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TRENDS ON THE ARTIFICIAL FERTILIZER MARKET AND IN FERTILIZERS USE IN HUNGARY

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Abstract: *The fertilizer market in Hungary is rather concentrated, which has a strong influence on the price of the fertilizer. Our domestic fertilizer use is primarily determined by that of nitrogen. The use of phosphorus is also significant but the trends in the use of potassium do not match the total quantities applied in individual years. Consequently, it can be concluded that the majority of farmers still focus on the application of nitrogen and also apply phosphorus but either neglect or do not pay enough attention to potassium fertilization. The changes in fertilizer prices between 2006 and 2017 can be broken down into two periods. Until 2012 a very important and dynamic increase was observed as a result of which the prices of N, P and K fertilizers increased by 80-120%, 160% and about 120%, respectively. This was followed by a downturn in the market and in relation to 2012 prices there were 20-30% decreases experienced until 2017 but the rate of this lagged behind the prices in other European countries. Owing to this trend the prices of N, P and K have increased by 60%, 100% and 80%, respectively, over the past ten years. The correlation between fertilizer application and the prices of fertilizers in any given year is low but there is a positive one observed between fertilizer application and the fertilizer prices in the preceding year. This means supposedly that farmers mostly buy the fertilizers they wish to apply not in the current but in the preceding year and store them until these are applied. There is a strong correlation seen between fertilizer prices and the prices of corn and wheat, which means that fertilizer traders also keep tabs on economic results and also increase fertilizer prices under the influence of higher prices. Furthermore, it can be claimed that there is no correlation between crude oil prices on the world market and domestic N fertilizer prices. This is an important factor since the primary base material of N fertilizers is natural gas and their production involves considerable energy costs as well. It can be seen, however, that this is not what determines our domestic fertilizer prices, which can be explained by the fact that the price calculations by the determining actors on the Hungarian fertilizer market is not based on costs but on the demand.*

Keywords: *Fertilizer Use, Fertilizer Prices, Fertilizer Trade*
(JEL Classification: Q13)

INTRODUCTION

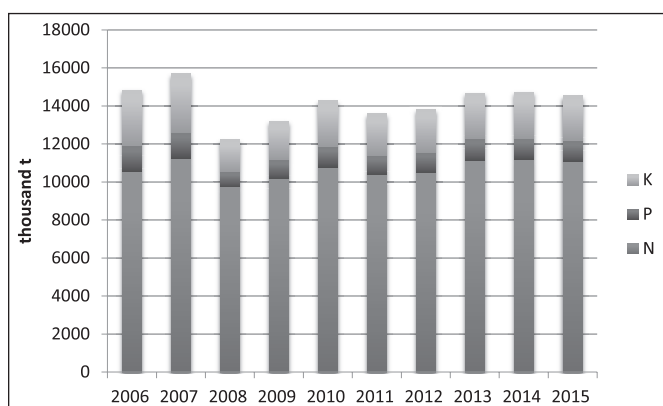
About half of the world's crop production, food supply, foraging fibre and fuel supply is closely related to fertilizer use. According to the forecast by WHO the world's current population of 7.3 million will have increased to over nine million by the year 2050. As a result a further increase in the demand for food and feeds can be expected. In order to increase crop production it is essential to maintain a viable and efficient fertilizer application, which in turn means that an increase in fertilizer application is to be expected globally. This is also supported by a FAO study of 2015, which says that according to FAO data the fertilizer application of the world was 185 million tons effective matter in 2015. The volumes of N, P and K amounted to 112, 42 and 31 million tons, respectively. These values increased

by about 2% despite the fact that they decreased owing to tense domestic interior conditions in Easter-Europe, and Central as well as Western-Asia, and because of decreasing crop buying up prices in North-America. Thus the increase was the result of the increases in Africa, Oceania, Eastern and Southern-Asia as well as Latin-America. According to forecasts the annual growth of 1-2% is to continue and so the application will have reached 200 million tons by 2020.

Fertilizer application in the EU has decreased to one third over the past thirty years. The lowest point was in 2010 and there has been a slight increase experienced ever since.

The total mineral fertilizer application in the EU member states in 2015 – based on the data of Fertilizers Europe – was 11, 1.1 and 2.4 million tons N, P and K fertilizers, respectively (Figure 1).

