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HUNGARIAN AGRICULTURAL RESEARCH

March 2014

Journal of the Ministry of Rural Development Hungary

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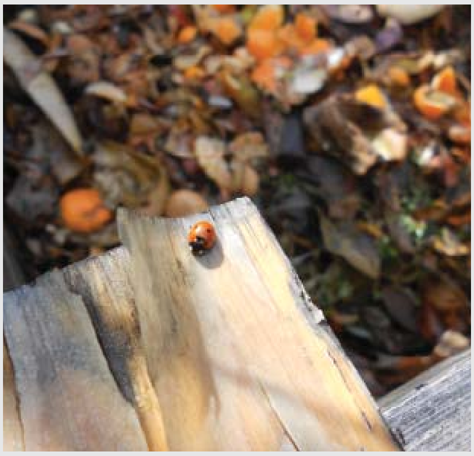
Dear Reader!

There comes a moment in the life of every periodical when it has to change both its design and contents, to be renewed according to the challenges of the era. This has happened to the periodical named Hungarian Agricultural Research, too. Since the beginning of 2014, the paper is issued by a new editorial board with members from the most prominent representatives of Hungarian agricultural sciences, covering all the decisive special fields. We tried to become more colourful, to be published in a more appealing way. But the change of form will be followed by the renewal of contents. We have set as our goal to gradually switch to the publication of studies that fulfil the requirements for scientific articles in every respect by conserving the readability and high scientific standard. We plan to start new columns by introducing the most prominent Hungarian professional and scientific events, celebrating significant anniversaries, standard-setting professional publications, books. We have set it as our goal that we will step beyond the borders to provide space to inform on the Hungarian-related results of the scientific communities in the Carpathian basin. But we do not want to change the mission of the paper even in the future: our most important goal will be to show the Hungarian agricultural economy, rural development, successes. We believe that through these articles, we serve not only the demanding Hungarian readers but broad layers of people interested in the country, may they live in the United States, Vietnam or in any other part of the world. We raise awareness – confined by limitations on volume – of our varied values on which we can be rightly proud, that we want to relay to even the faraway communities of the globe. I hope that our efforts will be met with trust, the former readership of the paper will continue to be faithful to us, and at the same time the number of those who read the periodical will increase.

I ask the Dear Reader in case he or she has a suggestion, opinion or any observation on the paper to send it to our editorial board without any hesitation. We are pleased to receive topic suggestions, ideas by which we can increase the standard of paper.

I welcome You on the occasion of the publication of the renewed Hungarian Agricultural Research, I wish you good reading!

Csaba Gyuricza
chief editor



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LEGAL GAME MANAGEMENT AND TECHNICAL ASPECTS OF THE WILDLIFE – VEHICLE COLLISIONS

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ABSTRACT

Wildlife - vehicle collision is one of the most common problems that can arise between hunters and non-hunters – beyond the agricultural and forestry game (caused) damages. Usually in these collisions significant material damage occurs, on the side of parties whose authorized to hunt and on the side of vehicle owners as well. Sometimes personal injury, even death can happen.

Examination of wildlife - vehicle collisions could be relevant from two aspects. One is the high number of vehicles and collisions plus the growing population of wild species which are involved in collisions, and the other is the changing legal regulatory environment.

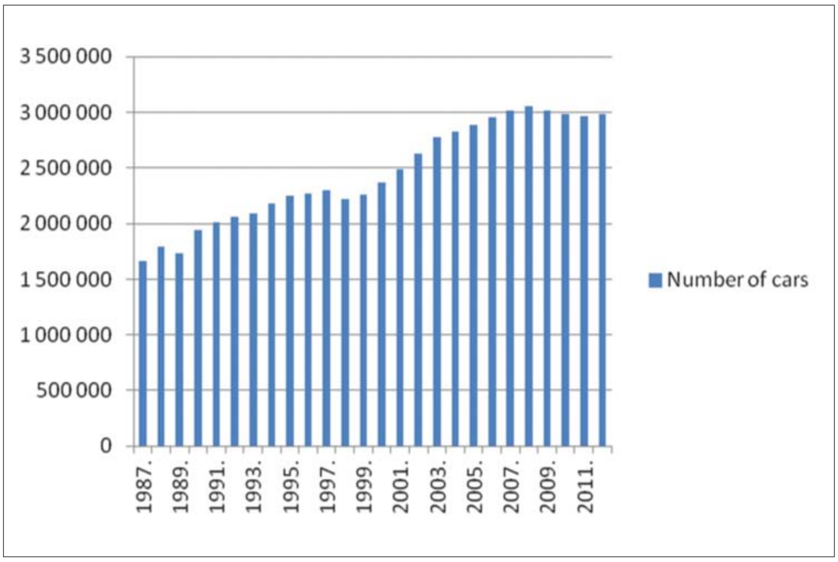

Chart 1: Change in number of cars between 1987-2012
Source: Hungarian Central Statistical Office, edited by the author

INTODUCTION

This study is the first of three, which is going to parse wildlife – vehicle collisions from legal, game management forensic and technical forensic aspests.

There has been a considerably simplified judicial approach to question liability problems recently. It would be useful if a competent forensic process could be worked out for the topic of wildlife – vehicle collisions. (Nagy, 2013)

MATERIAL AND METHODS

This study analyses the new – coming into effect - Act V of 2013 on Civil Code compared with the changing legal enviroment – the previous and new rules, commentaries and practise of justice. The study examines how the changing rules could respond to the liability questions of wildlife – vehicle collisions.

This study alludes the number of wildlife – vehicle collisions analysing the game kill data of the National Wildlife Management Repository between 2008 and 2012 hunting years, and the vehicle data of Hungarian Central Statistic Office between 1987-2012 years.

RESULTS

Over a long period - to the end of 1990's the party authorized to hunt (hunting societies and companies) had objective liability for damage from wildlife - vehicle collisions, threfore they had been contracting liability insurance.

In the 1990's insurance companies had significally tightened the conditions. The reasons were the increasing number of cars - including expensive new cars - and the occasional insurance abuses. Many of the companies and societies were no longer able to undertake these conditions.

The new Act LV of 1996 on wildlife conservation, wildlife management and hunting and the Act IV of 1959 on Civil Code amendments fundamentally changed the question. Liability damages originating from hazardous operation has applied also to the party authorized to hunt and driver.

The definition of liabilitiy damages originating from hazardous operation means – resulting from feature of these activities – the damage, the unlawfulness and their correlation establish the liability of the person who caused the damage - an attributable conduct is not required.

The rules of the meeting of the hazardous operations in the wildlife-vehicle collisions should be applied. It means, that if the cause of damage is not attributable to either party, but it derives from a malfunction that occurred within the realm of activity involving considerable hazard performed by one of the parties, that party shall be liable for paying damages. If the cause of damage is a malfunction that occurred in the sphere of both parties' activity involving considerable danger and furthermore such malfunction cannot be attributed to one of the parties, each party shall wear liability for his own loss.

Until 2004 - based on a ministerial regulation - the following actions had been considering attributable conduct by the party authorized to hunt:

If the wildlife-vehicle collision occurred on the road directly due to hunting activity; If the crash was due to artificially installed and operated wildlife feeders, salt lickers, water holes, wallows or agricultural land for wildlife were in one hundred meter zone of the road.

This legal provision was repealed, however, it is still respected in the judicial practice and in wildlife-vehicle collisions forensic expert reviews, as it could support the causality between the damage and the hazardous operation.

Salt lickers and wallows (Bleier, et al., 2006) and wildlife feeders are detectably popular among wildlife.

A provision of the Hunting Act is relating to the liability of the party authorized to hunt. He can initiate to prevent damage - for wild risk – to install appropriate security equipment, or road signs by person who construct or provide the road the placement of road signs. This initiative must be accomplished if the party authorized to hunt bears the costs of the establishment or the placement, maintenance and operation.

The rating of this provision does not appear consistent in the judicial practice.

There had been such judgment which would have been expected to initiate the placement of road signs in any case where a traffic route crosses the hunting area or passing along it, In such cases if the party authorized to hunt ignored the road sign should not be relieved of liability damages. (BDT.2000.139)

In other cases, although the traffic sign was established, the judgment found that the responsibilities of authorized hunting to the litigation many road accident occurred on a short road segment in a few years when the car and animals collided therefore it was not sufficient to prevent damage, it would have been necessary to establish proper safety equipment as well. (BDT.1998.28)

In another case the court did not appeal the liability of party authorized to hunt, claiming that despite the absence of danger signs, the driver must have taken into account that animals might be crossing the road, regardless security equipment, danger signs are there or not. (BDT.2000.307)

The Supreme Court decided that the release of game simply on the road cannot be evaluated a hazardous operations malfunction within the realm of the party authorized to hunt. The basis of damages liability may be the failure of obligation to prevent damage. (BH.2000.401)

A few years later, in another case, the Supreme Court decided to release the game appearing on the road in breeding period is a malfunction within the realm of the party authorized to hunt. The reason of this decision was the changed behaviour of game in the breeding period. (BH2003.237)

Findings of the Supreme Court, the game appearing on the highway is an unavoidable hazardous operations malfunction within the realm of the party authorized to hunt, which is basis of his damages liability. (BH2005. 212) Considering that the game companies have very little control over the highways security fittings, this is a very serious responsibility. For example, according to a study by the M3 motorway every hundred kilometer on average gets 81 game hits per year. (Markolt, et. al., 2010)

The Supreme Court in a later judgment evaluated a hazardous operations malfunction within the realm of the party authorized to hunt when in the inner area of a settlement, a game jumped from a high slope of hunting area down to the road - and clashed with a car. (BH2006.150)

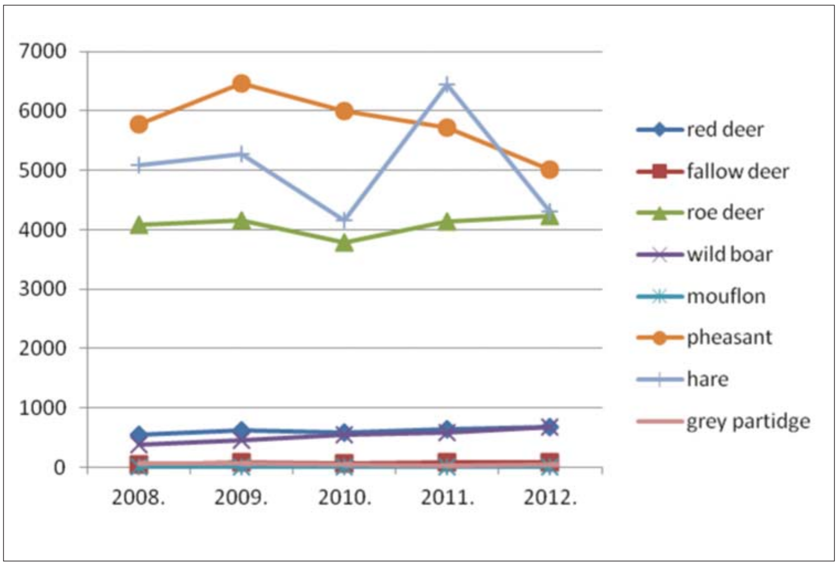

Chart 2: Yearly distribution of dead game in wildlife - vehicle collisions between 2008-2012
Source: National Game Management Repository, edited by the authors

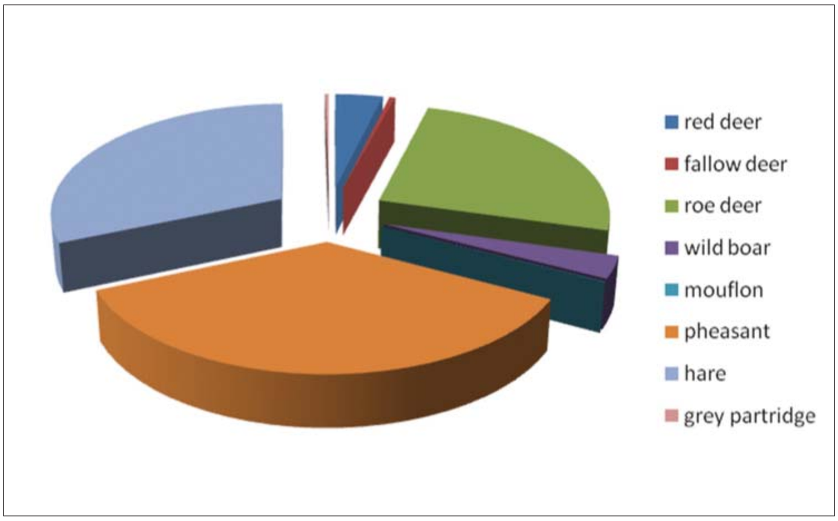

Chart 3: Distribution of dead game in wildlife - vehicle collisions between 2008-2012
Source: National Game Management Repository, edited by the authors

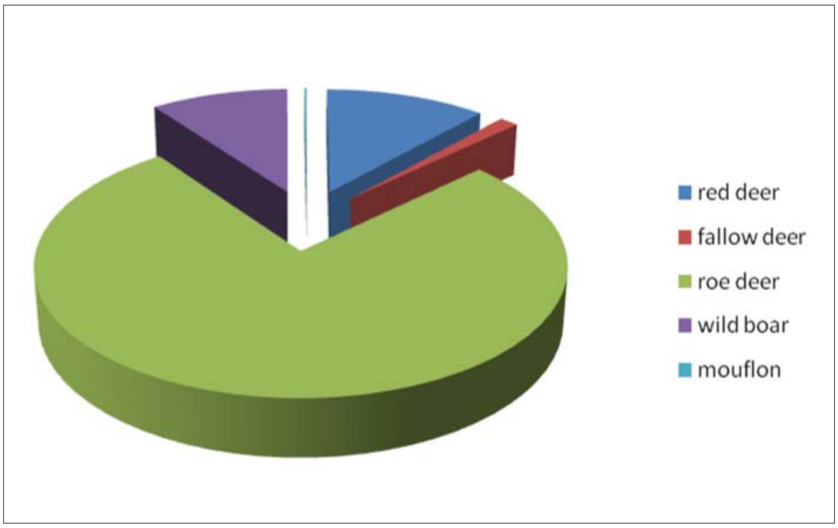

Chart 4: Distribution of dead big game in wildlife - vehicle collisions between 2008-2012
Source: National Game Management Repository, edited by the authors

The different judgments point out that the court shall consider all the circumstances of a case to able to decide in the question of liability. Many facts can influence what is considered a malfunction or attributable conduct in a case.

In case of wildlife – vehicle collision, the party who caused the damage could be relieved of liability if he is able to prove that he has acted in a manner that can generally be expected in the given situation. The party who caused the damage shall prove that his conduct was not attributable. He could be relieved of liability for damages if his prove would be success. (BDT2001. 400)

The seriousness of the problem indicates that - although not all collisions are reported- but for example only in 2012 more than fifteen thousand game perished in wildlife – vehicle collisions including big game (more than five thousand), which, given the fact that the monitoring data did not include all the wildlife species (for example fox, or badger), obviously represents more accidents.

The Act V of 2013 on the Civil Code of Hungary shall enter into force on 15th March 2014, and it changes at several points the previous regulation, furthermore, in connection with its entry into force are amended certain provisions of the Hunting Act.

The new regulation does not change the general rule of liabilitiy damages originating from hazardous operation, but complements it in several ways.

The prior regulation did not define the term "operator". The judicial practice operator shall be the person who maintains a hazardous operation, who permanently operated it, who can supervise, manage and control it, who has special obligation to protect against the hazards. It is not relevant from the operator's quality attributes that in whose interest does the hazardous operation work. (BH1988. 273.)

In comparison, according to the new regulation, the operator is in whose interest the hazardous operation works. If there are more than one operators, then they should be considered as persons who caused the damage together. The actual user is not under the stricter liability rules, but the operator is. This question is primarily significant in wildlife-vehicle collisions where the driver is liable. For example the occasional free assignments to use the car, shall not involve to driver the operator's quality.

Another modification of the complement regulatory the meeting of hazardous operations. Where the hazardous operations cause damage to each other, in proportion to the actionable conduct operators are required to compensate the damage caused to the other. If not the operator was the person who caused the damage, the operator is required to pay damages based on the attributable conduct of the real tortfeasor.

In connection with the liability of party authorized to hunt it is appropriate to examine changes in the regulation of game ownership and a new rule - liability for damage caused by fair game - all of the new Civil Code, all adapted to the Hunting Act to appear.

Basically the previous legislation followed by the provision that the game are owned by the state. Game that perishes or is killed or captured in hunting grounds shall be owned by a party authorized to hunt. Compared to the previous regulation, the new Civil Code has expanded into a significant element. Acquisition of ownership of game only occurs when the hunting rights of the party authorized to hunt is extended for this game. When the hunting rights does not extend for that game, it shall be owned by an other party authorized to hunt, whose game comes from his hunting ground, if he has got rights to hunt that game.

In our opinion, the question of the hunting rights of hunting authorized extends to a particular game, which is regulated implicitly by the Act LV of 1996 on wildlife conservation, wildlife management and hunting. The party authorized to hunt shall plan his activity per period, per game species, gender and age of fair game. These officially endorsed plans serve as a base of these rights.

According to the Commentary of Civil Code the amended provision was based on the Supreme Court, PK 5. resolution served. Pursuant to resolution this rule is applicable to wounded game which is hunted, captured or found on an other hunter area, and even if it is an illegal hunt or capture of game (for example by a poacher).

In our view, this amendment was not necessary, because already existing rules of the Hunting Act also directed this question that on the hunting area hunted, captured and perished game shall become the property of the party authorized to hunt. The wounded game which goes through from other hunter area will be the property of the other authorized if he – with consent of authorized- hunts or finds it after the search.

Due to the amendment, this provision is removed from the Hunting Act and from 15th March 2014 to the acquire the ownership of game the Civil Code's provisions shall apply.

Another issue of liability for damage caused by the fair game, which was also applied by the Hunting Act in the case of neither agricultural nor forest damage. According to the new shape of liability for damage caused by the fair game for compensating of the party authorized to hunt liable on whose hunting grounds the damage occurred, if it has not happened in a hunting grounds, whose hunting grounds the fair game cames from. The party authorized to hunt shall relieve from liability, if is he is able to prove that the damage occurred due to an unavoidable cause that falls beyond the realm of activities involving considerable hazards.

For the existance of the liability, it is not a necessary condition, that the party who authorized hunt would be entitled to hunt to that specific animal, which have caused the damage.

If a game perishes of a wildlife-vehicle collision, on which the hunting right of the party is not extended to who otherwise is authorized to hunt on that territory, then the perished game shall be owned by an other party authorized to hunt. The question is how the liability of the two parties authorized to hunt occurs in their relationship?

CONCLUSIONS

The correct and obivous determination of liability is the most important question at wildlife – vehicle collisions. These collisions cause significant damage and casualties, more than fifteen thousand times in every year. Several questions are raised by legal regulation and by practise of justice. In our opinion, the good solution is to call in a forensic expert into the procedure, with competent knowledge and process.

