Manufacturers' Association, the farmers from Europe and North America are increasingly avoiding overfertilization and they incorporate straw and manure instead in agricultural soils, partially in order to recycle phosphorus.

The pesticides are substances or a mix of substances mainly used in farming or in the public health protection programs to protect crops from weeds, pests or diseases. This category includes herbicides, insecticides, fungicides, rodenticides and plant growth regulators. Several authors discussed the advantages of pesticide use. For instance, it was found that, over time, there is a positive relationship between economic development and pesticide use. Jerry Cooper and Hans Dobson (2007) identified 26 immediate and undeniable primary benefits and 31 secondary benefits on the longer term, which are less intuitive and for which it is more difficult to establish causality. Lewis, Nancy M. and Ruud, Jaime (2005) attributed the doubling of US blueberry production and the subsequent increase in consumption mainly to herbicide use that improved weed control.

Other authors associated numerous negative effects upon health of chemical pesticides.

Box 1. Summary of reviewed studies on the effects of pesticides upon health

Health effect	No. of studies found	No. of studies included *	Summary of results	Average global score of included studies *
Dermatological effects	11	10	7/10 positive studies for dermatitis due to pesticide exposure	4.50
Neurotoxicity	60	41	39/41 positive studies for the development of 1 or more neurological anomalies due to pesticide exposure	4.99
Reproductive outcomes	64	59	Congenital defects: 14/15 positive studies; time to pregnancy: 5/8 positive studies; fertility: 7/14 positive studies; altered growth: 7/10 positive studies; fetal death: 9/11 positive studies; other results: 6/6 positive studies	4.83
Genotoxicity	15	14	11/14 positive studies for increased chromosomal aberrations with pesticide exposure †	5.03

*Reviewers scored each study on a 7-point scale for methodological quality from 1- very weak to 7- excellent. The studies with a score <4 were excluded.

Source: Non-cancer health effects of pesticides, Systematic review and implications for family doctors (2007), PMID

According to FAO forecasts conducted until 2022, taking into account the maximum achievable production (supply) and the total demand, there is a potential balance for nitrogen, phosphorus and potassium. The demand projections are based on agronomic considerations (for instance, cultivated area and fertilizer application rate), market feedback, estimates of industrial associations, growth models, econometric models and expert judgement. Unforeseeable factors such as raw material limitations, logistical problems, unscheduled suspension of activities due to technical problems, natural disasters (e.g. earthquakes, mine flooding) have not been taken into consideration. The forecasts of potential world balances of nitrogen, phosphorus and potassium, until 2022, are presented below.

Compared to the global capacity, Europe's production capacity is 23% for nitrogen, 10% for phosphorus and 40% for potassium; of the global demand, Europe accounts for 16% for nitrogen, 8% for phosphorus and 11% for potassium.

Table 1. World supply, demand and balance of nitrogen, phosphorus and potassium, 2016-2022 (thousand tons)

Specification	Capacity	Supply	Other uses	Fertilization availability	Demand	Potential balance
Nitrogen – World	190397	163219	40660	122559	111591	10968
Nitrogen – Europe	43589	37621	9595	28026	17552	10474
Phosphorus – World	63702	52066	7734	44332	43562	770
Phosphorus – Europe	6639	5688	1131	4557	3620	937
Potassium – World	64553	54197	6363	47834	40232	7602
Potassium - Europe	25790	22021	869	21152	4453	16699

Source: World fertilizer trends and outlook to 2022, Food and Agriculture Organization of the United Nations, Rome, 2019

Asia Pacific was the largest region in the global chemical fertilizer market, accounting for 41% of the market in 2020. North America was the second largest region, accounting for 18% of the global chemical fertilizers market. Middle East was the smallest region in the global chemical fertilizer market.

The main companies on the chemical fertilizer market include Nutrien Ltd.; Yara International; Mosaic Company; CF Industries Holdings Inc. and Israel Chemicals Ltd.