Figure 1: Agricultural uses of N, P and K fertilizers between 2006 and 2015



Source: private compilation on the basis of data by Fertilizers Europe 2017

The series of data well illustrates the decrease in 2008, the two reasons of which were the economic recession and the increases in fertilizer prices due to increases in fuel prices. By 2015 there was an increase again and fertilizer utilization reached the level for 2006. Current prospects and the increases in cultivated land areas indicate that further increases can be expected. These increases, however, are expected to be considerably different in individual regions of the EU. In EU-15 state and primarily in Germany considerable decreases are expected resulting from the Nitrogen regulation and as regards N, P and K applications, decreases of 35%, 50% and about 30% are calculated with, respectively. In France, Finland and the Netherlands decreases of about 10% are expected, respectively. In the East- and Central-European region, however, considerable increases are envisaged and as a result of soars in Potassium application increases of up to 50% are expected in Bulgaria, the Czech Republic and Romania. In Hungary increases of 20%, 15% and 10% are expected in N, P and K applications, respectively. Considering all the above together a decrease of 5% in N application and increases of 0.7% and 1.8% increases in P and K, respectively, are forecast by 2026 (Fertilizers Europe, 2017).

Fertilizer application in Hungary shows an increasing trend although its average volume lags behind either the world or the EU average.

MATERIALS AND METHODOLOGY

In preparing the current study my general objective was the analyze of fertilizer application in Hungary over the past ten-year period and finding as well as investigating individual factors that influence the application. My special, general objective-related goals serve the purpose of providing scientifically based answers to the questions emerging in relation to the investigation.

My questions relating to the topic are the trend(s) can be observed in fertilizer application and prices in Hungary over the past decade. The prices of natural gas and crude oil's influence domestic fertilizer prices. I looked for answers the influence the given price if use of fertilizers. And the correlation between the NPK use and some potential effect

factor such as yields, weather anomalies. Then I examined how can the domestic fertilizer application and prices be characterized with the help of different indicators?

In order to answer the questions I started by analyzing the available domestic and international databases and searched the illustrative world, EU and Hungarian fertilizer utilization and trade figures in secondary data collection. Next, an analysis with SPSS software of the database, which included 10 years' (2006-2015) data on the fertilizer market and agricultural crop production, compiled followed. The data lead to the calculation of partial efficiency indicators, with the help of which conclusions can be drawn on the domestic condition. In the analyses többlet space of the trends I used Excel software. Following the individual analyses correlation analyses between the domestic fertilizer utilization and other factors were carried out, such as:

- fertilizer prices in the given year
- fertilizer prices in the previous year
- corn and wheat prices in the previous year
- corn and wheat yields in the previous year
- corn and wheat average yields in the given year
- shaping of whether conditions in the given year
- crude oil prices on the world market
- natural gas prices on the world market

My research hypotheses were as follows:

1. Fertilizer prices show a continuous increase in Hungary also in the case of N, P and K fertilizers.
2. Increases in fertilizer prices considerably influence the volumes applied, the more expensive the given fertilizer is, the less of it will farmers apply.
3. Fertilizer application has a considerable bearing on the management results of the previous year, i.e., in case produce selling prices are higher, higher volumes of fertilizers will be applied in the next year.
4. Owing to the concentrated fertilizer market the price calculation is not cost-based, i.e., changes in the determinant crude oil and natural gas prices are not observed by the domestic fertilizer producers.

RESULTS AND DISCUSSION

Artificial fertilizer production in Hungary

Fertilizer production in Hungary is rather concentrated and a total of twelve producers cover 80% of the whole market (Varga, 2012). The domestic plants are owned by Nitrogénművek Co. and found in Pét and Szolnok. Peremartoni Fertilizers Producter Ltd. is located in Peremarton. The market leader is Nitrogénművek Co.. The total capacity of the Hungarian firms is some 1 900 000 tons and 90% of this is produced by the market leader.

Fertilizer trade

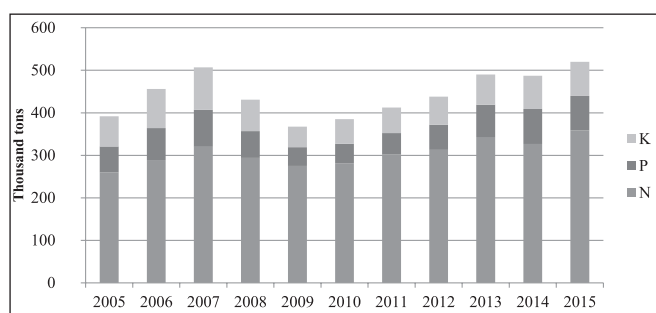
Hungary has a supply market of artificial fertilizers. 80% of the fertilizer sales in Hungary are done by 12 companies. Half of the volume produced by the companies are sold to their

domestic markets but they also produce for export to countries within the logistically economic about 600 km range. As a result, side by side with the domestically produced fertilizers import fertilizers are also present on the Hungarian Market.