REFERENCES

1. *Act IV of 1959 On the Civil Code of the Republic of Hungary* (eusoils.jrc.ec.europa.eu/.../ HungaryCivilCode.doc)
2. Bleier N., Katona K., Bíró Zs., Szemethy L., Székely J. 2006. A vadföldek, a kiegészítőtakarmányozás, a sózók és a dagonyák jelentősége a nagyvadgazdálkodásában VADBIOLÓGIA 12: pp. 29-39. (2006)
3. Csányi S. szerk.: Vadgazdálkodási Adattár Vadgazdálkodási Alapadatok 1960-2013
4. Csányi S. szerk.: Vadgazdálkodási Adattár 2008/2009 vadászati év Lelövés, befogás, vadtelepítés és értékesítés 15 p.
5. Csányi S. szerk.: Vadgazdálkodási Adattár 2009/2010 vadászati év Lelövés, befogás, vadtelepítés és értékesítés 13 p.
6. Csányi S. szerk.: Vadgazdálkodási Adattár 2010/2011 vadászati év Lelövés, befogás, vadtelepítés és értékesítés 15 p.
7. Csányi S. szerk.: Vadgazdálkodási Adattár 2011/2012 vadászati év Lelövés, befogás, vadtelepítés és értékesítés 13 p.
8. Csányi, S., Tóth, K. és Schally. G. (szerk.) 2013. Vadgazdálkodási Adattár - 2012/2013. vadászati év (javított kiadás). Országos Vadgazdálkodási Adattár, Gödöllő, 11 p.
9. Fézer Tamás 2013. A kártérítési jog magyarázata, 2013 Wolters Kluwer
10. Markolt F., Heltai M., Szemethy L., Lehoczki R. 2010. Az M3-as autópálya vadelütési adatainak szempontú elemzése „Agriculture and Countryside in the Squeeze of Climate Change and Recession" Hódmezvásárhely, 22nd April 2010 Conference CD issue ISSN 1788-5345
11. Nagy, É. 2013. Gépjármű és vad ütközésének aktuális problémái, Jura 2013.I.
12. Pásztor, L. 2013. A vadgazdálkodás jellemzői, 2008–2012, Statisztikai Tükör VII. évf. 79.sz. 2013. november 15.
13. Központi Statisztikai Hivatal – STADAT Hosszú idősorok - Szállítás, Közlekedés (http://www.ksh.hu/docs/hun/xstadat/xstadat_hosszu/h_odme001.html)

CHANGES IN THE EFFICIENCY OF AN AGRICULTURAL BIOGAS PLANT DEPENDING ON THE RAW MATERIAL

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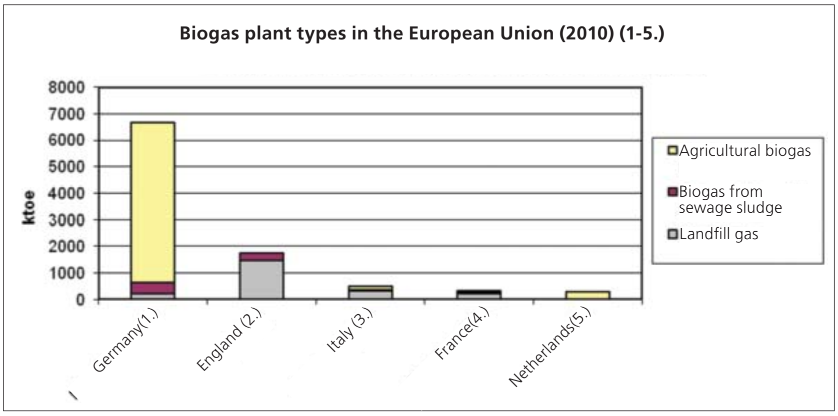
Biogas is a fuel gas produced from biomass and/or biodegradable fraction of waste matter that can be purified or upgraded to natural gas quality, to be used as biofuels, or the wood gas (Government Decree No. 42/2005 (10 March). During biogas production, biodegradable materials are decomposed into their components under anaerobic conditionshttp://en.wikipedia.org/wiki/Anaerobic_digestion. As a result, a gas mixture containing 50-75% methane and 25-50% carbon-dioxide is produced. Methane can be used to generate electricity and thermal energy, or – after purification – it can be fed directly into the natural gas pipeline as biomethane, or can be used as fuel. The residual organic matter is separated to liquid biogas by-product and solid biogas by-product, which can be used directly or after composting as plant nutrients.

Biogas is produced from raw materials obtained from:

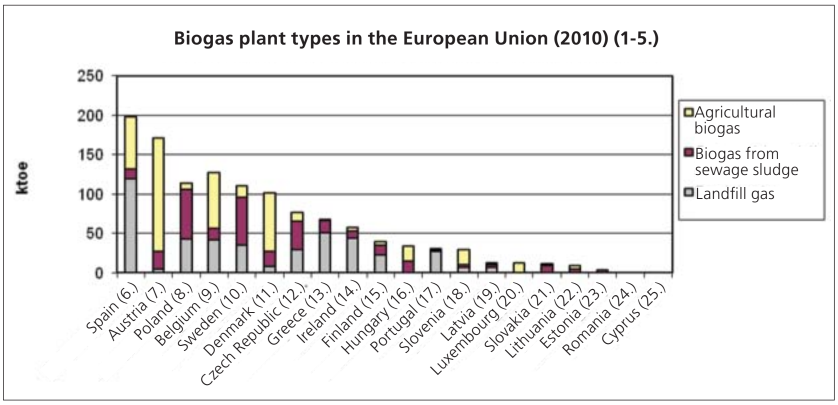
1. waste disposal sites, landfills (solid waste)=> landfill gas
2. sewage works (communal sewage, sewage sludge) => biogas
3. agricultural, food industry by-products, wastes (mixed raw material base) => biogas.

Figure 1 and *2* demonstrate the amount of energy produced in the European Union from biogas (in ktoe) in 2010 by plant types.



Agricultural biogas (non-centralized agricultural plants, solid communal waste fermenting plants, centralized co-fermentation plants); Biogas from sewage sludge (communal and industrial sewage sludge); Landfill gas

Figure 1: Amount of energy produced in European Union member states by biogas plant types in ktoe (Kilotonne of Oil Equivalent) (1-5) (2010) *(Source: EurObserv'ER, 2012)*



Agricultural biogas (non-centralized agricultural plants, solid communal waste fermenting plants, centralized co-fermentation plants); Biogas from sewage sludge (communal and industrial sewage sludge); Landfill gas

Figure 2: Amount of energy produced in European Union member states by biogas plant types in ktoe (Kilotonne of Oil Equivalent) (6-26) (2010) *(Source: EurObserv'ER, 2012)*

Countries with advanced biogas industry in the European Union are Germany (1), England (2), Italy (3), France (4) and the Netherlands (5). In Germany, Austria (7), Belgium (9), Denmark (11), Hungary (16) (19.3 ktoe) and Slovenia (18), primarily agricultural biogas plants are established, whereas in England, Italy, France and Spain (6), mainly landfill gas is produced (*Figure 1* and *2*).

Innovative sewage sludge fermenting technology is applied in England, France, Poland (8) and Sweden (10), the rate of which is high also in Hungary (12.3 ktoe in 2010).

TABLE 1: Parameters of the Regional Biogas Plant in Nyírbátor (2008)

Name of component	H	Ø	Retention time	Volume	Effective volume	Capacity
	m	m	day	m^3	M^3	kWh
2 mixing pits	4	10	1	628	628	
6 mesophil fermentor	5	18	18	7632	6409	
6 thermophil fermentor	5	20	22	9040	7914	
4 temporary bio-manure storage tank	5	5	30	9040	9040	
2 gas storage tanks		16		2000	2000	
1 temporary sewage storage tank				50	50	
4 block heat power plant						2600
1 gas treatment container	12,5	3				

Source: Petis, 2008 (H- geometric height, ø – width)

1. EXAMINATION OF RAW MATERIAL BASE OF REGIONAL AGRICULTURAL BIOGAS PLANT

The Regional Biogas Plant in Nyírbátor was built in 2002 at the request of Bátortrade Kft. In terms of its dimensions and technology, the plant is of world standard and unique in its kind. The regional plant is a multifunctional system performing agricultural activity and producing biogas with high methane content. The company carries out crop production on 3000 ha in its own land, while cereals, maize and sunflower are produced for them on 5000 ha on a contractual basis. In addition, 40 thousand tons of grains is dried, 1500 tons of alfalfa is dried, 9 million litre of milk is produced, 3.5 million broiler chicken are grown, 10 million broiler chicken are processed and sold, and biogas is produced *(Petis, 2008)*. Biogas is produced in low fermentors suitable for mixed raw materials, then utilized by gas engines that generate electricity and thermal energy at the same time. Biogas production is economic if raw material is supplied from local agricultural and food industry wastes or by-products. The technology is suitable for the processing of raw materials of both plant and animal origin, including animal wastes considered as environmentally hazardous. The plant is built next to a cattle farm and a poultry processing plant, thus, liquid manure and poultry wastewater is transferred to the fermentation space directly in pipelines, which reduces transportation costs and ensures continuous material supply. In the biogas plant, the mesophil and thermophil fermentors are connected in series. To supply the raw material for the biogas plant, a silo of 6000 m^2, an animal waste processing plant with a capacity of 100 t/day, and a composting plant with a capacity of 50,000 t/year were built *(Petis, 2007, 2008)*. The available fermentor capacity in the examined period (6 pairs of mesophil and 6 pairs of thermophil fermentors) was 17,000 m^3, producing about 20-25,000 m^3 biogas with methane 60-65% methane content (*Table 1, Figure 3*). The quality of biogas is measured in continuous mode using the computer-controlled gas analyser 'Chemec, BC20 Biogas controller'. The plant was enlarged in 2011-2012, as a result there are 16 fermentors (8 pre-fermentors and 8 post-fermentors) at present.

Figure 3: Layout drawing of the biogas plant before the expansion *(Source: I_1)*

In the biogas plant, about 120,000 m^3 mixed raw materials are processed annually, 85% of which is composed of crop production and animal husbandry by-products and wastes. The plant residues and manure is prepared alternately in the two mixing tanks in accordance with the daily supply requirements. When the substrate is properly homogenized, it is fed from the filled tank to the mesophil tanks though the delivery pipe using a pump. Meanwhile, the emptied mixing tank is filled in accordance with the recipe for the next material supply. The fermented material is separated and transferred to the 'bio-manure' tanks *(Petis, 2008)*. The solid biogas by-product is dried and reused as litter or in the biogas plant as supplementary raw material, or after composting for soil improvement. The liquid biogas by-product is exclusively used for soil improvement.

2. EXAMINATION OF RAW MATERIALS IN THE RECIPES, ESTABLISHMENT OF DATABASE

The first step of database construction is the examination of the quantity, composition and quality of organic raw materials fed daily into the fermentors between the period October 2006 and December 2008. The composition of the raw materials is of high importance in the biogas plant technology. The type and quality of raw materials available for a regional biogas plant based on mixed agricultural and food industry by-products and wastes may vary continuously. Accordingly, major attention should be paid on monitoring the effects of changes, and on analysing the effects of each raw material combination on biogas production and biogas quality. During the examinations, the average hydraulic retention time was defined then the correlation between the raw material combinations and biogas yields was analysed on the basis of long-term data queue (823 days).

Raw material is fed to the fermentors in two ways: either from the mixers after homogenizing or by direct feeding. First the quantities of each raw material fed into the mixers or the fermentors were recorded in the database, then the monthly changes in the raw materials was analysed to define the optimal raw material combinations. The quantity and quality of raw materials fed into the system vary day by day. These changes can only be tracked if the data are recorded and evaluated correctly. This is important not only for the comparison of biogas yields with quality values but also from the aspect of the traceability of the changes in quality features during the fermentation process.

The quality parameters (nitrogen-, carbon content, C/N-ratio, dry matter content, organic matter content, pH, temperature) of the raw materials and the fermentors are monitored constantly but with different regularity. As for raw materials, the examination of dry matter content and organic matter content is the most common in practice. As for the fermentors, the continuous checking of pH and temperature is essential as it provides important information to the operators. In Germany and Austria, the monitoring of volatile fatty acids (VFA) and/or FOS/TAC ratio (system buffer capacity) is also widely performed to avoid possible problems with anaerobic fermentation.

After the daily amounts of each raw material fed into the mixers and fermentors were defined, the quality parameters were assigned to the database, and the weighted values were calculated from the quality and quantity data. In this way, the quality correlated with the average quantities of the daily recipe (given in percent value correlated with dry matter content) is obtained which can be used to determine the values pertaining to ton/day. The correlation between the obtained weighted values and the biogas yield values can be analysed on the basis of retention times.

According to *Gruber* (2007), average hydraulic retention time (AHRT) can be calculated from the maximum volume of the fermentors (V_r) (m^3) and the amount of raw materials fed daily (V) (m^3/day), that is: AHRT =Vr/V. This interval indicates the degradability of the given material and the time required for the starting of biogas production.

The daily quantity of produced biogas is defined separately for the mesophil and thermophil fermentors, and by adding up these values we obtain the total daily gas yield in Nm^3 (a cubic metre of gas under a standard condition, defined as an atmospheric pressure of 1.01325 bar and a temperature of 15°C (I_2)).

3. EXAMINATION OF THE QUANTITIES AND DISTRIBUTION OF RAW MATERIALS

The average monthly raw material base is 8770 m^3 for the mixers, and 1456 m^3 for the fermentors. The quantity of raw materials fed into the mixers fluctuates considerably (standard deviation ±1165 m^3), while it is less for fermentors (standard deviation ±325 m^3). Knowing the quantity parameters and dry matter content, the order of importance was defined for the raw materials in the examined period for the mixers (*Figure 4*) and fermentors (*Figure 5*) (m^3/dry matter content).

The most important raw materials fed into the mixers, and thus into the fermentors, were cattle manure, silage maize and grained maize.

In 2007, the amount of gravy was also prevailing (1142 m^3). Comparing the two examined years, it can be seen that the annual amount of raw materials increased by 1.1% from 2007 to 2008. By 2008, the amount of gravy and glycerine was continuously raised, which provide easily degradable nitrogen and carbon sources, thus its positive effect on gas production can be realized almost instantly. The amount of liquid manure and poultry wastewater fed directly into the fermentors was gradually decreased by 2008 to zero.

The increase in the amount of acidic whey suitable for the setting of pH can be explained by the increased usage of alkaline gravy. In 2007, the liquid biogas by-product was recirculated into the system as an experiment,

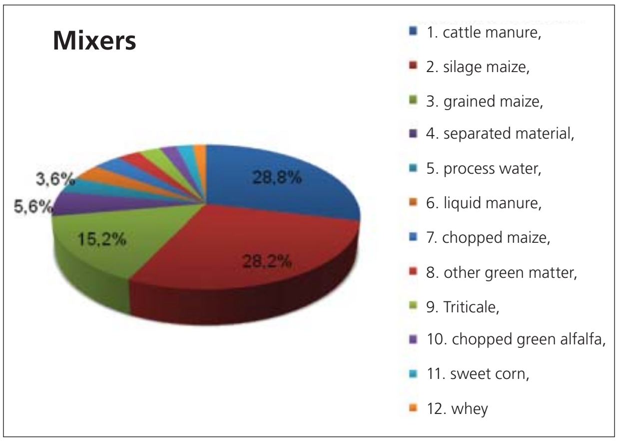


Figure 4: The major raw materials by dry matter content (2006-2008) (Source: Mézes, 2011)

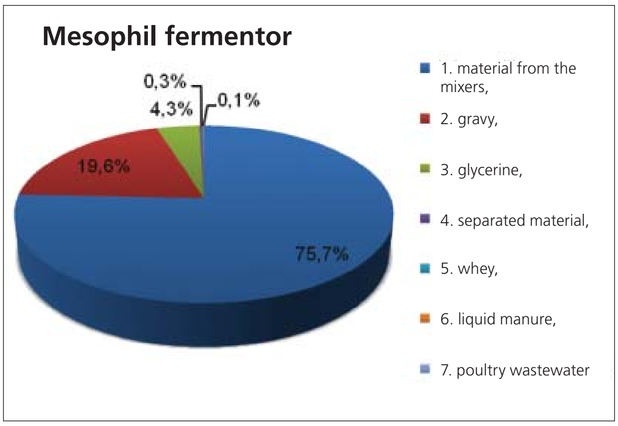


Figure 5: Average raw material basis for the mesophil fermentor (2006-2008) *(Source: Mézes, 2011)*

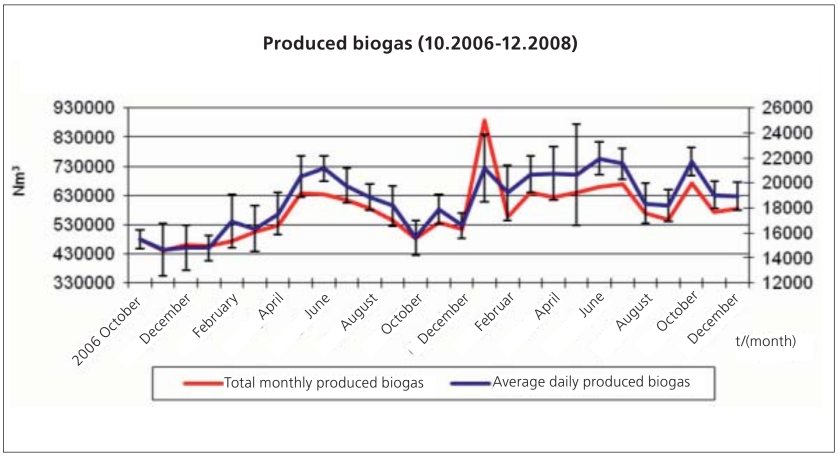


Figure 6: Monthly (red line) and average daily (green line) amount of biogas produced (Nm³) (2006-2008) ***(Source: Mézes, 2011)***

while in 2008, the separated solid by-product (separated material) was reused during the autumn and winter months when the amount of available fresh green raw material decreases.

Figure 5 demonstrates the average proportion of raw materials fed from the mixers into the fermentors and of other easily degradable raw materials and additives applied to ensure the safety of the process (pH setting). In addition to the raw materials transported from the mixers to the fermentors, liquid manure, poultry wastewater, whey, separated material, sterilized liquid slaughterhouse waste (class 2-3) (hereinafter: gravy) and glycerine (by-product of bioethanol production) was also added.

Beside the raw materials fed from the mixers, the proportion of gravy was the most substantial (11.2%), while the rate of poultry wastewater and separated material was 1.5% on average. From the yearly data, it can be seen that in 2006-2007 mainly poultry wastewater, while in 2008 mainly separated material and liquid manure was used. As for raw materials of animal origin, mainly cattle manure, liquid manure and heat treated gravy were used in the examined period. The availability of plant raw materials is temporary and their amount is varying. For this reason, the main component of the recipe is silage maize which is available continuously in the same amount. In spring and summer, when the amount of silage maize decreased, the recipe was supplemented with easily degradable green materials, for instance grasses, alfalfa and canning factory wastes.

4. DETERMINATION OF AVERAGE HYDRAULIC RETENTION TIME

Calculating with the useful volume of the fermentors (6409 m^3 for mesophil fermentors, 7914 m^3 for thermophil fermentors), retention time was specified separately for the mesophil and thermophil fermentors. After adding up the acquired values, the total hydraulic retention time is obtained, which is 43 days (excluding the capacity of post-storage tanks). The value of hydraulic retention time enables the determination of correlation between the raw materials and biogas yields. Statistical analysis was performed using the program SPSS 17.

5. THE AMOUNT OF BIOGAS PRODUCED

The monthly amount of biogas produced varied between 430000 and 920000 Nm^3, while the average daily amount was 18570 Nm^3 *(Figure 6).* As for the tendency in biogas yields, more biogas was produced in summer than in winter, in both examined years.

6. CORRELATION BETWEEN THE WEIGHTED QUALITY OF RAW MATERIALS AND BIOGAS YIELDS

To define the correlation, calculations were based on the 20-day moving average of raw materials (quality parameters weighted with the amounts fed daily) and on the biogas yields modified with the retention time (43 days). *Table 2* demonstrates the results of regression analysis, i.e. the relationship between certain quality parameters and biogas yields.