A current issue is the evolution of *fertilizer prices*, which sharply increased in 2021 and maintained or continued to increase in 2022, to reach levels close to those during the global financial crisis of 2008-2009:

- phosphate rock – 173.1 \$/ton in January
- DAP – 699.4 \$/ton in January
- triple superphosphate – 687.5 \$/ton in February
- urea – 846.4 \$/ton in January
- potassium chloride – 391.8 \$/ton in February

As compared to 2020, in the year 2021 the price for phosphate rock (P₂O₅) increased by 59%, for the diammonium phosphate (DAP - (NH₄)₂HPO₄) by 89%, and for triple superphosphate (TSP) by 100%; the largest price increase was for urea from Ukraine (E. Europa CO(NH₂)₂) by 108%. The potassium chloride price decreased by 5% in 2021 (Figure 1).

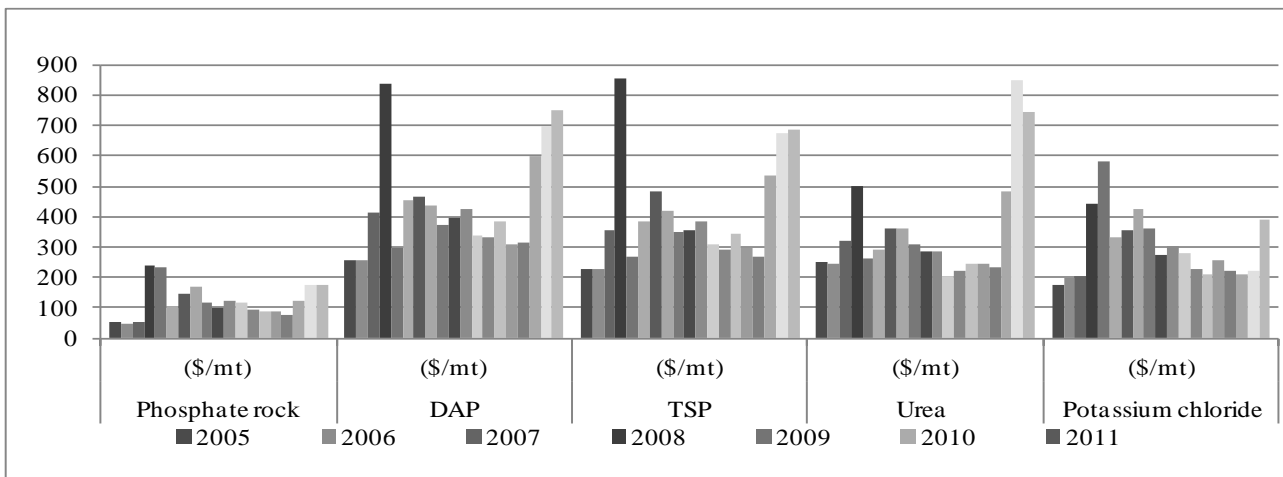


Figure 1. Evolution of chemical fertilizer prices (\$/mt)
 Source: World Bank Commodity Price Data (The Pink Sheet)

According to Mosaic Company, the largest American producer of potassium and phosphate fertilizers, each essential element has its own set of reasons why prices are high:

Box 2. Reasons behind the increase of fertilizer prices

- ✓ Nitrogen – supply interruptions due to weather events in 2020 and the increase of gas prices caused many facilities to shut down production, which led to significant increases of nitrogen prices globally. It is expected that these shutdowns will not be permanent, as gas prices return to more normal levels, production should increase and put less pressure on nitrogen prices in 2022.
- ✓ Phosphates – higher input prices, in the case of ammonia and sulfur; these two are critical inputs for phosphate production and their prices increased by 313% and 194% respectively from year to year – compared to 2020. In addition, the whole supply chain was deeply affected by the drastic increase in transport costs.
- ✓ Potassium – deliveries were limited due to unforeseen production disruptions in several mines, and the higher demand caused the increase of prices globally. The geopolitical situation in Eastern Europe might further complicate the interruptions of supply in 2022, leading to the increase of prices throughout the year.