According to Vágó et al. (2016) 50% of the fertilizers sold in Hungary comes from domestic producers and 50% is imported. The total volume of imported fertilizers reaches farmers via traders and the overwhelming majority of domestic fertilizers also gets to farmers via dealers. The volume that gets to farmers directly from the producer is about 10%.

The volume of the domestic fertilizer production between 2005 and 2015 is illustrated by Figure 2.

Figure 2: The volume of fertilizers in effective matter sold in Hungary between 2000 and 2015



Source: HCSO, 2016

Considered in natural mass 1.489 million tons of fertilizers were sold directly to farmers, of which 1.142 million tons were single component fertilizers and 347 thousand tons were complex ones. The ratio of single component and complex fertilizers was 75:25 in 2015, i.e., there are no significant changes (KSH, 2016).

As regards the utilization of nitrogen fertilizers it is worth noting that wing to its safety hazard (it was

declared explosive) the volume of the earlier dominating ammonium nitrate decreased considerably and farmers use Calcium Ammonium Nitrate (CAN) to replace it.

The value of the fertilizers sold is illustrated by (Table 1)

As it is seen in the Table 1., simple fertilizers accounted for 60-70% of the ones sold over the period analyzed and within this nitrogen fertilizers had a share of 90-95%.

Even in this case, what strikes the eyes is the volume increased due to the price explosion of 2008, which due to a decrease of up to 20%, exceeded the volume of 2006 by about 70%. Although this decreased somewhat in 2009, later, within six years doubled as a result of continuous increases and had risen to the level of 220%, i.e., HUF 136.5 billion by 2015.

Trends in fertilizer prices and the most important factors which influencing them

The price indices for fertilizers are shown in Table 2

Table 2 shows the changes in domestic fertilizer prices compared to those in 2005. All in all it can be claimed that the changes in fertilizer prices can be divided into two periods. Until 2012 there had been a very significant and dynamic change as a result of which the prices for N, P and K fertilizers went up by 80-120%, nearly 160% and about 120%, respectively. This was followed by a recovery of the market and until 2017 decreases of about 20-30% can be observed compared to 2012 prices but the rate of these changes lag behind the prices in other European countries.

Table 2: Price indices for artificial fertilizers on the basis of 2005 (=100%).

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
N fertilizers	100,0	117,3	126,7	185,4	164,6	154,1	194,9	213,7	206,5	204,5	207,2	179,7
P fertilizers	100,0	99,0	118,5	250,2	231,5	193,1	231,5	251,2	254,8	230,5	227,4	229,7
K fertilizers	100,0	111,3	111,9	248,8	279,0	198,4	231,5	258,5	250,0	216,9	226,0	210,5
NPK fertilizers	100,0	108,2	119,9	228,8	207,5	171,5	206,9	243,1	227,8	204,8	215,3	202,1
Fertilizers total	100,0	114,4	124,7	201,5	180,5	161,3	200,6	223,9	214,7	206,3	211,6	187,9