TABLE 2: Correlation between biogas yield and the quality of raw materials

Quality parameters	R^2	R	Correlation
N content (t)	0.77	0.88	Strong
C content (t)	0.74	0.86	Strong
C/N-ratio	0.38	0.62	Average
Dry matter content (t)	0.79	0.89	Strong
Organic matter content (t)	0.71	0.84	Strong

(Source: Mézes, 2011)

The hypothesis was that the quality of raw materials influence biogas production. The determination coefficient varied between 0.7 and 0.8 with quadratic polynomial functions, with the exception of the C/N-ratio, hence they showed strong correlation. As for C/N-ratio, power trendline can be fitted to the curve with average reliability (R=0.62). To reduce the hydraulic retention time in the biogas plant, the amount of easily degradable raw materials is recommended to be increased. At present, the C/N-ratio is not optimal (13-15:1).

Examining the quality parameters of input materials, in summer the amount of easily degradable plant materials with higher carbon content, while in winter the amount of glycerine, silage maize and separated material is recommended to be increased, while the amount of materials of animal origin (gravy) should be decreased to reach the optimal C/N-ratio (20-25:1).

SUMMARY

The cooperation between the University of Debrecen and the Regional Biogas Plant in Nyírbátor enabled the establishment of a database that can be used to reliably perform the examination of correlations. In addition, an advanced experimental biogas system and the connected laboratory background were also created. In this way, the effects of special and potentially toxic raw materials (gravy, poultry feather, Fusarium-infected maize, etc.) on the process of anaerobic fermentation could be examined. The development of the control technique apparatus for a biogas system represents great problem as the parametrization of commercially available software products has to be performed subsequently after the test period to calibrate for optimal operation. With agricultural and food industry raw materials, the constant monitoring of quality parameters is especially important to eliminate the extreme values disadvantageous for the system. A database management software is recommended for the examined plant that is capable of tracking a large number of data with varying compositions, and defining a correlation between input and output parameters on the basis of quantity and quality parameters, and also predicting expectable biogas yields and liquid biogas by-product quality on the basis of empirical data.

An important improvement of control technique could be the designing of a Fuzzy Logic Controller (FLC) which can be used to optimize fermentation processes, thus the efficiency of microorganisms. The main point of it is, on the one hand, to provide proper pH, redox-potential, acid-base balance required by microorganisms in various phases of the fermentation process and, on the other hand, to provide optimal temperature specified on the basis of the quality and quantity parameters of gas components.

The development of biogas plants is of major importance primarily to increase the quality and quantity of biogas produced, which ensures more economic operation and faster return of the investment. Countries with the most intensive development include France, Italy, Spain, Poland, the Czech Republic and Hungary, followed by Denmark, Finland, the Netherlands, Estonia and Romania *(EurObserv'ER, 2012).*

The increase of biogas yields and their methane proportion is an important direction of development. The inoculation of the fermentors using the bacterium strains selected for the given raw materials and conditions (mesophil or thermophil) can efficiently increase the biogas production of the given plant.

Another essential direction of development is the purification of biogas and its direct feeding into the natural gas network, for which the legislative background has to be adjusted or established. Further direction of development can be the more efficient conversion of biomethane and its transportation to the site of usage. As a distant aim, a biogas or biomethane network could be constructed in parallel to the natural gas supply network, for which a practical example is already available in Austria.

The examined biogas plant is a good example of the energy farm concept as it carries out crop production and animal husbandry activities in its vicinity. In addition, it operates a forage production plant, slaughterhouse, composting plant and animal waste disposal plant. The plant provides a good example of connected energy production. The energy produced is used not only for heating the fermentors, but also in animal husbandry, composting plant and animal waste disposal plant. However, it would be reasonable to purify the biogas and use it as fuel or feed it into the natural gas network. The plant does not have a biogas purifying equipment yet, which is explainable since the costs of investment would be very high for such a large plant and payback period would be long. Accordingly, it is only probable if a financial grant is acquired.

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REFERENCES:

1. EurObserv'ER 2012. Biogas barometer 2012.12. p.66-79.
2. Gruber, W. 2007. Biogasanlagen in der Landwirtschaft. Aid infodienst. Verbraucherschultz, Ernährung, Landwirtschaft e.V. Bonn. 1453.
3. Mézes L. 2011. Mezőgazdasági és élelmiszeripari biogáztermelés optimalizálása [Optimizing the Agricultural and Food Industrial Biogas Production]. Doktori értekezés. Debreceni Egyetem. Mezőgazdasági-, Élelmiszertudományi és Környezetgazdálkodási Kar, Víz- és Környezetgazdálkodási Intézet. Kerpely Kálmán Doktori Iskola. Debrecen.
4. Petis M. 2007. Biogázról a gyakorlatban [Biogas in practice]. Bioenergia. Bioenergetikai Szaklap. Szekszárdi Biorúma Kft. Szekszárd. II. évf. No. 2. 21-25.
5. Petis M. 2008. Biogáz hasznosítása [Utilization of biogas]. Energiapolitika 2000 Társulat. Energiapolitikai Hétfő Esték. 2008.02.11. Budapest.
6. I1:http://www.energiakozpont.hu/download.php?path=files/fooldal/palyazoknak/keop/keop_0902.jpg
7. I2: http://hu.wikipedia.org/wiki/F%C3%B6ldg%C3%A1z

EVALUABILITY OF APPLE ORCHARD WATER BALANCE PARAMETERS BASED ON THE SPECTRAL AND THERMOGRAPHIC PARAMETERS OF THE CANOPY

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In Hungary about 100.000 hectares of orchards can be found, from which apple is cultivated on one of the largest areas. The total area of apple and pear orchards is more than 45000 ha. Apple orchards cover about 60% of the total pomiculture in Hungary, although in the last period the production was reduced. The production of marketable horticulture products is difficult without quality horticulture practice, which in many cases is the primary condition of appropriate management and irrigation systems. The data of the Central Statistics Office show that 28% of the apple and pear orchards can be irrigated, but only 21% is irrigated. Since horticulture is a water demanding sector, high quality fruit-production is difficult without proper irrigation. Furthermore in some horticultural farms there is no irrigation applied, or its techniques is improper. There are several experiments going on around the world to develop methods of water management, which draw different technology combination for the water and energy saving water management and irrigation methods. One of the biggest professional challenges of the following years is to develop the water resource management for apple trees. For this the water norm of the trees has to be identified in the different phenological stages, the irrigation turns, and good cultivation practice and the transpiration surface. Hungary has favourable agro ecological potential for apple fruit production, although intensive apple orchards need irrigation to avoid plants from water stress and increase the apple yield security and quality. Modern irrigation system strongly requires proper irrigation scheduling and control (Gonda and Apáti 2011).

THE ROLE OF THE THERMOGRAPHIC PARAMETERS OF THE CANOPY IN EVALUATING THE WATER BALANCE OF THE ORCHARD

In large orchards up-to-date information is needed on water capacity and possible water stress of the fruit trees. The reason for this is that the physiological reactions against the changing water capacity appear much earlier than the water stress. These physiological changes cannot be observed visually in the early period of water stress. Combining airborne remote sensing technology and reflectance measurements of leaves can be the solution for detection of changing water content. Hyper- and multispectral technology is widely used in agriculture and environmental protection, and is appropriate for vegetation analysis. Vegetation, its chlorophyll content and vegetation indices are good indicators of photosynthetic activity, mutations, stress (Burai et al. 2009), degradation processes occurred in soils, and the state of plant nutrient, and this have a particular high significance in precision agriculture. The chlorophyll content is one of the indicators of the state of health (Burai et al. 2009), which affect the reflectance spectra of the vegetation and the vegetation indices as well. Minimum at the visible spectral range is related to pigments in plant leaves. Chlorophyll absorbs markedly spectral range between 450 – 670 nm. Healthy vegetation reflects the 40-50% of the incoming energy between 700-1300 nm spectral ranges due to the internal structure of the canopy. In this way, the measured reflectance plays an important role in distinguishing different plant species and possible water stress, even if these species are seems to be similar based on visible spectral range (Burai et al., 2009). In reference to this, searching areas referring to early recognizability of plant diseases, mapping of deficiency of nutrients by reflectance spectrum, the singular or association level approach of the vegetation in agro-ecological, cropping technologies respect, have to be mentioned.

For the examinations, the portable Konica Minolta Soil Plant Analysis Development (SPAD) type 502 dual-band manual instrument can be used that can be used easily, it is relatively cheap and enables instant, direct measurement without damaging the leaves. Another one of its advantages is its quite low weight since it is less than 300 g even with the batteries. Its principle of operation is based on that chlorophyll molecules can absorb different amounts of light with different wavelengths, the amount of which is closely related to the chlorophyll content of the leaves. It absorbs the most light at blue and red wavelengths, while light absorption is low in the green and yellow spectrum, and is practically null at infrared wavelengths. The measuring instrument uses red light, the absorption of which is not influenced by the carotene content of the leaf. There are 2 diodes (LEDs) in the instrument: one is red, 650 nm, and the other is infrared with a peak of 940 nm. The two types of light alternatively go through the leaf blade with equal strength, a part of which is reflected, another absorbed by the leaf, while the remaining part goes through the leaf. Chlorophyll only absorbs red light but no infrared. Passing light is sensed by a silicon photodiode and by transforming it to analogue electric signal, the instrument forms it to a number. Therefore this value is determined by the light transmittance of the leaf tissue at the abovementioned wavelengths. The instrument calculates the SPAD-value lacking a unit of measurement – ranging from 0 to values above 100 – from the difference of the relative optic density of red and infrared wavelengths. The more red light is absorbed by the leaf of the plant, the higher is its chlorophyll content. The measuring (illuminated) area: 2 x 3 mm, which is quite small, and the veins, the thickness of the leaves (max. 1,2 mm) and their water content can influence the resulting value to a lesser extent, therefore it is worth to do more measurements on the same leaf. The instrument can be used in the temperature range of 0-50°C with a maximum humidity of 85% (Terek 2012).

By making contact between the two clip-on ends of the instrument – with the leaf between them –, it almost instantly displays the measured value on the screen, therefore abnormalities can be instantly filtered out and the measurement can be repeated. The resulting SPAD-values correlate positively to the real chlorophyll content, so they provide quite a correct estimation, therefore they provide an opportunity to substitute excessively time- and energy-consuming chlorophyll measurement with acetone.

For the objective result some vegetation indices are available to detecting physiological changes during the life of plant or fruits, or after the storage, respectively. The leaf chlorophyll content is closely related to plant stress and senescence (Merzlyak et al. 1999). Due to the senescent of leaves the chlorophyll content is deceased. One of the oldest, most well known and most frequently used vegetation index is the Normalized Difference Vegetation Index (NDVI), which use of the highest absorption and reflectance regions of chlorophyll make it robust over a wide range of conditions. NDVI is a measurement value without a dimension for the activity and state of an area based on that the metabolic intensity of the vegetation influences spectral properties. It can be specified from satellite or hyperspectral images. Its index values can be calculated from the reflectance values of pixels with different wavelength ranges, because the reflectance of vegetation shows significant differences in the visible red (RED) and close infrared (NIR) spectra.

It is calculated by the following formula:

$$\mathbf{NDVI} = \frac{\mathbf{NIR - RED}}{\mathbf{NIR + RED}}$$

where: NDVI: vegetation index

NIR: the intensity of reflected light in the near infrared spectrum

RED: the intensity of reflected light in the visible red spectrum

This quotient is directly proportional to the chlorophyll content of the vegetation. We always have to get a result between -1 and +1. Vegetation index is widely used in agriculture, but it has applications in forestry, urban planning and other areas.

The Simple Ratio (SR) index is another old and well known vegetation index, which is similar to the NDVI. In case of very high spectral resolution reflectance data, such as from hyperspectral sensors, could be used the Red Edge Normalized Difference Vegetation Index ($NDVI_{705}$) and the Modified Red Edge Simple Ratio (mSR_{705}) indices. These indexes are more sophisticated measures of general quantity and vigor of green vegetation than the broadband greenness vegetation indexes. A third greenness vegetation index is the Modified Red Edge Normalized Difference Vegetation Index ($mNDVI_{705}$), which incorporated a correction for leaf specular reflection. These vegetation indices differ from the NDVI by using bands along the red edge, instead of the main absorption and reflectance peaks.

The plant senescent and fruit storage injuries could be investigated by several indices as well. The Plant Senescence Reflectance Index (PSRI) is designed to maximize the sensitivity of the index to the ratio of bulk carotenoids (for example, alpha-carotene and beta-carotene) to chlorophyll (*Merzlyak* et al. 1999). The Browning Reflectance Index could provide information about senescent of leaves and/ or ripening of fruits too.

Several other parameters were examined based on the spectra. The color, maturity and health status was analysed in the yellow –red (570-730) wavelength interval, where a significant sigmoid growth of reflectance appears. Differences between relative water content of the leaves can also be assessed in the near infrared (NIR) zone between 900-970 nm by the Water Band Index (WBI) based on airborne hyper spectral data. WBI is a ratio sensitive to the water content of the foliage that is a result of the following formula: WBI= 900/ 970. As the water content of the foliage increases, so does the absorption of light in the 970 nm spectrum compared to the 900 nm one. At our examinations in the apple orchard, it was also the 900 nm channel being a sensitive water indicator, but the 930-940 nm spectrum should be used in the denominator, because the reflectance curve showed a minimum there in contrast with the 970 nm channel cited in the literature. Based on this, the reflectance values of WBI= δ 886/ δ 937 channels provide a more correct result in the case of pomes. Beside the water supply of the examined specimens, mapping the areas of a plantation with different water supply by remote sensing methods can be the based on reflectance spectra.

APPLICATION OF THERMOGRAPHIC CAMERA IN APPLE ORCHARDS

Since canopy temperature acts as a good indicator of plant water status, infrared thermography is considered for the identification of plant water stress and is also used as a tool for irrigation scheduling method. The basic idea of its operation is that – because of optimal evaporation – the leaf temperature of trees with good water supply is lower compared to those short of water, therefore the cooling effect of evaporation can show up only to a lesser extent. If plant water stress increases, transpiration decreases and plant temperature may exceed air temperature. On the other hand, non-stressed plants will have canopy temperatures less than air temperature, particularly when vapour pressure deficit (VPD) is not greater than 4 kPa. The crop water stress index (CWSI) relates canopy–air temperature difference to net radiation, wind speed and vapour pressure deficit. However, a surrogate measure is calculable from the temperatures of the canopy and reference leaf surfaces corresponding to fully transpiring and non-transpiring canopies (Jones et al. 2002). Thus, by monitoring plant canopy temperature and the temperatures of wet and dry leaves, it is possible to estimate the underlying plant water stress status and therefore, intelligently control the related irrigation process. We can make an image of the surface temperature of the canopy with a thermographic camera (Figure 1).

In the outer steel case of the camera, there is a microblometer sensor with 7800 elements (in a 320x240 arrangement) that does not need cooling. Its sensibility is an average of 0,05 °C. Its range of measurement is between -20 and 120 °C, but its optimal working temperature is between -25 and 60 °C. We can analyse the images with IRPlayer software which is an own development of Hexium Ltd. The software makes it possible to export temperature values belonging to the pixels to an external csv file. The resulting file stores the values of each pixel in a matrix-like structure. With the help of this software, it is possible to save the image and the thermal scale, too. For the simpler use of the pictures and the colour intensity, we may use

Figure 1: HEXIUM PYROLATER-12 thermographic camera and its image in an orchard

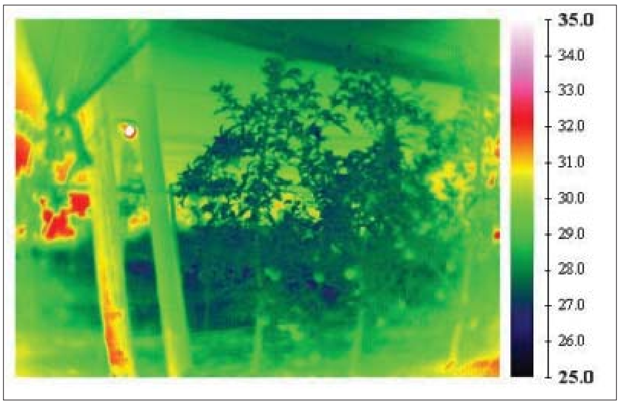

Figure 2: The thermographic image of the apple orchard

a black and white image. In the IRPlayer software, the thermal range that characterises the temperature of the surface best (Figure 2).

Based on thermographic image, the temperature parameters of apple yield, leaf, trunks were investigated. The air temperature was measured by analogous thermometers in shade and reached its minimum at dawn. The result suggests that parallel to the air temperature, the temperature of the examined apple tree parameters also increased. Furthermore, the leaf temperature exceeded the air temperature, which shows water deficiency and the inadequate transpiration (Figure 3).

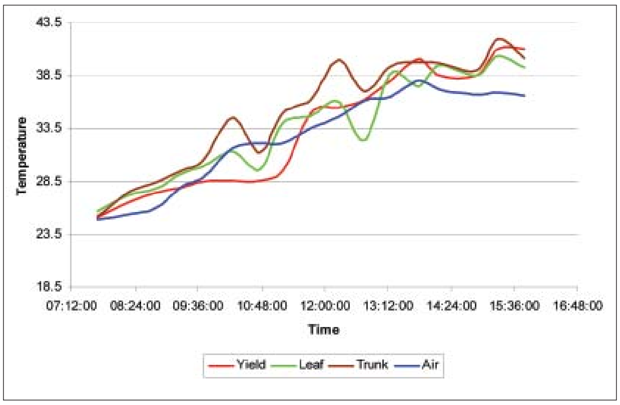

Figure 3: Temperature changes (°C) in apple orchard

As a consequence of this, increased water stress can be observed in the orchard, because the intensity of photosynthesis depends on the water supply of the plant. In the absence of irrigation, stomata close in noon time due to water shortage, therefore there is a minimum of photosynthesis intensity. This does not show up in irrigated areas with sufficient water supply.

A key procedure for the evaluation of crop water stress from plant canopy temperature was to calculate CWSI based on the data collected from IR thermography systems. The CWSI described by (Jones et al., 2002) is of the following generic form:

$$CWSI = \frac{T_c - T_w}{T_d - T_w}$$

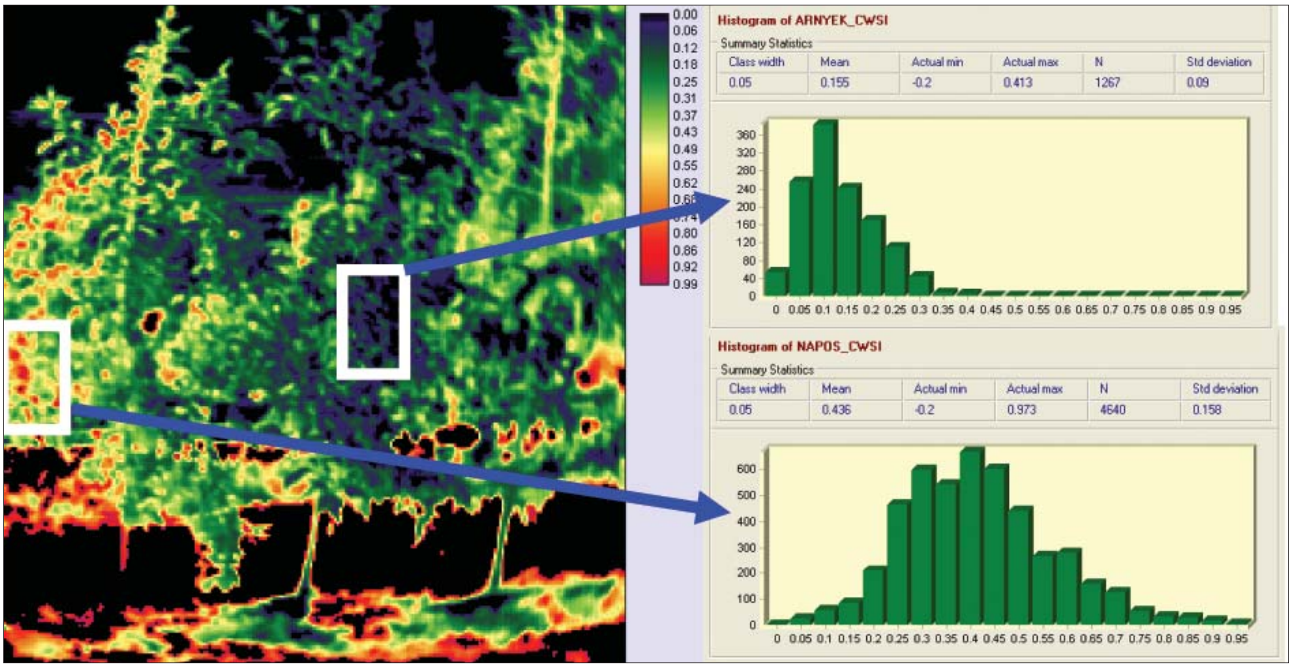

Figure 4.: CWSI of the apple trees on sunlite and shade side

where Td and Tw represent the reference temperatures for dry (nontranspiring) and wet (fully transpiring) leaf surfaces respectively. T_c is the temperature of the transpiring surface, i.e., the actual measured temperature of all sunlit leaves to represent the sunlit portion of the canopy. Although alternative methods for estimating reference temperatures may be found, reference leaves, which are artificially treated real leaves with known conductance to water vapour, can be physically embedded in the scene and so the reference temperatures T_d and T_w can be estimated from the leaf temperature distribution. In this study the reference temperatures T_d and T_w can be estimated from the leaf temperature and air distribution. Before the CWSI calculation masking was made in order to eliminate the background and keep only the apple trees on the infra red image. The image processing was made in IR Player, Surfer9 and the CWSI analysis were carried out in Idrisi Tajga software environment. Based on CWSI image, those parts of the canopy were easily eliminated, where the increased water stress occurred (Figure 4).