Source: <https://www.mosaicco.com/Article/What-Is-Driving-Fertilizer-Prices>

In Europe, the increase of natural gas prices led to a large-scale reduction in ammonia production, an important input for nitrogen fertilizers. The natural gas crisis forced several factories producing nitrogen fertilizers to limit or stop their production, including companies like *Yara International ASA* from Norway and the most important European manufacturer of chemicals, the German group *BASF SE*. Natural gas accounts for 80% of the production costs of fertilizers, and currently prices are four to five times higher than normally, according to Fertilizers Europe.

According to World Bank methodology, the price indices for natural gas and fertilizers increased in 2021 compared to 2010 by 29.93 % in natural gas and by 31.4% in fertilizers (Figure 2).

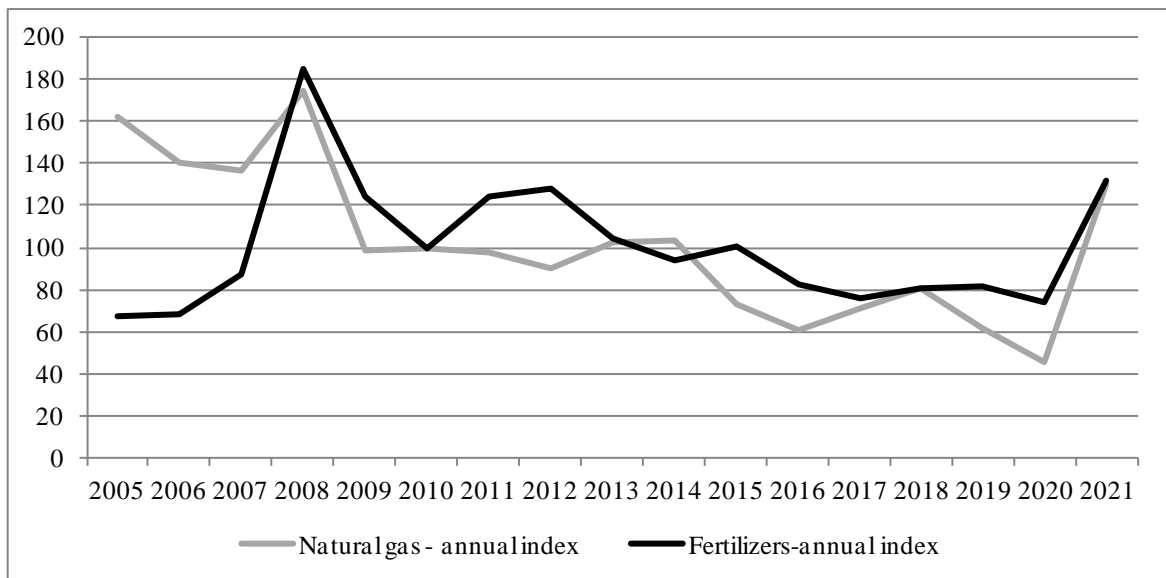


Figure 2. Evolution of annual index of natural gas and fertilizers, 2010=100

Source: World Bank Commodity Price Data (The Pink Sheet)

China is a key manufacturer of fertilizers, supplying urea and phosphates to the agricultural sector. China’s DAP (diammonium phosphate) and urea exports represents about one third and one tenth respectively of global trade. In 2021, China announced the suspension of diammonium phosphate (DAP) and urea exports. At the same time, Russia announced restrictions on the nitrogen and phosphate fertilizers starting with the last month of the year 2021.

The analysis of annual indices for energy, agriculture and food processing reveals that energy prices (coal, crude oil and natural gas) in 2021 were down by 6% compared to 2010. However, in agriculture the price index increased by 8%, and in food industry the price index increased by 21% compared to 2010.

Compared to the year 2020, in 2021 the energy price increased by 79%, the price of agricultural products by 22%, while food price increased by 29% (Figure 3). The sharper increase in food prices is explained by the share of energy expenses in total expenses, i.e. 27% in food industry compared to 14% in agriculture.