Table 1: The development of fertilizer sales in value over 2006–2015

Source: HCSO, 2017

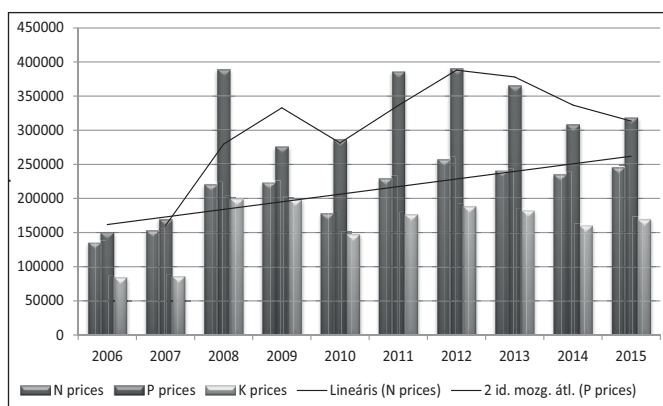
HUF million

Item name	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Simple fertilizers total	40 374	47 655	64 516	59 880	51 539	70 446	77 753	85 919	78 836	89 208
of which: Nitrogen	36 360	43 781	59 030	56 566	48 326	66 948	73 534	81 279	74 570	84 651
Phosphorus	714	433	318	125	255	378	349	290	206	314
Potassium	3 299	3 441	5 167	3 190	2 958	3 120	3 871	4 351	4 060	4 243
Complex fertilizers total	22 067	28 859	40 966	22 154	22 504	34 665	44 302	43 233	42 550	45 465
NPK fertilizers total	62 440	76 514	105482	82 034	74 043	105111	122055	129 152	121 386	134 673
Other, non-NPK fertilizers	n.a	n.a	1 643	1 397	1 487	802	1 085	1171	1 113	1 793
Fertilizer sales total	62 440	76 514	107125	83 431	75 530	105912	123140	130 322	122 499	136 466
Change (%)	100,00	122,54	171,56	133,62	120,96	169,62	197,21	208,72	196,19	218,56

Source: Research Institute of Agricultural Economics, 2017

Later an analysis of the trends in fertilizer prices between 2006 and 2015 followed (Figure 3). In each case the prices were proof-corrected to effective matter contents of 100%. The average prices for the most popular and wide-spread fertilizers, such as ammonium-nitrate (34%), urea (46.3%) and CAN (27%) were used. In the case of phosphorus and potassium I took the prices of super-phosphate (20%) and potassium chloride (60%) as bases.

Figure 9: NPK fertilizer prices corrected to effective matter(2006-2015)



Source: Own calculations and compilation based on data, 2016

It can be well seen that fertilizer prices increased considerably in 2008 due to primarily the price explosion of fuels, which was followed by a decrease. After 2012, however, prices started decreasing again. With application of SPSS trend analyses were conducted. It is to be noted that a ten-year period cannot be regarded as a short one in the case of fertilizer application but as regards item numbers it is still very low, anyway. Basic trend, however, can be inferred from them. It can be concluded that there is an increasing trend function that matches nitrogen prices, but phosphorus prices are characterized by a seasonal character indicated by a two-digit unstable average and as regards potassium there are not any matches over this time span. Over the time period indicated prices of N, P and K fertilizers increased by 82%, 136% and about 26%, respectively. Owing to the above, my hypothesis No. 1, which says that fertilizer prices in Hungary show continuous increases are discarded in the case of N, P and K fertilizers as well.

The individual factors potentially affecting prices were also analyzed, the results of which are contained in Table 3.

Table 3: Correlations between fertilizers and some potential effective factors

Factors analyzed	Pearson correlation value
Fertilizer utilization in the given year	0,259
Corn prices in the previous year	0,822
Wheat prices in the previous year	0,919
Precipitations over the given year	0,396
Mean temperature over the growing period in the given year	-0,649
Prices for natural gas (with the price of N)	- 0,623
Prices for crude oil (with the price of N)	0,464

Source own private calculation

The data in the table lead to the following conclusions:

- My presupposition according to which annual prices for corn and wheat positively influence the fertilizer utilization over the given year is not proven, there is no correlation between the two factors. As a result I discard my hypothesis No. 2.
- There are not any correlations between the annual prices in the given year and fertilizer application either.
- On the other hand there is a close correlation revealed between fertilizer prices and corn and wheat prices of the preceding years, which presupposes that fertilizer traders observe economic results and as a result of higher crop prices increase fertilizer prices, too.
- There is a weak negative correlation between N fertilizer and crude oil prices and there is no correlation between domestic N fertilizer prices and world market crude oil prices. The former is an important factor because natural gas is one of the determining base materials of N fertilizers and fertilizer production involves high energy costs but as we can see it is not this fact that determines domestic fertilizer prices. The explanation may be that in Hungary the price calculation by the crucial actors on the fertilizer market is not cost-based but is aimed at increasing the demand on the one hand and increasing the market share on the other. For this reason I accept my hypothesis No 4.

Fertilizer utilization

In the EU the highest doses of 400 kg fertilizer per hectare on the average are applied in Luxemburg, which is followed by Ireland at almost the same level, then the Netherlands, Croatia and Belgium at 300 kb/ha each. As regards Belgium's high fertilizer application the country's much higher than average (30 kg/ha) potassium application is also worth mentioning (World Bank, 2012). In Hungary similar doses (285 kg/ha) were applied between 1980 and 85 but this intense application entailed several negative consequences. As MARESELEK (2006) also highlights, industrialized farming started harmful, environment-polluting trends. Environmental damage was mostly the result of the excessive use of fertilizers and plant protecting agents.

Our current domestic fertilizer utilization is ultimately determined by the application of N fertilizers. Phosphorus application is also of considerable significance but potassium application does not reflect the volumes of fertilizers applied in individual years. This leads to the conclusion that most of the farmers still focus on the application of nitrogen and phosphorus is also applied but potassium application is either neglected or not enough attention is paid to it.