This due to water deficiency, caused by the lack of precipitation and irrigation, stomatal closure can occur thus, according to several studies (Pethő 1996) the photosynthesis is blocked and reach its minimum. Not only the transpiration is blocked but also the CO_2 uptake, therefore reactive hidroxil radicals are produced which are harmful for the chloroplasts and cell membranes, which eventually causes the water stress symptoms in plants.

Based on CWSI image, it can be stated, that irrigation was urgently needed for the orchard. This result is also confirmed by soil water monitoring survey, which was carried out by tensiometers. According these results, irrigation should have been started 2 weeks before.

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REFERENCES

1. Burai, P., E. Kovács, Cs. Lénárt, A. Nagy, and I. Nagy. 2009. Quantification of vegetation stress based on hypersectral image processing. *Cereal Research Communications*. 37: 581-584. Hungary
2. Gonda I, Apáti F 2011. Present and future of apple growing in Hungary (Almatermesztésünk helyzete és jövőbeni kilátásai). [In. Tamás J (eds.): Almaültetvények vízkészlet-gazdálkodása.] Debreceni Egyetem, AGTC, Kutatási és Fejlesztési Intézet, Kecskeméti Főiskola, Kertészeti Főiskolai Kar. 13-25 p.
3. Jones, H.G., Stoll, M., Santos, T., de Sousa, C., Chaves, M.M., Grant, O.M., 2002. Use of infrared thermography for monitoring stomatal closure in the field: application to grapevine. Journal of Experimental Botany 53 (378), 2249–2260.
4. Merzlyak MN, Gitelson AA, Chivkunova OB, Rakitin VY 1999. Non-destructive Optical Detection of Pigment Changes During Leaf Senescence and Fruit Ripening. *Physiologia Plantarum.* 106: 135-141.
5. Pethő M.1996. Mezőgazdasági növények élettana, Akadémia Kiadó, Budapest
6. Terek, O. 2012. A vágott virág tartósságát növelő eljárások hatásvizsgálata szegfű és rózsa esetén. Doktori disszertáció. Budapesti Corvinus Egyetem, Kertészettudományi Doktori Iskola

ECOTOXICOLOGY EFFECTS OF LIQUID BIOGAS BY-PRODUCT INFECTED WITH FUSARIUM GRAMINEARUM ON THE GERMINATION OF MAIZE (ZEA MAYS L.)

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BERNADETT **GÁLYA** [1]- ATTILA **NAGY**[1] - GYÖRGYI **BIRÓ** [1]- LILI **MÉZES** [1] - JÁNOS **BORBÉLY** [2]- JÁNOS **TAMÁS** [1]

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The number of phytopathogenic fungi is enormous: there are over 20000 recorded fungi species that can live on higher plants, including Fusariums which are involved in the decomposition of dead plant and animal residues. Certain species in the genus *Fusarium* may cause considerable losses as they damage food raw materials and foodstuffs. They reduce the quality and yield of cereals and maize and also the nutritional values of foodstuffs. The optimal conditions for the spreading of *Fusarium sp.* and the symptoms of Fusarium head blight and Fusarium cob rot have already been described in detail (Békési 2010, Kovács-Bíró 2002). The majority of the fungal pathogens in the genus *Fusarium* produce mycotoxins: zearalenone, fumonisins or trichothecenes (DON, T2, HT-2 toxins) (Halász –Valovics 2011*).* The mycotoxin contamination of forage raw materials is a worldwide problem, generating direct threats and - through farm animals - indirect hazards to the consumers (Mézes et.al. 2010).

Fusarium infection and mycotoxin production could not be eliminated. As the maize infected with *Fusarium* and thus containing toxins cannot be used either as food or as forage, it might be utilized as biogas raw material to produce energy. The aim of our examinations was to determine the toxin content of the liquid by-product produced from contaminated maize during biogas production and to examine its effects on plant germination as this fermented product is usually used later for soil improvement. *Fusarium sp.* might cause, among others, seed rotting or seedling death, therefore, we examined its germination inhibition effect on maize (*Zea mays L.*). In Hungary, one of the most notable field pathogens is *Fusarium graminearum*. As for mycotoxins, trichothecenes are the most common ones, among which Deoxynivalenol (DON) was detected most often in cereals (Biró et al. 2011). On the basis of the above, germination tests were carried out to demonstrate the effects of liquid biogas by-product with different compositions (infected or not infected with *Fusarium graminearum*) on plant growth.

DESCRIPTION OF THE MATERIALS USED FOR THE EXAMINATIONS

The liquid biogas by-product used for the examinations was prepared in the biodegradation laboratory of the University of Debrecen, Faculty of Agricultural and Food Sciences and Environmental Management, Department of Water and Environmental Management where 4 stainless steel tanks with the capacity of 6 litres are used for fermentation (Figure 1).

Figure 1: Incubators and Fisher-Rosemount biogas analyser

The process is carried out at atmospheric pressure under anaerobic conditions. To absorb the possible organic acid content of the gas mixture discharged from the reactor, gas washer bottles filled with water are used. The subsequent cooling apparatus is used for dewatering the gases. The composition (CH_4, CO_2, O_2) of the final gas mixture is determined by Fisher-Rosemount NGA 2000 gas analyser (Figure 1). Hydrogen-sulphide and ammonia (H_2S, NH_3) are measured by MX42A gas analyser, which does not require the preliminary application of gas washer and cooling apparatus. The above precision gas analyser specifies the mixture composition during continuous operation, while the Oldham MX42A analyser specifies it during intermittent operation at fixed intervals. Fisher-Rosemount gas analyser is equipped with a direct signal output unit that can be connected to a computer through RS232 port, while the

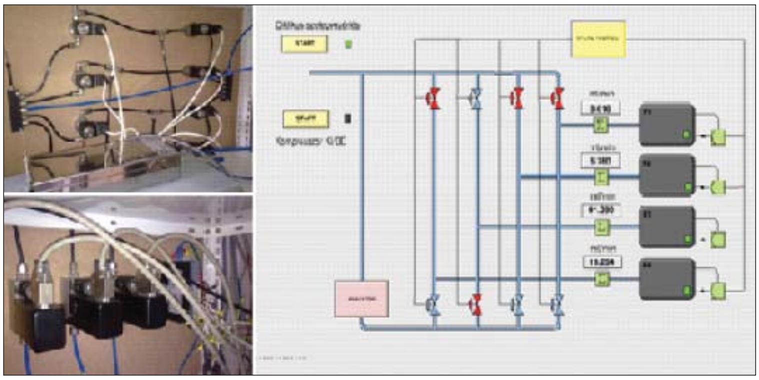

Figure 2: Digital implementation and mass flow controlling system of the anaerobic fermentation process

output unit of the MX42A gas analysing instrument can be converted into an RS232 port, thus the obtained data can be stored and directly evaluated on a computer (Mézes et. al. 2008). In the past 10 years, the control of the system (temperature control: mesophile (38°C), thermophile (55°C), biogas concentration (volume%), data storage, gas quantity measurement, valve control) as well as the collection of data were enabled by the software ADVANTECH GENIE 3.0 designed for this purpose. As of 2010, Compair Adaptive Control Environment (ACE) is applied with Linux platform (Figure 2) (Tamás 2012).

THE EXPERIMENTAL SET-UP

The effects of *Fusarium graminearum* and DON toxin were examined in three different culture dish experiments using two types of liquid biogas by-product. Type 1 contained 26% (d.m.) Fusarium-free maize grits, while Type 2 contained maize grits infected with *Fusarium sp.* (i.e. containing DON toxin). Both types contained 220 g gravy, 160 g silage maize, 43 g separated material, 500 g manure, 4020 g liquid biogas by-product. The raw materials used for the experiments were obtained from the regional biogas plant in Nyírbátor where recycling is carried out to produce energy. Each treatment was repeated three times, and the results were compared to control treatments. The amount of liquid biogas by-product (70 ml) was calculated on the basis of the amount of liquid biogas by-product produced by the biogas plant in Nyírbátor and applied on nitrate-sensitive agricultural soils, in accordance with the pedological expert opinion prepared for the given area. As a control, quartz sand without any treatments was used. For the first and second treatment, the liquid biogas by-product prepared in May in the biodegradation laboratory of the University of Debrecen, Faculty of Agricultural and Food Sciences and Environmental Management, Department of Water and Environmental Management was used, while for the third treatment, the liquid biogas by-product prepared in March was used. For our examinations, quartz sand was used. Germination tests were performed under sterile laboratory conditions. The soil had been sterilized in hot-air cabinet for 24 hours before the experiments were started. A control was set-up for each treatment to enable better observation of differences in time and space. The control culture dish contained nothing else but quartz sand. After mixing, the soil was watered in such a way to soak it through to obtain maximum water saturation. After 24 hours, each culture dish was weighed to define the minimum water capacity. The weights of the culture dishes were recorded, and deionized water was added daily to supplement water. For the experiments, the maize hybrid LG3395 was used. This is an early maturing dent maize with good yielding ability and fast drying down at ripening. The grain moisture content at harvest is more favourable than the average of its maturity group. The plant is tall and the stem stays green during ripening. The ear is long with good grain set. The cob is thin and red. The hybrid has excellent adaptability and drought tolerance. It is able to give good yield under various production conditions. The non-infected maize seeds went through preliminary microbiological tests to confirm that they are free from *Fusarium sp.* The seeds were sown after surface sterilization by placing 20 seeds in the sand in the culture dish at the depth of 3-4 cm using sterile tweezers. The seeds used for the germination tests

were sterilized in fungicide and bactericide solution (10 minutes in Neomagnol solution) and were rinsed twice. The seeds were then kept at room temperature (22±2 °C) for 6 days on the basis of soil temperature, which was measured before the starting of the experiment. After the germination period, the seedlings were picked out of the culture dishes, then they were cleaned and weighed. The results were assessed in three ways: the germination capacities in each treatment were expressed as percentage (%) of the control, root length was evaluated on the basis of Németh's qualification, and general statistics were prepared. As it was mentioned before, the effects of the liquid biogas by-product on germination were examined in three different experiments.

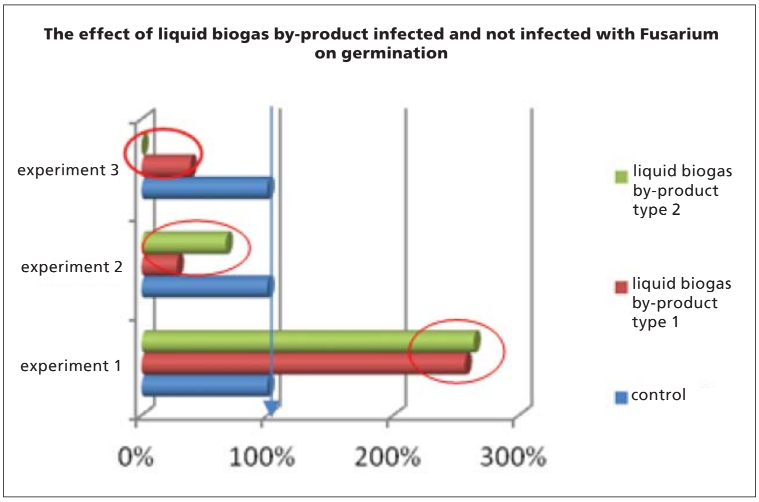

Figure 3: The effect of liquid biogas by-product infected (green bars) or not infected (red bars) with Fusarium on germination, expressed as percentage of the control (blue bars) in three experiments *(Source: own data)*

EVALUATION OF THE EFFECTS OF LIQUID BIOGAS BY-PRODUCTS

In the first experiment, we wanted to determine the effects of infected and non-infected liquid biogas by-product on germination. For this, culture dishes with liquid biogas by-product type 1 and type 2, and control dishes were used. The results were demonstrated in three different ways: *Figure 3* shows the rate of germination in each of the three experiments as compared to the control. In the first experiment, both liquid biogas by-product type 1 and type 2 stimulated the germination of maize seeds. This might have been caused by that sowing depth was not uniform and that humic sandy soil was used for this experiment. The control treatment could not be assessed possibly because the soil was burdened. For this reason, standard quartz sand was used for the further experiments.

In the second experiment, further tests were performed to examine the liquid biogas by-product used for the first experiment. *Figure 3* clearly demonstrates that in the culture dish containing the liquid biogas by-product type 1 the rate of germinated seeds was 72% less, while for type 2 it was 33% less than in the control treatment. This is probably because substances inhibiting germination might have been produced during the long storage period (3 months). *Figure 4* shows the germination test in the second experiment.

In the third experiment, three treatments were used just as in the first two experiments. This experiment differed from the two previous ones in that we used liquid biogas by-product prepared in March for the third one in contrary to the first and the second one where liquid biogas by-product prepared in May was used. The stimulating effect of the liquid biogas by-product prepared in May could not be confirmed statistically. Substances inhibiting germination might have accumulated during storage, and this is why the usage of the liquid biogas by-product prepared in March was reasonable to examine if there really is a correlation between inhibition and the duration of storage. It can be seen from *Figure 3* that in the culture dish containing the liquid biogas by-product type 1 the rate of germinated seeds was 61.5% less than in the control, and that no maize seeds germinated in the dishes with type 2 liquid biogas by-product. This is probably because substances strongly inhibiting germination might have been produced during the 5-month storage period. During the evaluation of the results, the toxicological qualification of the germs was performed for each treatment on the basis of Németh's method (on the basis of the average root length in the percentage of the control) where 0-5% means extremely poisonous, 6-50% poisonous, 51-90% slightly poisonous, 91-120% non-poisonous, over 120% stimulating medium (Németh 1998). The results obtained in the three experiments were evaluated on the basis of the above qualification (Table 1).

Figure 4: Germination test conducted in the second experiment (Source: own data)

	Treat-ment	Average root length in the percentage of the control	Qualification
Exp. 1	Control	100	non-poisonous
	Type 1	102.5	non-poisonous
	Type 2	101.8	non-poisonous
Exp. 2	Control	100	non-poisonous
	Type 1	28	poisonous
	Type 2	67	slightly poisonous
Exp. 3	Control	100	non-poisonous
	Type 1	38.5	poisonous
	Type 2	0	extremely poisonous

Table 1: Qualification of average root length in the percentage of the control *(Source: own data)*

	Treatment	Median	Mode	Average	Standard deviation
Exp. 1	Control	8	8	7.99	4.15
	Type 1	8.8	11.9	9.24	3.42
	Type 2	8.4	4.4	8.99	3.73
Exp. 2	Control	13.6	13.6	13.37	3.61
	Type 1	5.3	5.3	5.45	2.56
	Type 2	8.45	9.3	8.73	4.45
Exp. 3	Control	18.1	5.5	17.97	7.11
	Type 1	9.35	0	10.5	5.58
	Type 2	0	0	0	0

Table 2: General statistics of the three experiments *(Source: own data*)

During the evaluation of the results, general statistics were prepared for each experiment (Table 2). The germs' root length (mm) was measured at the end of the experiment, and the Tukey range test was used to specify the significant differences between the treatments, i.e. to determine the ecotoxicological effect of mycotoxins on germination. No significant difference was found between the treatments by Tukey range test in the first and the third experiment, accordingly, neither stimulating nor inhibiting effect on germination could be demonstrated.

In the second experiment, significant difference was found between the control and the treatments type 1 and type 2, thus, the inhibiting effect of the liquid biogas by-product was proved statistically (there was no significant difference between treatment type 1 and treatment type 2) (Table 3). This is probably because substances inhibiting germination might have been produced during the storage period.

Treatment	Maize
Type 1	4.42[a]
Type 2	5.85[a]
Control	12.09[b]

Table 3: The result of Tukey range test in experiment 2 *(Source: own data)*
***there is no significant difference between values with the same index letter (P <0.05)**

Germination vigour of maize infected or not infected with Fusarium

For the examination, Fusarium-free seeds were placed in a control culture dish containing quartz sand and Fusarium-infected seeds were placed in another culture dish containing quartz sand. The germination period took 2 weeks, during which water was supplied every day. To specify the percentage value of Fusarium infection, the determination of germination ability was performed in accordance with HILTNER scale which specifies both the seed percentage and the intensity of infection (1-2

Figure 5: Fusarium-free and Fusarium-infected maize seeds (Source: own data)

%: negligible, 2-5 % minor, 5-10 % slight, 10-20 % moderate, 20-30% slightly severe, 30-50 % severe, >50 % very severe infection) (Radulescu E.- Negru A.: 2010). During the experiments, the infected maize seeds did not germinate due to the considerable infection, the seeds were damaged and easy to crumble. In contrary, the Fusarium-free maize germinated. In accordance with the HILTNER scale, all the seeds in the experiment fell into the category of very severely infected as the infection exceeded 50%. *Figure 5* demonstrates the infected and non-infected seeds.

Our experiments are justified by the fact that previous rainy years provided favourable conditions to fungi. In Hungary, the year 2010 rich in precipitation promoted the development of *Fusarium sp.* to a great extent. One of the most notable field pathogens in our country is *Fusarium graminearum*. As for mycotoxins, Deoxynivalenol (DON) was detected most often in cereals. *Fusarium* infection and mycotoxin production could not be eliminated anywhere so far, however, special analytical procedures have been developed to analyse them. A possible way of disposal is using Fusarium-infected maize as biogas raw material. Although *Fusarium sp.* is destroyed by fermentation, DON toxin is not decomposed and thus remains in the ferment and, if sprayed on agricultural fields, might affect the germination of certain crops. The aim of our experiments was to determine the effects of liquid biogas by-product containing or not containing DON toxin on germination.

Germination tests in culture dishes containing standard quartz sand were carried out at room temperature. The germination capacities in each treatment were expressed as percentage (%) of the control. The germs' root lengths (mm) were measured at the end of the experiment, and the Tukey range test was used to specify the significant differences between the treatments, i.e. to determine the ecotoxicological effect of mycotoxins on germination. Examinations to define the germination vigour of maize infected (containing DON toxin) or not infected with Fusarium were also performed.