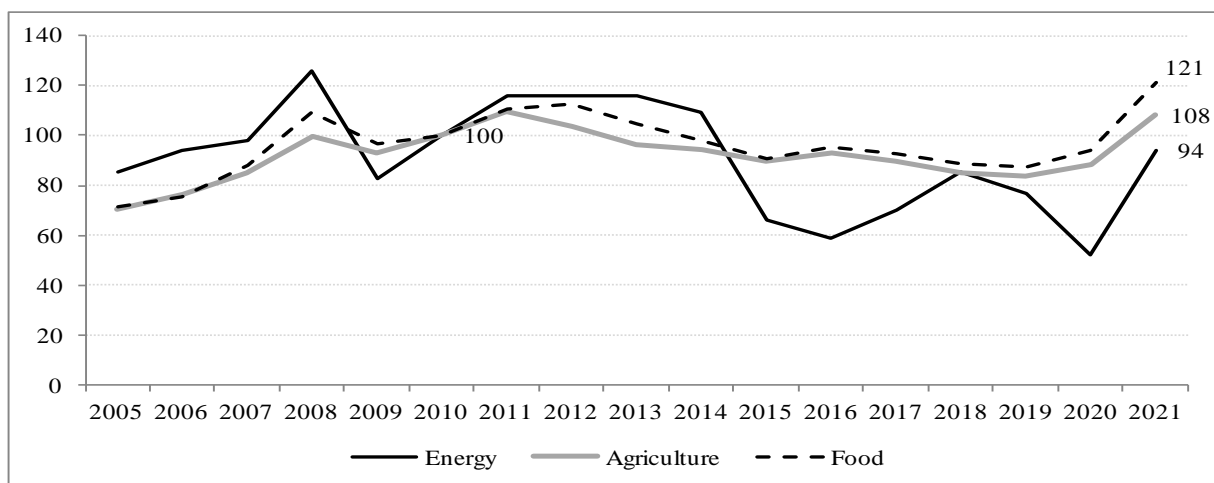


Figure 3. Evolution of annual indices in energy, agriculture and food industry, 2010=100

Source: World Bank Commodity Price Data (The Pink Sheet)

According to fertilizerseurope.com., the total fertilizer consumption in the EU amounted to 20 million tons in 2019. The share of imports in total consumption represented 40%. Fertilizer consumption (% of fertilizer production) in Romania was reported at 129% in 2018, according to the World Bank's collection of development indicators.

In Romania, the consumption of chemical fertilizers amounted to 738453 tons active substance, out of which 63% nitrogen fertilizers, 25% phosphate fertilizers and 11% potash fertilizers.

As compared to 2010, the total fertilizer consumption has increased by 54%, more consistently since 2018. The consumption of natural fertilizers reached 18680226 tons active ingredient in 2020, up by 23% compared to 2010.

The land area on which chemical and natural fertilizers were applied was 7522224 hectares, up by 6% compared to 2010 (Figure 4).