I conducted a correlation analysis of the variables that may have effects on fertilizer application, such as fertilizer prices in the given year, fertilizer prices in the previous year, weather conditions (precipitation, temperature) in the given year as well as the results of the management in the previous year, which were then compared to the cereal (wheat and corn) prices in the previous year and also tried to find correlations between fertilizer application and wheat and corn yields. The analysis was conducted at 95% reliability.

The correlations between fertilizer application and certain active components are contained in Table 4.

Table 4: Correlations between fertilizer application and some possible active components

Factors analyzed	Pearson correlation value
Nitrogen prices in the given year	0,259
Phosphorus prices in the given year	0,049
Potassium prices in the given year	-0,173
Nitrogen prices in the previous year	0,284
Phosphorus prices in the previous year	0,077
Potassium prices in the previous year	-0,090
Corn prices in the previous year	0,478
Wheat prices in the previous year	0,429
Annual precipitation in the given year	-0,366
Mean temperature during the growing season in the given year	0,475
Wheat yield and N fertilizer application	0,470
Wheat yield and P fertilizer application	0,433
Wheat yield and K fertilizer application	0,166
Corn yield and N fertilizer application	-0,259
Corn yield and P fertilizer application	-0,155
Corn yield and K fertilizer application	-0,228
Average wheat yield and N fertilizer application	0,467
Average wheat yield and P fertilizer application	0,261
Average wheat yield and K fertilizer application	0,188
Average corn yield and N fertilizer application	-0,297
Average corn yield and P fertilizer application	-0,127
Average corn yield and K fertilizer application	-0,042

Source: own private calculation

The major findings of the study

- No correlations can be shown between fertilizer application and fertilizer prices in the given year but although low, - however, stronger than with the given year- correlations are found between fertilizer application and fertilizer prices in the preceding year. This suggests that farmers mostly buy the fertilizer volumes they wish to apply

- not in the given but in the preceding year and store them.
- There is a negative correlation between fertilizer utilization and the price of potassium, which may lead to the conclusion that potassium is not necessarily applied by farmers even when its price is more favorable.
- My stipulation, according to which corn and wheat prices in the given year positively influence fertilizer application in the given year, was not proven and there is no correlation between the two factors.
- There is a weak correlation between fertilizer application and wheat yields in the given year but the former does not correlate with corn yields and the same can be said for average yields, too.
- There is, however, a close correlation revealed between fertilizer prices and corn and wheat prices in the preceding year, which suggests that fertilizer traders keep tabs on economic results and also increase fertilizer prices under the influence of higher prices. This conclusion is linked to my 3rd hypothesis but in lieu of certain data cannot be verified.
- The weather (precipitation and temperature) over the given year does not influence fertilizer application and thus I infer that weather related anomalies e.g. too much or too little precipitation in the given year are not made up for by farmers by applying higher doses of fertilizers.

Trends on the domestic fertilizer market revealed by partial efficiency indicators

To conclude the analysis I produced partial efficiency indicators for 2016, with the help of which conclusions may be drawn of further characteristics of the domestic fertilizer market. The most important indicators are contained in Table 4.

Table 5: efficiency indicators of the fertilizer market

Domestic fertilizer market's indicators	Value	Unit
Fertilizer dose per 1 ha (kg/ha) agricultural land	97	kg/ha
Fertilizer dose per 1 ha (kg/ha) arable land	120	kg/ha
Corn price – fertilizer price ratio (%)	561	%
Wheat price – fertilizer price ratio (%)	577	%
Rapeseed price – fertilizer price ratio (%)	232	%
Fertilizer mass 1 ton corn (t) can buy	0,18	t
Fertilizer mass 1 ton wheat can buy(t)	0,17	t
Fertilizer mass 1 ton rapeseed (t)	0,43	t

Source: own private calculation

As Table 5 reveals fertilizer application per 1 hectare in Hungary is below 100 kg/ha, which volume is below that in most EU member states and what is more shows a lower than global average (120 kg/ha) value. When the above figure is calculated for arable land only, the value rises to 120 kg/ha.

As regards the correlations between buying up prices of the most important domestic crops and fertilizer prices, we can see that fertilizers account for 561%, 577% and 232% of corn, wheat and rapeseed prices, respectively. This in turn means that in 2016 the price of 1 ton of corn, wheat and rapeseed could buy 0.18, 0.17 and 0.43 t fertilizers, respectively.

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