As a summary, it can be stated that the effects of liquid biogas by-product containing or not containing DON toxin on germination could not be clearly defined on the basis of our experimental results. In the future, we plan to conduct experiments where the liquid biogas by-product is used right after the minimum storage period is over. In addition, the changes in the liquid biogas by-product during storage, and their effects on germination are also planned to be examined. During the comparative examinations of the germination vigour of maize infected (containing DON toxin) or not infected with Fusarium, the infected seeds did not germinate at all. Due to the apparently severe infection, the seeds were crumbled. Further examinations using other hybrids are planned to test the extent of infection and to find hybrids more resistant to Fusarium.

REFERENCES

1. Békési P. 2010. Ismét a kalászfuzáriózisról. [Further studies on Fusarium head blight.] Agrofórum. (21. évf.) 1. sz. Budapest. 53-56. o.
2. Biró GY.-Tamás J.-Borbély J.-Mézes L.-Hunyadi G. 2011. Mikotoxin-termelő *Fusarium* fajok okozta káros környezeti hatások csökkentésének lehetőségei. [The possibilities of reducing adverse environmental effects caused by mycotoxin-producing Fusarium species.] Acta Agraria Debreceniensis. ISSN: 1587-1282
3. Halász Á. - Valovics A. 2012. A magyarországi őszi búza tételek *Fusarium*-fertőzöttség felmérésének eredményei 2011-ben. [Fusarium infection of winter wheat lots in Hungary in 2011] Agrofórum. 23. évf.) 4. sz. Budapest. 28-31. o.
4. Hornok L. 2001. A biológiai sokszínűség fenntartásának különleges módjai a *Fusarium* nemzettségben. [Special ways of maintaining biodiversity in the genus Fusarium] Magyar Tudományos Akadémia. Budapest. 1.o.
5. Kovács F. – Bíró G. 2002. Élelmiszer-biztonság az EU-szabályozás függvényében. [Food safety and EU regulation] Magyar Tudományos Akadémia. Budapest. 53-54. o.
6. Mézes L.- Bíró T.-Tamás J. 2008. Results of biogas production experiments based on agricultural and food industry wastes. Tamás J.,
7. Csép N.I., Jávor A. (szerk.) "Natural resources and sustainable development." *Acta Agraria Debreceniensis.* Supplement. pp. 297-303.
8. Mézes M.- Balogh K. -Tóth K. 2010. A takarmány alapanyagok mikotoxin tartalmának és mikotoxin szennyezettség által előidézett toxikus hatások mérséklésére alkalmas megelőző módszerek. [Preventive methods suitable for the reduction of toxic effects caused by mycotoxins in forage raw materials] In: Kovács Melinda (szerk.) "Aktualitások a mikotoxin kutatásban" 141. o.
9. Németh J. 1998. A biológiai vízminősítés módszerei. [Biological water qualification methods] Környezetgazdálkodási Intézet. Budapest. 230-232. o.
10. Radulescu E.- Negru A. 2010. Indrumator pentru determinarea bolilor si daunatorilor la seminje. Agro-Silvicia. Bucuresti. 32-33.o.
11. Tamás J.-Mézes L- Biró GY.- Nyírcsák M.- Borbély J. 2012. Fuzzy system to optimize the anaerobic digestion in biogas reactors. In: 8th International Conference. Global assessment for organic resources and waste management. Konferencia helye: Rennes, Franciaország, pp. 35-39.

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THE EFFECT OF BIOCHARS AND COMPOSTS ON SANDY SOILS

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INTRODUCTION

The importance of composting lies in that it provides a solution on the utilization of biodegradable wastes, while reducing and stabilizing their quantities (Christensen T. et al.). This is beneficial in terms of both environmental protection and waste management (Aleksza L et al. 2009).

Adding composts to the soil not only supplies nutritive materials but improves the soil as well.

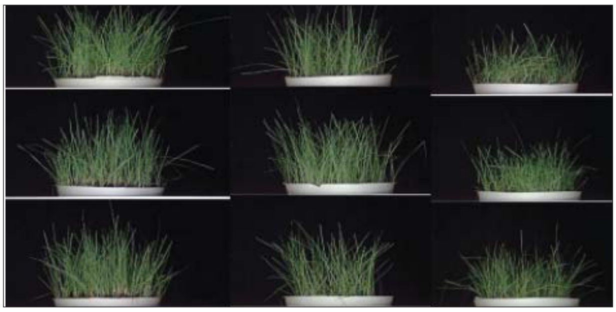
The aim of our examinations was to facilitate organic matter stabilization in the soils by adding composts and biochars to them, and to improve the texture, the nutrient and water retention capacity of the soil.

Several studies describe the composition and effects of organic matters leached from compost into the soil. In this article we assess the effects of various composts and biochars on sandy soil. During the examinations, composts and biochars were mixed to the sandy soil in different proportions. Then the changes in certain physical, chemical and biological parameters of the soil samples were monitored. Also, the water soluble organic matter content was measured.

Our aim was to specify the optimal compost – soil – biochar ratio.

EXAMINATIONS ON BIOCHAR AND COMPOST

As the characteristics of composts of different types can significantly differ, first we compared the composts available before conducting the examinations involving



Picture 1: Perennial ryegrass (Lolium perenne) in bone char (100g/1000g sand)+ compost, biochar (100g/1000g sand)+ compost, sand (control) samples on day 28.

TABLE 1: Comparison of composts available

	quantity of dissolved organic carbon (mg/ml), average			quantity of dissolved organic carbon (mg/ml), average			Ignition loss % (average)	lime content % (average)
	without lime	with 0.5 g lime	difference (mg/ml)	without lime	with 0.5 g lime	difference (mg/ml)		
COMPOST I.[1]	5.53	4.52	1.01	8.65	5.44	3.21	31.84	3.67
COMPOST II.[2]	4.19	3.18	1.01	8.33	6.4	1.93	33.43	3.53
COMPOST III.[3]	3.18	2.18	1.00	7.37	3.84	3.53	20.73	4.39

[1]: compost prepared from green waste from parks; [2]: compost prepared from green waste from gardens collected separately from the public ;[3]: compost prepared exclusively from fallen leaves

TABLE 2: Mixing ratios used for the examinations

Sample ID	sand (g)	BCP (g)	BCA (g)	compost (g) [COMPOST I.]	distilled water (ml)
10g b+c	1000	10		200	300
25g b+c	1000	25		200	300
50g b+c	1000	50		200	300
100g b+c	1000	100		200	300
10g bo+c	1000		10	200	300
25g bo+c	1000		25	200	300
50g bo+c	1000		50	200	300
100g bo+c	1000		100	200	300
sand	1000			200	300

*1000 g sand was mixed with 10 g, 25 g, 50 g or 100 g biochar and 200 g dry compost.

both compost and biochar. The three composts were examined after mixing with sand (100 g compost + 400 g sand) (Table 1).

The soluble organic matter content in the mixtures was examined using hot and cold water. The samples were examined with or without added lime sludge (0.5 g). The dissolved organic matter content was examined in the filtrates using the method of titrimetry. The solution prepared from the compost-sand mixture was mixed with potassium dichromate, then it was heat-treated (130°C) and titrated with Mohr's salt until the colour changed. The concentration of dissolved organic carbon was calculated from the amount of Mohr's salt used. For further examinations, 'COMPOST I' was chosen as it had the highest soluble organic carbon content. Two different kinds of biochars were compared: biochar produced from plant residues (BCP) and biochar produced from animal bone-meal (BCA) by pyrolysis. Table 2 specifies the mixing ratios.

Bone char was mixed in the same ratios with the sand. As a control, 1000 g sand was used.

The following parameters of the soil mixture samples were measured: pH, conductivity and salt content. The samples were incubated in 300 ml water for 14 days. After the incubation period, 200 g of samples were collected in three repetitions, and 2 g of perennial ryegrass (*Lolium perenne)* seed was sown in each of them. The plants were grown for 28 days under constant moisture content and light intensity (Picture 1), then the green mass was weighed (Figure 4). Also, the pH, conductivity and salt content of the soils were measured again, together with the soluble organic carbon content (Figures 1-3).

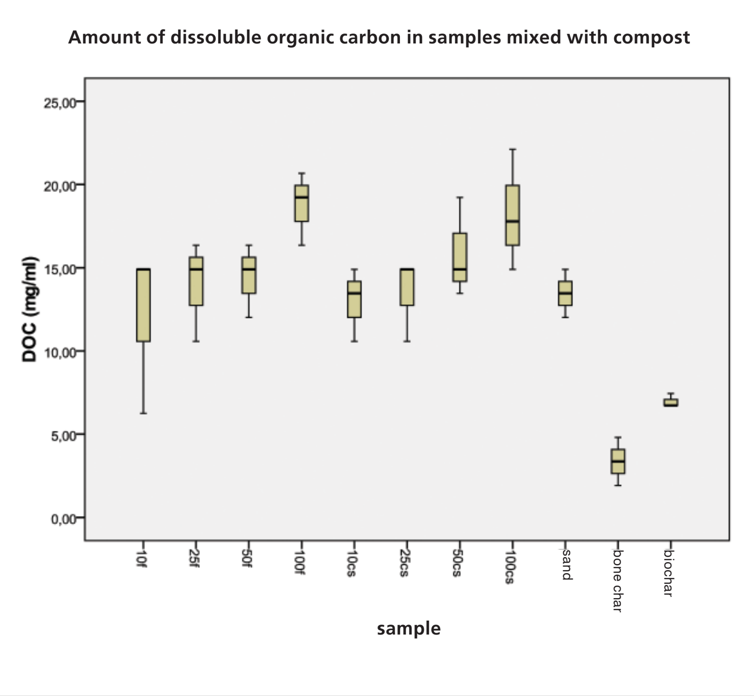


Figure 1: Amount of dissoluble organic carbon (DOC) in samples mixed with biochar and compost in culture dish examinations

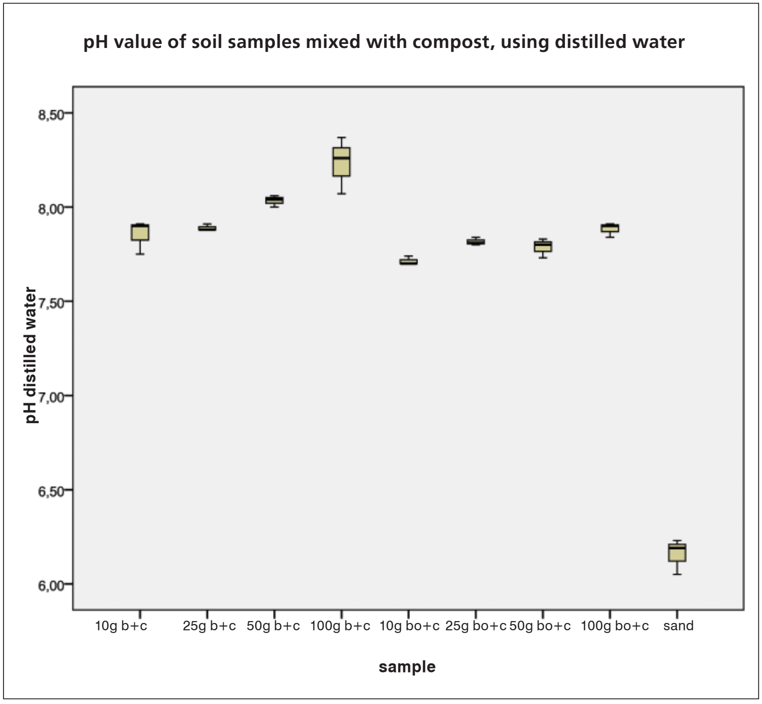


Figure 2: pH value of soil samples mixed with biochar and compost after culture dish examinations, using distilled water

CONCLUSIONS

The following results have been obtained from the examinations of sandy soil – compost – biochar mixtures.

Three composts with different dissoluble organic carbon content were compared. Liming improved the dissolvable organic carbon fixing capacity of the sandy soil. With cold water leaching, the amount of dissolved organic matter is 1 mg/ml less on average in samples treated with 0.5 g lime. With hot water treatments, the amount of dissolved organic matter differs significantly between samples treated with lime and samples not treated with lime. This difference is approximately 2-3 mg/ml. Compost types also vary in terms of dissoluble organic carbon content, which might be caused by that composts contain certain amounts of lime without any treatments, and they are on different levels of maturity and stability. Our measurements showed that composts

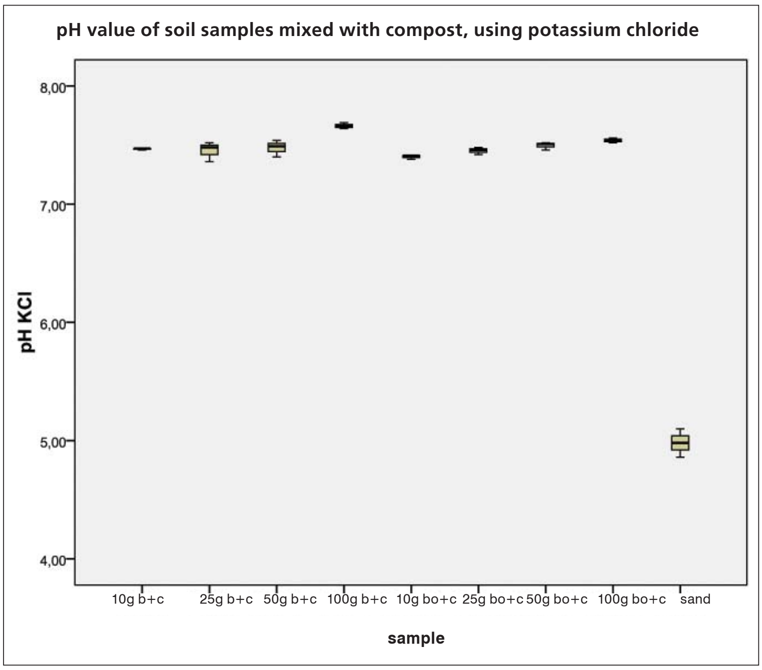


Figure 3: pH value of soil samples mixed with biochar and compost after culture dish examinations, using potassium chloride.

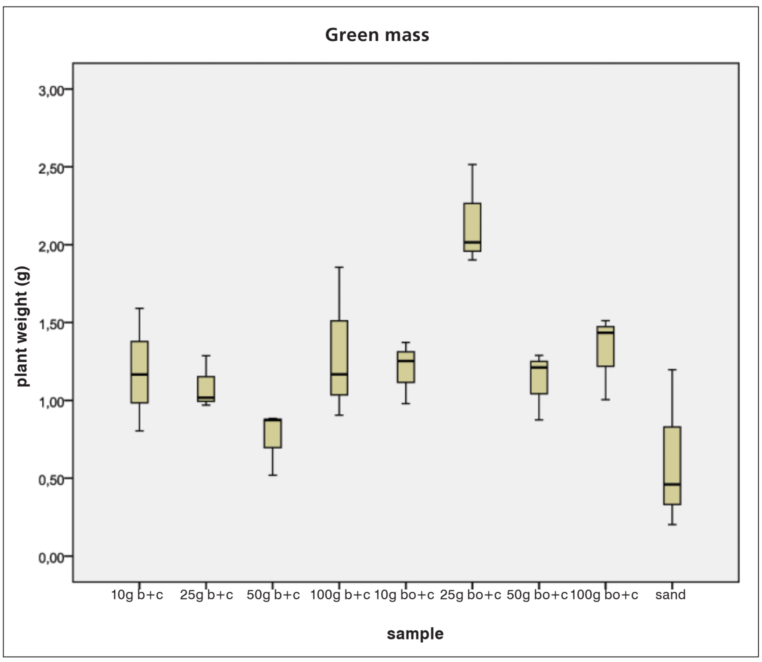


Figure 4: Green mass of plants grown in soil samples mixed with biochar and compost

contained 3-5% lime on average before the treatments. The variations in ignition loss explain why dissoluble organic carbon contents differ in each compost types with hot water leaching. It can be stated that the ignition loss and dissoluble organic carbon content of compost prepared exclusively from leaves are below those of the other two compost types. This is probably because of the high lignin content of leaves as lignin decomposes very slowly.

Next, we examined the effects of compost and biochar on sandy soils. The results of the tests showed that both conductivity and pH increased significantly in proportion to the amount of biochar added (Figure 2, Figure 3). The changes in the quantity of dissoluble organic carbon content showed similar tendency (Figure 1), but the difference from the sand sample is not that considerable. The green mass was also found to increase (Picture 1), however, the quantity of green mass (Picture 4) does not show clear proportionality to the amount of biochar added to the soils. Further examinations are planned to reveal the causes of this.

REFERENCES

1. Aleksza L.- Gyuricza Cs.- Füleky Gy. 2009. The impacts of composts on the heavy metal content of the soil and plants in energy willow plantation, ORBIT China. 16-19 November 2009, Peking, China
2. Aleksza L. 2010. Implementation, legislation and funding for biowaste management, 15. February 2010, Conference on biowaste recycling in Europe. Barcelona, Spain.
3. Christensen T. H. - Nielsen C. W. 1983. Leaching from land disposed municipal composts: 1. organic matter, *Waste Management & Research* 1, 83-94
4. COM(2006)231 final: Thematic Strategy for Soil Protection. Brussels, 22.9.2006,SEC(2006)1165.
5. Czibulya Zs.- E. Tombácz- T. Szegi- E. Michéli, - Á. Zsolnay. 2010. Standard state of soil dispersions for rheological measurements. *Applied Clay Science* Volume: 48 Issue: 4 Pages: 594-601
6. Lal R. 2004. Soil Carbon Sequestration Impacts on Global Climate Change and Food Security *Science* 304, 1623
7. Sorensen H. 1961. Decomposition of Lignin by Soil Bacteria and Complex Formation between Autoxidized Lignin and Organic Nitrogen Compounds, Denmark, Pages: 21-22
8. Zheng-Hao Shao et al. 2009. Characterization of water-extractable organic matter during the biostabilization of municipal solid waste, Journal of Hazardous Materials 164 (1191–1197)

http://www.energiacentrum.com/biomassza/a-bioszen-kedvezo-hatasai/

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THE SITUATION OF RURALITY AND PEOPLE MAKING A LIVING WITH AGRICULTURE IN HUNGARY

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INTRODUCTION

Hungarian agriculture and food industry is characterised by strong market dependence, and this influences the development of agriculture and the countryside. Two-thirds of the territory of Hungary is under agricultural cultivation. More than half of the country (50.6 %) is covered by tillage which means 4.5 million hectares. The study shows the effect of the regime change and European Union accession on rural agriculture and – through the characteristics of land use – the change of Hungarian land use according to the types of agriculture. We get a comprehensive characterisation of the change in the share of those land users, the formation and consequences of the effect of ownership changes and the change of the role Hungarian agriculture has in the national economy and its effect. One of the factors in this is income in the Hungarian agricultural sphere, i.e. how the earnings of agricultural population and the net agricultural added values per yearly labour unit change.

THE CHARACTERISTICS OF LAND USE

According to data on land ownership and land use typical by the end of the 1980's, 31.8% of the area was used by state-owned farms and firms, 61.0% by production cooperatives (agricultural, fishing and specialised cooperatives together), and 7.2% of them by privately owned and auxiliary farms (Dorgai 1990). The land use of state farms, private and auxiliary farms also meant ownership – state and private ownership – rights. Land use and ownership were separate in the case of cooperatives, they were based on mixed ownership (cooperative-owned and private lands ceded for use). The cooperatives cultivated 3.8% of their land

in as state-owned, 61.1% as commonly owned by the cooperative, while 35.1% of their territory was owned by members and ceded for common use.

The goal of the regime change started at the beginning of the 1990's was the radical transformation of ownership, and the (re)establishment of the dominance of private ownership.