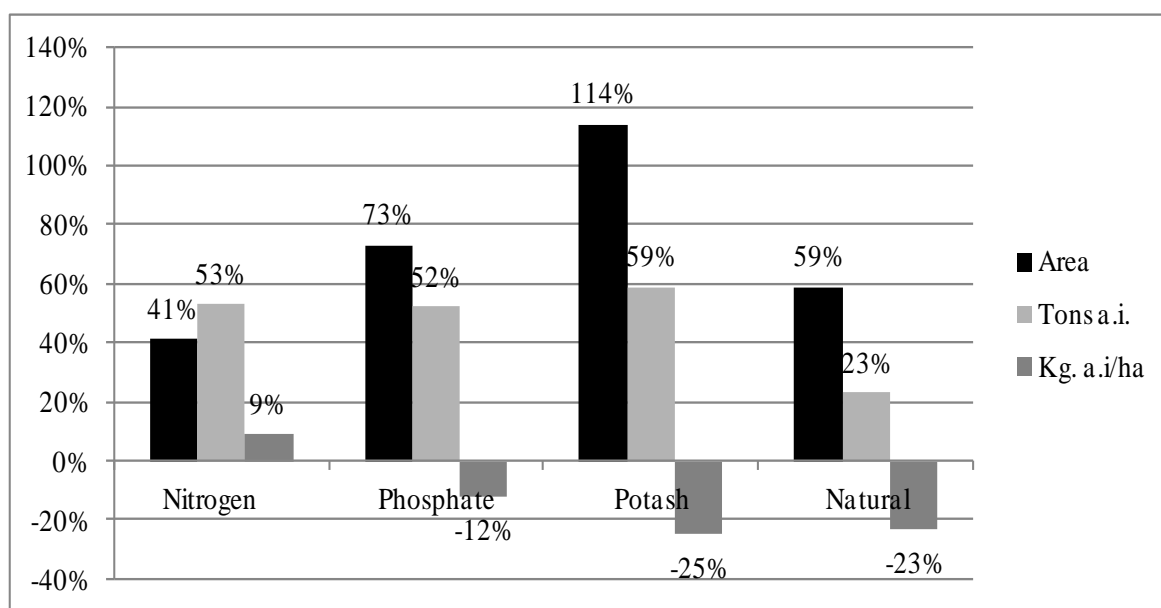


Figure 4. Evolution of area on which chemical fertilizers were applied, of total consumption and of consumption per hectare, 2020/2010 %

Source: Tempo online

Although the total fertilizer consumption increased, if we refer to consumption per hectare, we find that the amount of active ingredient per hectare increased only in the case of nitrogen fertilizers, while for the remaining fertilizers it decreased.

Table 2. Consumption of fertilizers in kg active ingredient / ha

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2020/2010
Chemical	67.8	70.6	69.1	79.4	67.7	81.0	79.2	80.0	104.3	101.7	98.2	45%
Nitrogen	71.0	71.2	65.0	76.3	64.5	76.7	71.2	73.1	85.4	74.7	77.4	9%
Phosphate	58.2	56.5	46.9	49.0	45.1	50.8	47.0	52.4	60.2	54.0	51.2	-12%
Potash	55.1	57.0	36.7	34.8	29.4	40.4	37.0	43.2	46.2	48.2	41.1	-25%
Natural	25384.0	23021.3	21946.1	21789.6	20454.2	17602.4	17310.3	17822.9	18912.9	18762.2	19615.1	-23%

Source: Tempo online

Table 3. Fertilizer price index in Romania and in the EU-27, 2015=100

	EU-27	Romania
Nitrogenous fertilizers	120.24	129.79
Phosphatic fertilizers	118.22	129.79
Potassic fertilizers	109.12	129.79
Compound fertilizers	110.01	130.80
NP fertilizers	109.35	140.18
PK fertilizers	113.73	130.80
NPK fertilizers	109.87	128.88

Source: Eurostat [apri_pi15_ina]

The price indices of the means of agricultural production (fertilizers, plant protection products and herbicides) increased more sharply in Romania than on the European market as compared to 2015. Overall, the price of fertilizers increased by 16% in the EU, while in Romania the fertilizer price increased by 30%. In the EU, the price increase is significant for nitrogen fertilizers, while in Romania the highest increases were noticed in complex fertilizers of NP type (Table 3).

The general price increase index for plant protection products and herbicides compared to that in the year 2015 was 103.12 in the European Union and 143.98 in Romania. While in the EU the price of herbicides increased by 5.13%, in Romania the increase was significantly higher, by 56.23% in insecticides and by 55.3% in herbicides (Table 4). The impact of inputs used in agriculture on the price of agricultural products is different on the two markets and by types of products, with the mention that lower increases are maintained in the EU compared to Romania. The highest impact for the Romanian market was found in vegetables, fruits and potatoes (Table 5).

Table 4. Evolution of price indices for plant protection products and herbicides, 2015 = 100

	2015	2016	2017	2018	2019	2020	2021
European Union - 27 countries (from 2020)							
Fungicides	100.00	101.34	101.81	101.14	100.25	99.82	100.63
Insecticides	100.00	101.01	101.93	103.41	103.54	104.39	105.57
Herbicides	100.00	100.88	101.58	102.80	102.44	101.69	105.13
Romania							
Fungicides	100.00	144.33	142.80	108.63	91.71	111.02	118.00
Insecticides	100.00	102.50	118.83	156.41	142.17	154.33	156.23
Herbicides	100.00	117.97	101.39	125.65	118.61	124.62	155.30

Source: Eurostat[apri_pi15_ina]

Table 5. Evolution of price indices of agricultural products in the year 2021, 2015 = 100

	EU 27	Romania
Cereals (including seeds)	137.03	139.97
Industrial crops	131.98	134.69
Forage plants	124.39	133.96
Vegetables and horticultural products	122.35	166.36
Potatoes (including seeds)	134.88	146.49
Fruits	136.31	158.59

Sursa: Eurostat [apri_pi15_outa]

There are four pillars to food security: availability of food (food supplied from domestic production or imports, food aids inclusively); access to food (rights); utilization of food through adequate diet, clean water, food hygiene; stability (of food supply). The stability concept may refer to both food supply and access.