One of the big questions of the political and economic regime change was denationalisation and compensation, more specifically whether to give the citizens assets en masse and for free, and if the answer is yes, how and when it should be realised. The practice in Eastern Central Europe was quite varied. In Hungary, there were assets handed for free (compensation), although in a differentiated way, the basis of which was the limitation of ownership and freedom that had happened earlier or deprivation of life. Securities used for the free handover of assets were the notes defined legally in 1991: the compensation note embodies the demand from the state, it is valid for showing, can be transferred, and does not have an expiry date. As a result of the changes, currently 86-88% of arable land is private property. 10-12% of land is leased by business associations from the state (permanently state-owned associations, national parks, nature reserves) and approximately 2% is owned by transformed cooperatives.

The main reason for the disadvantageous situation despite the good conditions is the fragmentation of holdings, the lack of capital and the opening of agricultural price scissors, although it closed a bit last year. The fragmentation of the holdings is a consequence of the compensation, a lot of people gained land at that time, the size of which was not sufficient for rentable cultivation. Many people who live and work in cities got land without the means or will to cultivate it. The size of the lands could be increased by buying, but farmers do not have the money for that. The opening of agricultural price scissors means that the price of machinery and material used by agriculture increases faster than the price of their produced output. This decreases profitability, in other words the money that could be invested in development. Despite all these factors, Hungarian agriculture after EU accession will produce competitively on the long term because of the good conditions.

THE INTERPRETATION OF THE COUNTRYSIDE IN THE EUROPEAN UNION AND HUNGARY

In the European Union since 1995, many documents tried to formulate the concept of the countryside. Among them is the European Charter for Rural Areas (1995), The Cork declaration (1996), the European Charter of Rural Areas (1998) and the Agenda 2000 adapted in May 1999.

In the last few decades, we have defined the concept of rural settlements based on many index numbers. To measure "rurality", the main principle of the measuring method used by the Organization for Economic Cooperation and Development (OECD) in foreign countries is that the countryside, rurality and urbanity depend on population density. According to this, if population density is below 150 people per km^2 in more of 50% of the settlements, then we are talking about basically rural areas. If this rate is between 50% and 15%, that it is typically rural area, if this rate is below 15%, it is an urban area. According to documents related to Common Agricultural Policy, the threshold of rurality in the EU is set at 100 people/km^2 on NUTS V. level, and in Hungary, 120 people/km^2 is regarded as justified as a solution because this fits average Hungarian population density and typical settlement structure better than the 150 people/km^2 proposed by OECD (Bainé 2004).

If we accept the population density of 100 people/km^2 as the criterion of rural areas, than 17.5% of EU population lives in the countryside representing not less than 80% of EU territory. More than 90% of the territory of Hungary, therefore the whole area of the country except the agglomeration of the capital can be called the countryside.

The role of food industry in the national economy is decreasing according to longer term international tendencies, but in Hungary, the process has been faster than justified. The share of agriculture –lacking strategic goals and tools, as a result of years of "drifting" – has been steadily decreasing in employment. 2009 was an exception, but even this was not a positive change, explained "only" by that because of the crisis, the decrease in employment was steeper in other sectors of the national economy. In agriculture, employment is fluctuating over the years, but this rather shows a decreasing tendency. The GDP value in production and investment decreases, but it increased in the 2010's. The rate of employment in food industry is less than in agriculture, which has also decreased over the years and currently stagnates. In production, the value of GDP is almost the same, it barely changes, while regarding investments, their number has reduced related to the 2010's. Food industry products are mostly used up by Hungarian consumers, only a quarter of these are produced for export (Table 1).

Only a few years broke the negative trend in the production of gross added value, the output calculated on current prices in 2010 increased faster than in the case of the national economy because of the price increase of plant products.

Out of the 9.3 million hectares of the territory of Hungary, 6 million hectares are cultivated by agriculture, 4.5 million hectares are tillage, and almost 2 million hectares are covered by forest. Grassland and non-cultivated areas are more than one million hectares each. The rate of arable land compared to agricultural land (tillage, horticulture, vinery, orchard, grassland) in Hungary is – similarly to Denmark – very high among European countries. Agricultural production activity is conducted on 70 percent of the territory of the country.

thousand ha

Out of the 9 million 303 thousand hectares of Hungary, 7 million 360 thousand were cultivated in 2011. In 1963, this was 8 million 400 thousand hectares, its share has been gradually reduced over the long period. The reason for this can be explained by the expansion of settlements and infrastructure that resulted in that the size of non-cultivated area increased substantially compared to 1963, from 902 thousand hectares to 1 million 943 thousand hectares in 2011. The share of agricultural area in cultivated area is 5 million 337 thousand hectares. Tillage is 4 million 322 thousand hectares, while grassland is 1 million 67 thousand hectares. The 4 million 322 thousand hectares of tillage with its 48% share of the territory of Hungary is outstandingly high.

Since the political and economic regime change, there has been a significant transformation in Hungarian agriculture that has not been finished even today. The process of privatisation that had a different pace in each sector and geographic area affected agriculture in a way that the relations in land ownership and use had been very significantly modified. Almost 60% of land use is related to an almost negligible share (0.5%) of business associations (mostly the legal successors of former large companies), but 40.5% of the area is cultivated by private farm owners making up more than half (53.2%) of farmers. But regarding their proportions and territorial share, producers not reaching the farm area cultivating hobby gardens and lands around the house producing for their own consumption should not be neglected (Table 2).

In the case of Hungary, changes in the 1990's called a new group of land owners into being, private ownership emerged beside the transformed cooperatives. The will of farmers to use the land is broken by high transaction fees, therefore a majority of these are cultivated in the form of land-lease by minor private farmers. But cooperatives, major companies have bigger knowledge on farming than minor private farmers. It can be observed in Table 3 how the number of various business organisations changed from before to after the regime change. The number of companies, business associations had been reduced by a

TABLE 1: The role of Hungarian agriculture in the national economy

Years	The share of agriculture[a]				The share of food industry			Food industry products, drinks, tobacco			Consumer Price Index previous year = 100,0	
	in employment %	Gross national Product (GDP) in production	in investment	Gross added value in production	in employment[b] %	Gross national Product (GDP) in production	in investment[e]	share		the balance of external trade, billion		
								in consumption[d]	in export[c]			
		current prices, %				current prices, %					food	total
1995	8	6.8	2.9	8.1	-	-		31.8	20.3		131.2	128.2
2000	6.6	4.6	4.7	5.4	_	_		27.3	6.9	302.2	109.2	109.8
2006	4.9	3.5	4.2	4	3.6	2.1	3.1	25.5	5.5	214.8	107.7	103.9
2007	4.7	3.4	4.0	4	3.4	1.9	3.2	26.6	6.3	360.5	111.5	108.0
2008	4.4	3.7	4.6	4.3	3.3	2.0	2.5	27.1	6.7	373.4	110.2	106.1
2009	4.6	2.5	5.6	3	3.5	2.1	2.5	28.0[e]	7.2	347.6	104.4	104.2
2010*	4.5	2.9	4.8	3.5	4.5	2.9	4.8	27.5	6.9	458.9	103.2	104.9

Source: based on KSH data

TABLE 2: change of land use according to the type of cultivation, 1963–2011

Type of cultivation / Years	1963	1983	1993	2003	2011	Change % 1993/1983	Change % 2011/2003
Tillage	5106.4	4681.3	4712.5	4515.5	4322.3	100.67	95.72
Horticulture	154.9	338.5	35.3	96	81.5	10.43	84.90
Orchard	134.9	114.8	93	98.3	92.4	81.01	94.00
Vinery	229.3	156.7	131.7	93.3	92.9	84.05	99.57
Grassland	1359.3	1279.2	1156.6	1061.6	**1061.1**	**90. 42**	99.95
Agricultural area	**6984.8**	**6570.5**	**6129.1**	**5864.7**	**5337.2**	**93.28**	**91.01**
Forest	1389.2	1632.7	1763.9	1803.9	1921.7	108.04	106.53
Reed	27.3	39.6	40.4	60.5	65.5	102.02	108.26
Fishpond	..	26	27.1	**33.4**	35.4	104.23	105.99
Cultivated area	8401.3	8268.8	7960.5	7762.4	7359.9	96.27	94.81
Non-cultivated area	902	1034.8	1342.5	1541	1943.5	129.74	126.12
Total	**9303.3**	**9303.6**	**9303**	**9303.4**	**9303.4**	**99.99**	**100.00**

Source: own edition based on KSH data

TABLE 3: The changes of land users between the period of 1989-2008

Name	1989	2003	2008
Companies, business associations*			
land size, 1000 ha	2588.3	1346.4	1187
share, %	31.8	14.472128	12.8
Cooperatives		Cannot be identified for farms	
land size, 1000 ha	4965.2	2990.7	2695
share, %	61	32.146312	29
Farming organisations		Business organisations	
land size, 1000 ha	7553.5	3781.4	3788
share, %	92.8	40.645355	40.7
Privately owned farms			
land size, 1000 ha	586.1	2 531.30	2820
share, %	7.2	27.208332	30.3
Total:			
land size, 1000 ha	8139.6	9303.4	9303.4
share, %	100	100	100

Source: own edition based on KSH data (2010)

half just as the number cooperatives, farming organisations. The number of private farm owners has significantly risen and their number has been increasing since then. But their share is much lower than that of major farming organisations.

Regarding the changes of the holding structure, it is apparent that we do not experience a substantial difference compared to previous years in the light of data. It can be generally said that the declared land use of every land user group has been reduced. Beside this, the circle of land users is also smaller by approximately 3.6%.

CHANGES IN EMPLOYMENT AND INCOME

Agriculture was a traditional employer in the villages. This role has radically changed after 1990. In 2003, only 5.5% of employed people worked in agriculture, but this is still higher than the EU average which was 4.3% in 2000 (Fehér-Bíró 2005).

The smaller the population of a settlement is, the narrower the employment options of villagers are and in villages with less than 1000 inhabitants, the share of inactive population effectively dependent on support – social or family help – is higher than 70%.

The improvement of Hungarian employment is an urgent task, because the share of inactive working-age people who are the potential source of labour, in other words the under-utilisation of existing labour capacity has grown since the regime change.

The predestined lower labour and income-generating capacity of population living in villages and making a living mostly in agriculture is coupled with an above-average support obligation. The significant share of those who are supported can only count on the family from a social aspect, too, because they did not get into the social support system where employment is mostly required. In recent years (since 1999), this situation has been eased by benefits for which they are entitled based on subjective rights, but no significant change can really be expected because of these without other factors improving their livelihood, especially new jobs.

The problems of agricultural labour force are the following: many farmers are "anchored to a place" meaning they have problems with mobility; lower income standard, differences in the qualifications of labour force, discrepancies between the cultural and living standards of the villages and cities; the specifics of physical labour, cyclical peaks in work; illegal work is prevalent, especially in sectors requiring a lot of manual labour. Table 4 shows the change of employment and income standard is showed. It can be observed that in agriculture, most people work in plant cultivation, while the least in fish farming. Regarding personal income, it can be seen that the basic income of a person in wildlife management is much higher than in any other sector.

The income of agricultural population is lower than the average of the national economy by 21.1 percentage points. Nor demand and supply, neither state organisations tasked to do so managed to prevent the use of market dominance by certain actors of the food supply chain. This contributed to the formation of a more disadvantageous income situation.

The employment rates of groups in the sector shifting towards the service sector are in line with the direction of economically developed nations. But it is a significant difference that this rearrangement there is the consequence of technological development, increase of labour productivity and the strengthening of solvent demand to services. But in Hungary, the change of the rates towards the same direction is accompanied by the decrease of production, the alarming lack of technical improvement in certain sectors.

The loss of the role in agriculture and the modest

TABLE 4: Income data of agricultural employees in 2008

	Man-power	Division of manpower	Personal basic income				Total income			
			Average	Relative deviation	Compara-tive	Relative status	Average	Relative devia-tion	Compar-ative	Rela-tive status
					Index		Ft/ person, month	Index		
	people	%	Ft/ person, month	%				%		
National economy Total	**2294291**	**100**	**147805**	**92**	**-**	**100**	**187850**	**98.7**	**-**	**100**
Plant cultivation, horticulture	24098	1.05	102541	65	86.2	69.4	122145	64.5	83.9	65
Animal breeding	20468	0.89	99579	66.3	87.2	67.4	122210	63.1	86.7	65.1
Wildlife management	533	0.02	134902	82.6	87.4	91.3	157518	87.4	83.6	83.9
Agriculture, wildlife management	**63214**	**2.76**	**100636**	**64.1**	**86.1**	**68.1**	**121861**	**62.1**	**84.9**	**64.9**
Forestry	**9513**	**0.41**	**107115**	**66.4**	**82.7**	**72.5**	**130843**	**153**	**77.2**	**69.7**
Fishing, fish farming	2354	0.10	96826	51.6	81.5	65.5	103488	80.8	67.1	55.1

Source: own calculation and edition based on data of the Hungarian National Employment Service and KSH

growth of employment of industry and services are typical in every region. National data cover a significant difference depending on the different conditions of regions and the different traditions of production. The differences of the employment rate were eased a bit because of the retreat of the agricultural sector concerning every region. But on the other hand, the areas are still clearly outlined where agricultural production is still significant today due to favourable conditions, producing traditions and relative economic advantages.

This tendency – typical in most sectors of the national economy – did not realise in some sectors such as agriculture, because the increase of gross income did not reach the rise of consumer prices, resulting in the decrease of the real value of agricultural incomes.

Beside the abovementioned factor, the traditionally less favourable "ranking" of agricultural activity, the lower qualification level of employees, the option of additional income sources upon which decision-makers also count, and last but not least the very low profitability play a role in the creation and still ongoing intensification of agricultural income disparity.

The traditional, integrated forms and options of getting additional income (market gardens and auxiliary farms) have become strongly limited. This concerned not only agricultural workers unfavourably but population living in the countryside being employed in other sectors of the national economy, too. Solutions serving primarily self-sufficiency, operating without stronger economic background can even become the main source of a very modest level of income – especially in regions with an employment crisis.

If we compare the changes of minimum wage of a developed country, Belgium, and a country that recently joined the EU, Romania, it can be observed that the minimum wages in Belgium have steadily increased over time. In Romania as a country that joined the EU later, one can see a significant increase of minimum wages only since 2008 and this shows a steadily growing tendency. The same process can be observed in Hungary. Since the EU accession, the value of minimum wage has increased threefold. After that it decreased in 2009 because of the problems caused by the economic crisis, but it is has been steadily increasing since then. According to data from 2012, Belgian minimum wages are five times higher than in Hungary, and in Romania it is only half of those working in Hungary (Table 5-6).

THE BREAKOUT OPPORTUNITIES OF DISADVANTAGED AREAS

Settlements that have appealing natural circumstances (beautiful environment that is good for excursions, wine region, thermal spring) see an opportunity in developing rural tourism, too. But its high capital need is also clear for them, and they reckon that it can only spread in a limited way as the main source of income and in a broad circle.

The example described next can unfortunately be said to be typical in the abovementioned regions, it exemplifies the situation of mainly agricultural-type settlements well.

TABLE 5: The change of minimum wages in Belgium, Hungary and Romania 1999–2012

	1999	2005	2008	2009	2010	2011	2012
Belgium	1074.44	1210	1309.6	1387.5	1387.5	1415.24	1443.54
Hungary	89.15	231.74	271.94	268.09	271.8	280.63	295.63
Romania	27.31	78.7	138.59	149.16	141.63	157.2	161.91
Rates compared to the minimum wage of Belgium in %							
	1999	**2005**	**2008**	**2009**	**2010**	**2011**	**2012**
Belgium	100	100	100	100	100	100	100
Hungary	8.30	19.15	20.77	19.32	19.59	19.83	20.48
Romania	2.54	6.50	10.58	10.75	10.21	11.11	11.22

Source: based on KSH - EUROSTAT data

TABLE 6: A-type indicator calculated on income from agricultural activity (1999–2010)

GEOPOLITICAL ENTITY/ YEARS	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
EU–27	..	94.9	104.3	105.8	101.6	110.2	100	104	114.8	109.9p	98.9	111.1
Eurozone (16 countries)	104.2	107.1	110.9	103.7	105.3	107.6	100	103.3	112.1	102.8	91.4	104.9
Hungary	77.5	75.1	79.3	62.7	65.4	99.1	100	106.6	114.3	153.4	107.2	123.3

(„A" indicator corresponds to (deflated, in other words calculated on real value) gross agricultural added value per yearly labour unit. The added value is calculated on factors cost. The implicit price index of GDP is used for its calculation.)

Source: based on KSH data, own edition

At the settlement, the cooperative reduced the number of its workers to its tenth. They opted for early retirement, their formerly significant industrial activity (brick factory, sewing workshop) was gradually reduced and partly sold. People ceased keeping animals because of the low level of profit and at first overdue payments of the meat processing plant nearby, and after that due to its liquidation. Currently they settled in for a production structure that requires a low level of manual labour and they undertake machinery services in the neighbourhood. The leadership of the cooperate retreated to its service basis for the sake of cutting costs and it also plans to sell its well-equipped office building that is under-utilised because of the small labour force. In the settlement, unemployment rate rose to 20%, animal keeping that was formerly a significant side income has been scaled back, people without a job are making a living from welfare benefits and temporary jobs. The number of schoolchildren is getting fewer year by year because a significant part of them is enrolled by their parents to the school of a nearby bigger settlement or the county seat. There are more and more families moving in from the abandoned crofts of former big companies nearby who are struggling to make ends meet and to be employed, adding to the already not so few problems of the settlement and making the future – without radical economic changes – quite dubious.

In disadvantaged settlements in agricultural areas with unfavourable conditions described above or very similar to it, the following – amongst others – can be listed as breakout opportunities:

- establishing mixed-profile peasant farming,
- processing local products in place,
- building up local retail chains,
- developing and applying special sub-regional decrees,
- the improvement of services typical of the regions in question,
- strengthening the organising, integrating activity of local governments in this direction.

(Józsa 2006)

The number of the workers whose principal occupation is in agriculture was approximately 194 thousand people in 2005. Most of the reduction occurred until 1994, but the sector is still continuing to gradually lose its role in employment – uniquely among the sectors of the national economy. On average, 8-10 thousand agricultural jobs per year (opportunity to make a living) ceased to exist. Finding jobs after losing it is still the hardest in this employment group. The loss of people in agriculture is decisively (70-80% in some counties) concentrated on villages. The rate of unemployed people over 40 years is the highest in general and those who fell out from agriculture, and since the qualification level of those who are concerned does not correspond to the needs of new jobs, the rate of permanent unemployment is really high.

Programmes establishing cooperation between those who are willing to participate in the form of an association, preparing, organising the production of plantations (melons, vegetables, spices, fruits, vines) with a high need for labour want to increase the chances of agricultural unemployed to make a living. Programme organisers find the calls for applications and the organisations and unemployed who can be included in the programme, and after that they operate the programme. This proved to be a successful solution, but it mobilises only a small circle of unemployed people for now.

CONCLUSIONS

▪ The labour reduction of the sector did not stop and with people who lost their jobs in other workplaces and returned to the village without a job, it significantly – at a substantially higher rate than registered – increased the number of unemployed people and the duration of being without a job.

▪ Those who are employed prefer full-time jobs in agriculture, too, but with the current economic conditions, 69% of farms currently cannot provide this.

▪ Among the estimations on the fate of labour force out of agriculture at the settlements examined, permanent unemployment is expected in the first place – in almost 90% of those who are older than 40. On the second place, temporary jobs coupled with benefits are the "perspective" for 60% of those who are over 40. Taking a job that requires commuting or changing the place of residence is an option only for young people, just like training and retraining. At the last place of the opportunities to make ends meet is the establishment of privately owned farms for production, and self-employment as an exclusive income source.

▪ Agricultural activity – despite the weakened performance of the sector in the last decade – has been appreciated more in regions with critical employment situation and small villages, it plays a very important and increasing role in people living there, in easing their social problems.

SUMMARY

The share of agriculture has been reduced in employment and – in correlation with that – in gross national income since the regime change, while some fluctuation can be experienced in investments. The Hungarian national economy has kept the level of value generation.

In line with international tendencies, the role of agriculture in the national economy, the numerical share of its output is being reduced in Hungary, too.

In general, it can be said that in Hungary, the share of people employed in agriculture has been gradually and significantly reduced in the last one – one and a half decades (in 2010, it was 4.5%, while it was 4.9% in 2006). The reason for that is the end of the cooperatives and the cooperatives (business organisations) that are still working have robustly scaled-down activity. Privately owned lands have become fragmented, therefore their owners employ smaller workforce than former cooperatives. Fragmentation is detrimental not only for employment but also because of the drop in production efficiency. Cooperation between small holdings would be advantageous from every perspective.

Almost half of the lands in Hungary, 41% was used by business organisations, 32% by privately owned holdings in 2010. The remaining 27% is economically unidentifiable, with almost half of them not being used by agriculture. Substantial change cannot be identified in the composition of land use based on the types of farming.

The incomes of agricultural population are behind the average of the national economy. Nor demand and supply, neither state institutions for this end were able to prevent the use of market dominance for certain actors of the food supply chain. This also adhered to the creation of further disadvantageous income disparities.

It can be stated that in Hungary, the role of agriculture in the national economy is still considerable despite the significant setback. This can mostly be traced back to the much more advantageous conditions of agricultural production than the average, the traditions of production and the proportions of the sector that are well above the EU average (because of the share of the area used for agriculture, those who are doing agricultural activity). In parallel, agricultural activity – not rarely as the almost only source of income – is appreciated more and more in regions with a critical economic situation. This phenomenon re-evaluates the basically production-based role, significance of the countryside and more specifically agricultural activity so far, and strengthens its multifunctional nature.

The issue of developing Hungarian farms, the Hungarian countryside is on the agenda of the whole country and society, furthermore, in a really prominent place. In the last few years, the number of opportunities to develop Hungarian villages, rural society, rural areas opening up in EU accession process shot up which is welcome news. There are many reasons for this increased interest. First of all, the increased sensibility of the new government to the problems of the countryside should be mentioned. This more intense government interest expressed is luckily coupled with many EU initiatives that served making regional development, rural development more prominent in Hungary, too.

REFERENCES

1. Bainé Szabó B. 2005. Vidéki gazdaságok ökonómiája, Egyetemi jegyzet. Debreceni Egyetem Agrártudományi Centrum Agrárgazdasági és Vidékfejlesztési Kar Vállalatgazdaságtani és Marketing Tanszék. 8-15.p.
2. Dorgai L. 1990. A föld jelenlegi használati és tulajdonviszonyai Magyarországon. In: A földtulajdon és a mezőgazdasági struktúra átalakítása címűtanulmánykötet. Budapest. Agrárgazdasági Kutató és Informatikai Intézet
3. Dr. Fehér A. – Bíró Sz. 2005. A multifunkciós mezőgazdaság megteremtésének esélyei és teendői. Budapest. Integrációs és Fejlesztéspolitikai Munkacsoport Agrár- és Vidékfejlesztési Témacsoportja
4. Forman B. 2003. Az Európai Unió strukturális és előcsatlakozási alapjai. – Interpress Külkereskedelmi Kft, Budapest, 2003. – 397 p.
5. Harsányi E. : A földhasználat különböző típusainak befolyása a mezőgazdaságból élők életkörülményeire Magyarországon

APPLICATION OF INTEGRATED REMOTE SENSING METHODS IN A NATURE CONSERVATION AREA

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Nature conservation and environment protection are in major focus both at international and national level. By the accession to the European Union, Hungary undertook to integrate the EU's nature conservation and environment protection laws with the national legislation, and to bring them into force. The general aim of regulation is the preservation of biodiversity and the detection of changes. In the EU, one of the ways of maintaining biodiversity is the European ecological network NATURA 2000 which orders the designation of sites on the basis of the Birds Directive and the Habitats Directive in order to protect natural habitats, animal and plant species. To ensure the sustainability of these habitats, their conditions and changes have to be monitored using the methods of biodiversity monitoring based on habitat mapping. Monitoring of various habitats is not an easy task, particularly from the aspect of selecting the examination tool. Remote sensing technology enables the up-to-date, quick, accurate and cheap observation, examination, monitoring and analysing of living and non-living objects on the surface of the earth in a large area. Remote sensing is the acquisition of information using special instruments and sensors about objects, relief features or phenomena without making physical contact with the object (Demeter et. al. 2002; Belényesi et. al. 2008).

CLASSIFICATION OF REMOTE SENSING TECHNIQUES

Remote sensing techniques are classified in many different ways. Some aspects of classification are introduced below: As for the **energy source** of the electromagnetic radiation used for the examination, passive and active remote sensing are distinguished. Passive Remote Sensing is the remote sensing of energy naturally reflected or radiated from the terrain using instruments like multi- and hyperspectral sensors or microwave radiometers. In Active Remote Sensing, the system transmits its own radiation to detect an object or area for observation and receives the reflected or transmitted radiation. Such systems include the LiDARS (Light Detection And Ranging) which enable the 3D recording of surface geometric information. As for the **height and carrier device** of data recording, information may be collected by terrestrial measurements (*instrument column, vehicle, post, etc.*), airborne measurements (*aircraft, helicopter, hang-glider, UAV*) or by sensors installed on satellites (at 600-1500 km). On the basis of the **number of channels**, panchromatic (PAN), multispectral (MSS) and hyperspectral sensors are identified. ***Analogue*** images are sensed on only one channel where three layers sensitive to different wavelengths are applied on the carrier after one another (RGB). By today, they have almost completely been pushed to the background. ***Multispectral*** instruments collect data on two or more (3-20) spectral bands. Multispectral scanners were first installed on aircrafts then on satellites. In ***hyperspectral*** data collection, sensing occurs on over a hundred or even a thousand adjacent spectral bands. This enables the accurate distinction between plant species or various material types of the ground, whereas the multispectral technique can only identify different material groups. As for **geometrical** (*spatial*) **resolution**, the images can be low resolution (above 100 m), average resolution (1-100 m) or high resolution (below 1 m) (Tamás 2000; Lóki 1996).

THE DESCRIPTION OF EXAMINATIONS

The increasingly widespread application of remote sensing techniques provides suitable basis for numerous national and international environment protection and nature conservation research. ChangeHabitats 2 (2011-2014) is one of these international projects and is aimed at establishing an international habitat protection monitoring system for Natura 2000 sites playing an important role in the preservation of protected species and their habitats by using data from traditional field, airborne hyperspectral and airborne LiDAR instruments. In the frame of the project, airborne hyperspectral and airborne LiDAR images were taken on five different Natura 2000 habitat types. Herewith, we present the results of the examinations conducted in the Nature Conservation Area named Nagyerdő (great forest) in Debrecen within the *Special Protection Area* of Debrecen-Hajdúböszörményi tölgyesek (oak forests) (site code: HUHN20033).

Nagyerdő is one of the most famous forests of the Great Plain of Hungary and of the city of Debrecen. It was the first area in Hungary that was declared as nature conservation area in 1939. It preserves the memory of sand land oak forests of the region Nyírség whose indigenous stand-forming tree species is Pedunculate oak (*Quercus robur*), and the most common admixing tree species are White poplar (*Populus alba*), Quaking aspen (*Populus tremula*), Little-leaf linden (*Tilia cordata*), Field maple (*Acer campestre*) and Wild pear (*Pyrus pyraster*). The majority of its trees are young, and forest parts of older trees (80-100 years of age) can only be found in the nature conservation area. Old trees provide habitat for numerous animal, plant and fungus species, therefore, the project lays special emphasis on the assessment of their conditions. The greatest problems of the forest are increasing aridness, the declining of old oak-groves, the presence of non-endemic species and illegal waste dumping. As a result of the changes in the ecological environment – due to, for instance, the closeness of the city, climate change, etc. – weed-like herbaceous plants proliferated everywhere, the process of degradation started and accelerated. Locusts and Ailanthus grow in the entire area of the forest, even under the old oak trees. In the formerly diversified shrub stratum, nitrophyte weeds (e.g. elder, bramble) are now common, significantly supplanting the original plant population (I1).

Our sample area was selected in one part of the Nagyerdő Nature Conservation Area in Debrecen, which is included in Natura 2000 network and the national project ChangeHabitats 2. Each plot is a Natura 2000 site and includes forest patches categorized as 'forest parks' for their secondary purpose. The area starts at the main building of the University of Debrecen and spreads to the north to Debrecen-Pallag in a 5.5 km long and 600 m wide zone. From this data collection zone, our examinations covered the area from the Klinikák to Debrecen-Pallag. Figure 1 shows the airborne hyperspectral and airborne LiDAR images taken on the examination area.

The aims of the examinations were to identify the tree species with the highest coverage (at least 70% for the dominant species and 20-30% for the admixing species) in the sample area in each plot on the basis of the data collected in the field and by airborne remote sensing instruments using the method of image classification, as well as to assess the possibility of applying mobilGIS, airborne hyperspectral and airborne LiDAR data collection methods to complete or replace traditional terrestrial data collection. Data collection involved fieldwork and the processing of airborne hyperspectral and airborne LiDAR images, which was performed on the basis of training areas specified with the field GPS device. Data integration included spectral and geometrical corrections, and photogrammetric processing. Data were evaluated with the geoinformatics software ArcGIS 10.2 and Exelis 5.3, including the creation of mosaic datasets, the definition of sampling locations and the processes of spectral image processing.

AIRBORNE SURVEYS

The airborne hyperspectral image was taken by an AISA Dual hyperspectral sensor system operated in joint venture by the Mechanization Institute of the Ministry of Agriculture and Rural Development and the University of Debrecen, Department of Water and Environmental Management since 2006. The system provides hyperspectral data in the range of 400-2452 nm. The image contains 395 spectral bands and its spatial resolution is 1.5 metres. The AISA Dual system combines two hyperspectral cameras (AISA Eagle and Hawk) installed in one cabinet to enable coordinated data collection from the VNIR (visible wavelengths; near infrared) and SWIR (shortwave infrared) spectral ranges. The Eagle camera takes images in the visible (400-700 nm) and near infrared (700-1300 nm) range, while Hawk operates in the middle infrared range (1300-2500 nm). The AISA Dual system includes push broom imaging sensors with fibre optic down welling irradiance sensor (FODIS); a miniature integrated GPS/INS sensor to monitor the position, height and location of the aircraft; a PC-based compact data collection and mobile storage unit; a CaliGeo pre-processing software integrated in Exelis to perform spectral and geometric corrections. Due to the several hundred narrow wavelength bands, highly detailed data are obtained from hyperspectral images on the spectral material properties of the surface. In this way, they are perfectly suitable for the identification

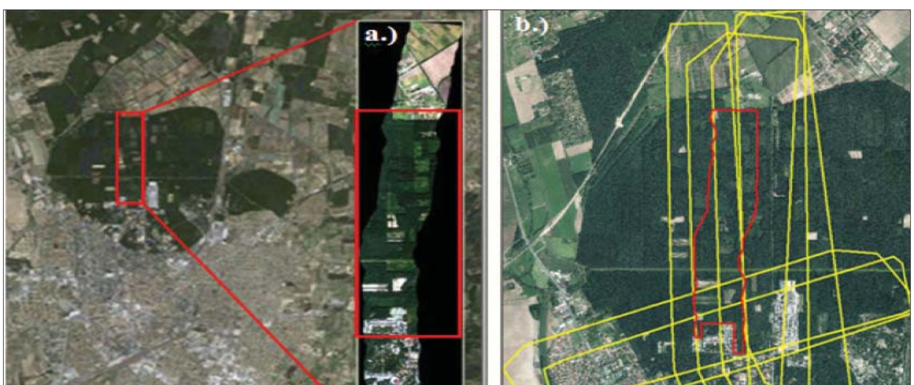

Figure 1: The a.) airborne hyperspectral and b.) airborne LiDAR images taken on the sample area ***(Source: Google Earth and University of Debrecen, Centre for Agricultural and Applied Economic Sciences, Department of Water and Environmental Management, UD CAAES DWEM)***

of different objects, vegetation types (in our case the most common tree species in the sample area) through image classification (Tamás et. al. 2009).

The airborne LiDAR image was prepared by the Austrian company, RIEGL Laser Measurement Systems GmbH using the laser scanner RIEGL LMS-Q680i they designed. This instrument enables the quick and accurate recording of 3D data on large areas which can then be used to prepare digital terrain models (DTM) where the relief model is completed with vegetation and other spatial objects and their heights. The laser scanner, as an active remote sensing device, is a sensor with known position and orientation that emits laser radiation of different frequencies in a given angle and then measures the return time and the angle of radiation reflected by the surface examined. The airborne laser scanner collected data at the wavelength of 1054 nm which is in the near infrared range. The survey was performed in six flight zones with 33.88 laser points per square metres, on average.

MOBIL GIS – FIELD SURVEY

Digital image processing was preceded by a field survey using the forest map and descriptive database made available by the Forestry Directorate of the Government Office of Hajdú-Bihar County. During the fieldwork, the vegetation in the plots of the sample area was surveyed and homogenous forest patches, tree groups and individual trees were recorded as points or polygon layers using the manual GPS device Trimbel Juno ST. A part of the recorded points were defined as training areas required for the classification, and some polygons were selected to verify the classification result of each species on the basis of the forestry records (Table 1).

EVALUATION OF THE AIRBORNE HYPERSPECTRAL IMAGE

The aim of digital image processing is the quantification of the data of the image taken on the examination area and it is performed by the method of image classification. Image processing is a multistep data processing procedure where radiometric and geometric correction is followed by the defining of classes to be identified (training phase), then verified or non-verified image classification is performed (Hargitai et. al. 2006). During image classification, areas with similar characteristics are sorted in individual classes on the basis of the content and texture of image pixels. The training areas required for verified image classification included the GPS points recorded during fieldwork of the five stand-forming tree species (Pedunculate oak – *Quercus robur,* Northern red oak – *Quercus rubra*, Scots pine – *Pinus sylvestris*, Eastern black walnut – *Juglans nigra*, Linden – *Tilia sp.*) and the two most easily identifiable admixing species (White poplar – *Populus alba* and Black locust – *Robinia pseudoacacia*) defining 9 forest types. Classification was carried out by the method of Spectral Angle Mapper Classification (SAM) which is an algorithm defined by Kruse et. al. (1993) that uses an n-D angle to match pixels to reference spectra. The algorithm determines the spectral similarity between two spectra by calculating the angle between the spectra and treating them as vectors in a space with dimensionality equal to the number of bands. The success of the method requires the correct determination of endmembers, while accuracy can be increased if the examination angle (radius between 0-0.1) is set properly. We used different angle sets for each species, the values and results of which are demonstrated in Figure 2.

EVALUATION OF RESULTS

During the evaluation of the results, the equivalence between the classified image and the coverage values specified in the forestry records was checked in the examination plots defined by species. The accurateness of the defined training areas was also checked to examine if the identification of the seven tree species involved in the survey was successful in the checking areas (Post Classification). In parallel to this, Normalised Difference Vegetation Index (Rouse et. al., 1973) was also determined which defines the relation between the radiation reflected by vegetation in a given area in the near infrared (NIR) and visible red (VIR) ranges. The vegetation activity features were examined for the plots where classified coverage values reached or exceeded 70% and for the Linden plot

Table 1: Vegetation types characteristic to the sample area and their occurrence by plots

Forest type	Coverage (%)		Number of plots
	Dominant	Admixing	
Pedunculate oak	≥70		41
Northern red oak	≥70		6
Scots pine	≥ 70		1
Eastern black walnut	≥ 70		1
Linden	≥ 70		1
Pedunculate oak mixed with other broad-leaved trees	50- 70	20-30	18
Pedunculate oak mixed with other coniferous trees	50-70	20-30	1
Scots pine mixed with other broad-leaved trees	50-70	20-30	2
Locust mixed with other broad-leaved trees	50-70	20-30	2

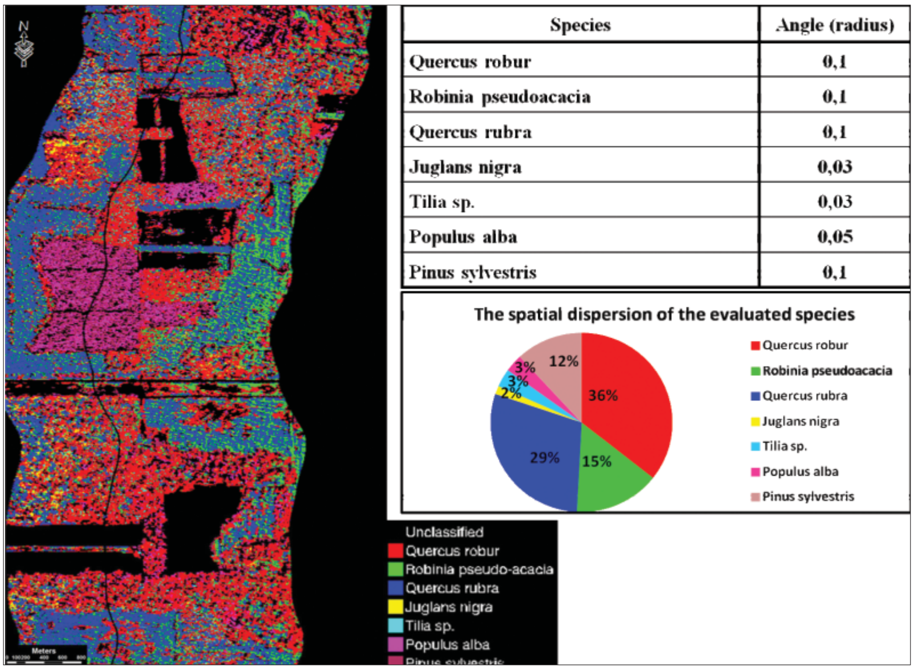

Figure 2: Results of SAM classification with different angle sets for each species

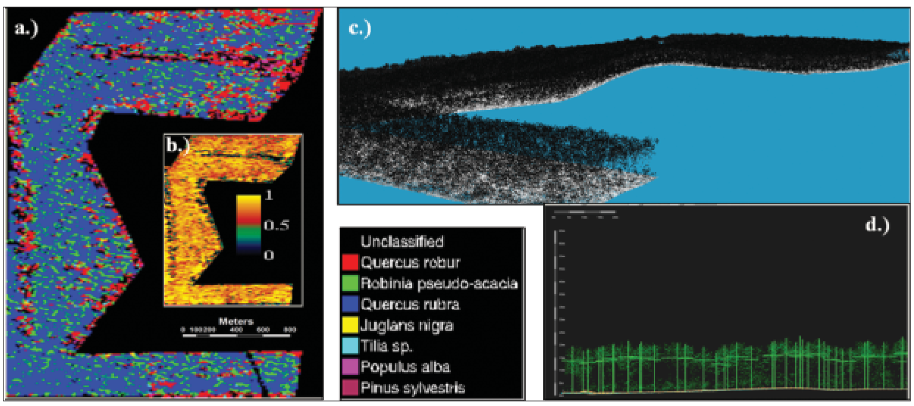

Figure 3: *a.)* classified *b.)* NDVI and *c.), d.)* 3D spatial sectional view created from the airborne LiDAR image of the checking area of Northern red oak (*Quercus rubra*)

that was rated by the forest management organization as forest with incomplete canopy. The assessment of the classification integrated the results of mobilGIS (own field data, forestry database) and airborne hyperspectral analysis, as well as the information obtained from the airborne LiDAR image.