According to FAO, there are four groups of factors that put food security at risk: 1) natural factors (pests, diseases, drought, fire), 2) market factors (falling prices, unemployment, increase of interest rates), 3) public and state factors (reduced spending on public health, increased taxation, fewer nutritional programs) and 4) other (displacement of communities as a result of war or embargoes).

Regarding the market factors, it should be mentioned that in the new global context, in the first place it is the increase in the prices of agricultural inputs that contributes to the increase of prices of agricultural products, being a serious threat to food security, if we take into account their transmission in the food chain.

CONCLUSIONS

Common responses to the problems related to resource scarcity include higher prices, more efficient use of resources, introducing alternatives and recovery of resource after use. Besides the natural factors (pests, diseases, drought), price increases in fertilizers and pesticides on the domestic and global market as well as the non-involvement of public factors in supporting farms can seriously affect a large part of the population.

As regards the consumption of fertilizers in our country, the consumption of active ingredient per hectare increased only for nitrogen fertilizers, and it decreased for the remaining fertilizers compared to the year 2010, these accounting for 63% in crop fertilization.

The recent increases in fertilizer prices are due to several factors, such as fluctuating natural gas costs, rising commodity prices driving global demand for fertilizers, supply disruptions, fertilizer export restrictions to ensure self-supply.

The high fertilizer prices put inflationary pressure on food prices, exacerbating food security concerns, while the restriction of fertilizer and pesticide use through environmental policies is another force that will shape the market in the next years.

In the years to come, the market will focus on organic products that contain live micro-organisms, such as bacteria, fungi and algae, able to fix atmospheric nitrogen or to transform the soluble phosphate and potassium from soil into forms available to crops. As regards pesticides, if the ecological principles are not taken into account, the outcomes can be harmful and irreversible in the long term.

Without denying the negative impact of the use of inorganic fertilizers and pesticides on soil and human health, reality shows that the transition to alternative methods must take place over a sufficiently long period of time, so that the supply of fertilizers and organic products will be sufficient, should not affect farmers' incomes and the availability of food on the market as well as the accessibility of healthy foods for all.

The main threats to food security are the prices of foodstuffs and the disappearance of the variety of crop species. Just as during the Green Revolution the cultivation of indigenous crop varieties was reduced, an alternative is to encourage the production of local varieties of fruits and vegetables in the kitchen gardens, using clean methods, a practice by which people are directly interested in the family's food security. At the same time, the consistent support through subsidies to

the cultivation of local varieties on farms with green technologies would allow the increase of supply, facilitating consumers' access to healthy products.

REFERENCES

1. Dana Cordell, Jan-Olof Drangert, Stuart White (2008) The Story of Phosphorus: Global Food Security and Food for Thought, DOI:[10.1016/j.gloenvcha.2008.10.009](https://doi.org/10.1016/j.gloenvcha.2008.10.009)
2. Jerry Cooper and Hans Dobson, The benefits of pesticides to mankind and the environment (2007), [Crop Protection](#) 26(9):1337-1348, DOI: [10.1016/j.cropro.2007.03.022](https://doi.org/10.1016/j.cropro.2007.03.022)
3. LEWIS, Nancy M.; RUUD, Jaime. (2005) Blueberries in the American diet. *Nutrition Today*, , 40.2: 92-96.
4. [M Sanborn](#)¹, [K J Kerr](#), [L H Sanin](#), [D C Cole](#), [K L Bassil](#), [C Vakil](#), (2007); Non-cancer health effects of pesticides: systematic review and implications for family doctors, PMID: **17934035** 53(10):1712-20.