As for the Northern red oak (*Quercus rubra*), our classification exceeded the value of 70% defined in the forestry records by over 5%, which can be considered as the most successful from the seven classified tree species. The selecting of training areas was made easy by the dense, closed canopy and the mostly homogenous plot, which is demonstrated by the 88.4% accuracy of the training areas, the high (0.8-1.0) NDVI value and the low relative standard deviations of average height values specified from LiDAR data (Table 2, Figure 3). The most common admixing tree species of Northern red oak is Locust which mainly occurs in the border zone but can grow anywhere in the forest where there is a gap in the canopy. In the edge of the plot, Pedunculate oak mixed with other broad-leaved trees border the area.

As for the only Linden (*Tilia sp.*) plot, our value was 61% less than the rate (dominant species with at least 70% coverage) specified in the forestry records, which was caused by the highly incomplete canopy of the plot where trees mainly grow in the centre of the area, and where NDVI values vary between 0-0.5 only (Figure 4). The forestry records and field observations also confirm that the canopy of the Linden-grove is incomplete due to forest management failures. The trees grow in smaller groups with a diameter of about 5 metres and an average height of 9.8 metres. These are located in the edges of the plot, whereas in the middle there are some older Linden trees with Pedunculate oak trees and weed communities. This very heterogeneous composition is indicated also by the high value of relative standard deviation (30%) which is 23% higher than the relative standard deviation of the Northern red oak's (*Quercus rubra*) homogeneous stand. In the border zone, the Northern red oak and the Locust can also be found, spreading here from the neighbouring areas just as the Scots pine. The accuracy of training areas is also low (11.8%), which might be caused by that Linden is shorter than any of the admixing trees, thus the rate of clear pixels is reduced.

Table 2: Coverage and height values of Northern red oak (*Quercus rubra*) in the checking area

Forest type	Rate of dominant species (%)		Accuracy of training area in the checking areas	Average height (m)	Relative standard deviation (%)
	As per classification	As per forestry records			
Northern red oak	75.2	≥ 70	88.4	20.6	13

Table 3: Coverage and height values of Linden (*Tilia sp.*) in the checking area

Forest type	Rate of dominant species (%)		Accuracy of training area in the checking areas	Average height (m)	Relative standard deviation (%)
	As per classification	As per forestry records			
Linden	9.4	≥ 70	11.8	9.8	30

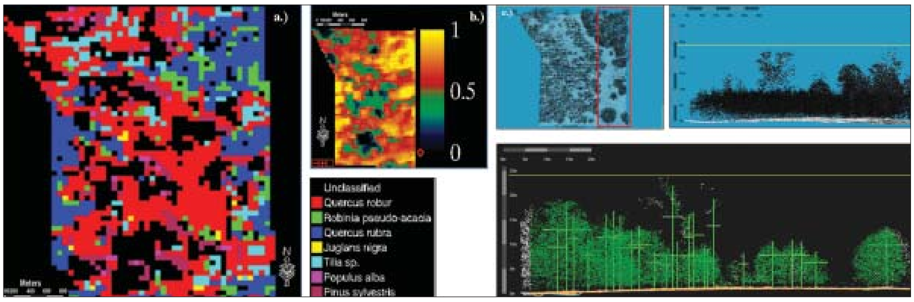

Figure 4: ***a.)*** **classified** ***b.)*** **NDVI and** ***c.), d.)*** **3D spatial sectional view created from the airborne LiDAR image of the checking area of Linden (*Tilia sp.*)**

Images taken by the airborne laser scanner enable the examination of the surface's structural composition. These values were assessed as complementary information to the material features specified on the basis of the hyperspectral image. By the separation and mapping of the canopy, details that are hard to be perceived or cannot be perceived at all on hyperspectral images become visible, analysable. During the selection of training areas, such 'invisible' factor was that Linden, because of its shortness, is hidden by other tree species, primarily Pedunculate oak and Northern red oak, which significantly reduced the number of clear pixels on the hyperspectral image. It can also be seen on the spatial sectional view of the Linden plot (Figure 4/c) that Linden is hidden more or less by Pedunculate oak (*Quercus robur*) in the upper canopy level and Northern red oak (*Quercus rubra*) at the plot edges. To evaluate mixed pixels, the geometric parameters obtained from airborne laser scanned images and describing the surface might be required. Sub-pixel operations are reasonable to improve the accuracy of classification, which are planned to be performed in future surveys.

Summing up the examinations, it can be stated that airborne hyperspectral data collection is perfectly suitable for the examination of the composition of large homogenous forest parts containing only a few tree species and for the identification of these tree species. Classification was the most accurate in the homogenous plot (coverage over 70%) where the canopy was closed, and the trees were almost the same age and were healthy (Northern red oak – *Quercus rubra;* Scots pine – *Pinus sylvestris*). However, the establishment of a monitoring system and the monitoring of changes in the plant stands require wide-ranging data which can only be supplied efficiently from several data sources. To reduce the occasions and duration of data collection and to obtain extra spectral and geometrical information, the integration of field surveys, airborne hyperspectral and airborne LiDAR technologies may provide, depending on the research aims, a suitable basis for analysing vegetation and habitats.

REFERENCES

1. Belényesi M. – Kristóf D. – Skutai J. 2008. Térinformatika Elméleti Jegyzet. [Geoinformatics University Handbook] Egyetemi jegyzet. Szent István Egyetem Mezőgazdaság és Környezettudományi Kar Környezet- és Tájgazdálkodási Intézet. Gödöllő.
2. Demeter A. – Gergely E. – Magyar G. – Outi A. 2002. Természetvédelem az Európai Unióban [Nature conservation in the European Union] (In: Szerk.: Demeter A.: Magyarország és a Natura 2000 – I. Natura 2000 – Európai hálózat a természeti értékek megőrzésére. ÖKO Rt. Budapest. 12-30.)
3. Hargitai H. – Kardeván P. – Horváth F. 2006. Az els magyarországi képalkotó spektrométeres repülés és adatainak elemzése erdőtípusok elkülönítésére [The first imaging spectrometry flight in Hungary and the possibility of its data to identify forest types]. Geodézia és Kartográfia, 9.
4. Kruse F.A. – Lefkoff A.B. – Boardman J.B. – Heidebrecht K.B. – Shapiro A.T. – Barloon P.J. – Goetz A.F.H. 1993. The Spectral Image Processing System (SIPS). Interactive Visualization and Analysis of Imaging spectrometer Data. Remote Sensing of Environment, 44. 145-163.
5. Lóki J. 1996. Távérzékelés. Kossuth Egyetemi Kiadó. Debrecen.
6. Tamás J. – Lénárt Cs. – Burai P. 2009. Evaluation of applicability of airborne AISA DUAL hyperspectral imaging system to map environment conditions in orchards. International Commission of Agricultural and Biologiacal Engineers, Section V. Conference. Rosario,Argentina. 1-4. September, 2009. 1-13.
7. Tamás J. 2000. Térinformatika I. [Geoinformatics] Debreceni Egyetem Mezőgazdaságtudományi Kar. Debrecen.
8. I1: http://www.nagyerdo.com/

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COMPETITIVENESS ANALYSIS IN AGRICULTURAL TRADE – THE CASE OF VISEGRAD COUNTRIES

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ABSTRACT

As regards Visegrad countries, the integration into the European Union in 2004 resulted wider agro-trade possibilities, as well as difficulties from many aspects. The elimination of the former customs duties and other trade barriers instantly led to a growing trading activity. The expansion of trade turnover was inevitable due to the free flow of goods on the common internal market which was developed after the integration. The trade turnover - which was gradually increasing in case of old EU member states – has grown strongly and within a very short time in the relation of neighbouring countries. In this paper we are examining the main tendencies of the trade in the field of agriculture and food industry among the Visegrad countries with statistical analysis. Our examinations have demonstrated that the value and volume of agricultural foreign trade turnover of V4 countries has substantially expanded due to the changes which have occurred in the last 12 years.

INTRODUCTION – GENERAL AGRO-TRADE EFFECTS

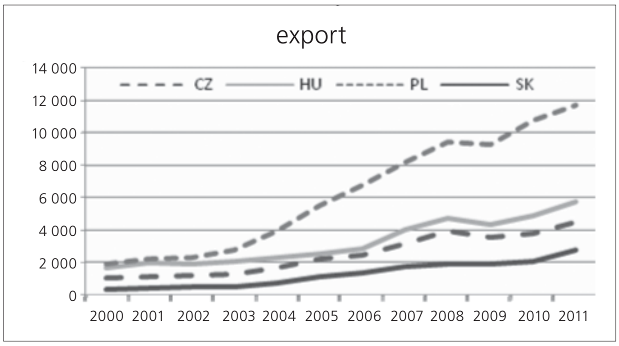
The agro-trade of Visegrad countries[1] - in trade policy aspect – was basically affected by two main events in the early 2000s. On the one hand, the favours implemented in the frames of the European Treaty concluded with the European Union before the accession and the updated versions of favours, which has led to considerable decrease of barriers in bilateral trade with the old member states of the European Union (EU15).[2] On the other hand, the European Union membership has enabled in the trade among the new member states to implement free trade without restrictions, according to the principles of common internal market.

As regards the analysis of other topics, many authors referred to the development of trade relations.[3] Out of these, for example, works by Fertő (2003), Fertő et al. (2005) or Jámbor (2011) should be highlighted which examined the features of general competetiveness in relation to Hungary and EU15. Recently, among others, Bartosova et al. (2008), Bojnec et al. (2009), Savtos et al. (2010), Rajcaniova (2012), Bielik et al. (2012), and Qineti et al. (2012) analysed

[1] The Visegrad Cooperation (Visegrad countries or V4) is the regional organization of the Czech Republic (CZ), Hungary (HU), Poland (PL) and Slovakia(SK). The aim of this cooperation is to provide joint representation for the economic, diplomatic and political interests of these countries, harmonization of their actions in relation to EU with special regard to agricultural policy, structural funds, common foreign and defence policy, as well as the Schengen Agreement.

[2] The EU has given substantial agro-trade favours by extending the Generalized System of Preferences (GSP), then it has created new condition system for agro-trade in the frames of Association Agreement concluded in 1991. The second amendment to this included the arrangement enhancing liberalization process prior to the accession. The mechanism of favours were extended in this framework: (a) system of customs-free quotes – "four zero solution", (b) customs-free option without quantity restrictions – "double zero solution", and (c) tools of traditional customs quotes. The degree of preferences considerably increased due to the measurements, the quantity limits decreased, thus afterwards the preferential agricultural trade was in fact equal part of internal market, the market competition. (Halmai, 2007)

[3] The development of trade relations has been significantly influenced by changing of input factors. For example cereal land use was analysed in Takács-György et al 2012.



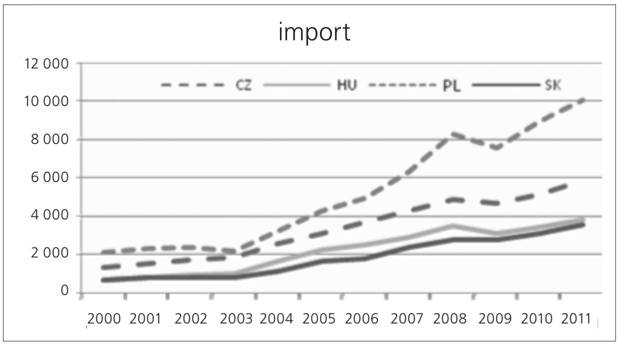


Figure 1. Agricultural export and import turnover between Visegrad countries and the European Union (2000-2011, at current prices, million euro)
Source: own work on the basis of EUROSTAT 2012a

the specific features of trading activities of new member states, with special regard to Visegrad countries. Out of Hungarian authors, Jámbor et al provided a detailed review of issues within narrow Visegrad relation. Other analyses can be found in Hungarian references but typically these concern only individual products which are traded within V4 relation. Such papers are, for example, the PhD thesis of Poór in 2010, or conference presentation by Mészáros in 2012 in which he reviews the local interrelations of beef trade based on a study performed by Mészáros and co-author in 2011.

On the basis of EUROSTAT trade statistics data, the trade turnover in EU15 relation has clearly increased following the accession. (EUROSTAT, 2012) (see Figure 1) The countries which integrated after the enlargement in 2004 (EU12) had very different conditions concerning the role of agriculture in national economy: its level, the volume of agricultural subsidies as well as in regards the efficiency and competitiveness of the sector.

In spite of the fact that the trade policy approach was more liberal in regards to EU15 because they headed towards a large and solvent market, basically very serious restrictions were implemented in the relations with EU12 countries, due to the tail effect of former trade policy trends. As a consequence, a special, distorted situation was set up, which – in spite of the efforts made in order to treat this [4] – clearly included the often unfavourable foreign trade impacts, which broke as an explosion after the EU accession.

MATERIAL AND METHODS

The research aimed to reveal the lessons that can be learnt from the example of Visegrad countries. Basically two reference points can be distinguished. On the one hand, the trade in goods between different country groups of EU, and, on the other hand, the special features of Visegrad countries. The data for the research were collected from EUROSTAT database, in SITC (Standard International Trade Classification[5]) system and covered the period from 2000 to 2011. The double digit distribution of SITC system was applied for the treatment of data.

It has become clear during the research, that, in general, a lot of difficulties and restrictions can affect the uniformity and reliability of data due to the characteristics of the database. Out of these, the following should be highlighted:

- Following the EU integration, in case of import, the goods coming from countries out of EU appear as goods from within the EU since they cross the EU border and the seat of the importing corporation is in the EU.
- In case of export, entry and exit summary customs declaration should be filled only in case of trade outside the EU, thus the control of actual turnover within EU is not possible on the basis of customs declaration.[6]
- The series of VAT frauds within the EU has a significant distorting impact, because the effect of fictious turnovers within the Union is very uncertain in administration and, consequently, in statistics.
- Moreover, the black or illegal trade can be added to the above, because it has a strong impact on some special product groups.[7] The avoiding trade, however, should also

[4] Due to the trade agreements between the new member states, substantial integration was set up right before the accession both in regards to agricultural trade and the agricultural markets. The Central European Free Trade Agreement (CEFTA) was ratified in 12 December, 1992, in Cracow and its main objective was to increase trade among members. Its actual expansion, however, was only moderate.

[5] The Standard International Trade Classification, is a product classification of the United Nations and used for external trade statistics (export and import values and volumes of goods). In cooperation with Governments and with the assistance of expert consultants, the United Nations Secretariat drew up the 1950 edition of the United Nations Standard International Trade Classification (referred to below as the "original" SITC) By 1960, many countries were compiling international merchandise trade data according to the original SITC or national classifications correlated to it and major international organizations had adopted SITC as a basis for the reporting of international trade statistics. SITC is allowing for international comparisons of commodities and manufactured goods. (UN, 2006)

[6] It should be noted that the paper which serves to follow the movement of goods is called accompanying document in the trade of excise goods. It had been used only in internal trade earlier, but following the EU-accession, the goods are accompanied with this, too, in case of excise goods trade between member states, because the value added tax and the excise duty can be recovered on the basis of this. (EUVONAL, 2012)

[7] The Hungarian cattle stock, which has excellent animal health capabilities (free from bluetongue disease) has found a strong market in Turkey. In cases of some lots, however, some dealers exported calves to Turkey which born out of Hungary but got Hungarian papers. Due to this, Turkey has introduced sanctions.

be noted here, because it goes legally at union level, but it does not appear in the statistical reports [8] of the individual member states.

A lot of methods, ratios and indices were applied in the frames of the research. The share of member countries in the changes of export market ratio was explored.

$$MR_{E/I} = \frac{\sum_{j}^{i} x_t - \sum_{j}^{i} x_{t-1}}{\sum_{j}^{i} X_t - \sum_{j}^{i} X_{t-1}} \qquad (1)$$

Where $MR_{E/I,}$ gives the ratio in the market proportion change, x_t, x_{t-1} is the value of the export and import goods of the given country in *t* and *t-1* year. X_t, X_{t-1} is the value of the total export and import turnover of the given country in the two periods. The value of the ratio can also be negative, which means that the goods turnover decreases in case of the given country, in the examined relation. The structure of the index allows values above 100% and below -100%, too. It can be due to the temporary features that the value of the denominator is extremely low, thus even a slight change may seem significant. It can distort the interpretation, therefore the swinging values are maximized.

The next index is the export-import balance, which clearly expresses the difference between export and import of the country.

$$B_{E/I} = x_{ij} - m_{ij} \qquad (2)$$

Where $B_{E/I}$ gives the sum of balance, x_{ij}, is the sum of export value of the given country, and m_{ij} is the sum of the similar values of import.

The third index applied in our research quantifies the export-import ratio. The ratio is the simplest export specification index which correlates the export of the countries to their import.

$$R_{E/I} = \frac{x_{ij}}{m_{ij}} \qquad (3)$$

Where $R_{E/I}$ is the value of index, x_{ij}, is the sum of export items, currently the sum of export values of the given country, while m_{ij} gives the sum of similar values of import.

The analysis also includes the calculation of Herfindahl–Hirschman-index (HHI) value of the examined country. In the course of this, the export share of each product group is squared and the values received are summarized. Formally, the index is formed as follows:

$$HHI = \sum_{i=1}^{N} S_i^2 \qquad (4)$$

where S_i is the market share of given *i* product group. Subsequently, the value of the index is between 0 and 1. The higher values indicate higher level of concentration.

The examination is finished with the index developed by Béla Balassa for measuring the comparative advantages. The formula of *B* index is the following:

$$B = \frac{x_{ij} / \sum_i x_{ij}}{\sum_j x_{ij} / \sum_i \sum_j x_{ij}} = \frac{x_{ij} / \sum_j x_{ij}}{\sum_i x_{ij} / \sum_i \sum_j x_{ij}} \qquad (5)$$

where *x* indicates the export, *i* is for the product group, *j* is the examined country, and, subsequently, x_{ij} means the product-level, while $\sum_i x_{ij}$ is the total export of the given country, $\sum_j x_{ij}$ indicates the product-level export, and $\sum_i \sum_j x_{ij}$ is the total export of the world or a country group.[9] (Balassa, 1965)

[8] It is a difference in the reports of member states that data should be given above different turnover values in each country. In case of Hungary it is 100 million HUF annual turnovers.

[9] In the original paper of Balassa, the i index indicated the combined export of 74 industrial products, while j index was for the sum of 11 developed industrial countries. In order to moderate the trade policy distortions, the B-index originally was limited only to the examination of industrial products. B-index starts from the fact that the export structure is sensitive both for the relative costs and the differences in non-price factors. Thus the comparative advantages are expected to determine the structure of export. (Fertő, 2003)

The B index starts from the fact that the export structure is equally sensitive to the relative costs and the differences in non-price factors. Therefore comparative advantages will probably determine the export structure. (Fertő, 2003) The reference point in the current examination was the value of trade with EU27 countries. In this regard, there are two ways to examine the comparative advantages. On the one hand, it can be examined, how the share of the given product or product group within the export relates to the export share within reference market (EU27). In other words, spatial comparison of relative value amounts can be carried out. On the other hand, on the basis of the second half of the formula, the export ratio of source countries (V4) can be examined within the total export (EU27). Comparative advantage can be detected if the export share of the product group is larger than the basis of comparison, or the share of the examined country is larger than its value within the total export.

The numerator and denominator of Balassa index is between 0 and 1. [10] Accordingly, the value of the index can be within [0;∞[interval..[11] If B>1, the given country has a comparative advantage in case of the examined product, if the value of the index is between 0 and 1, we speak about comparative disadvantage. The index is asymmetric in its structure because it is limited only from the bottom which results skew dispersion in the positive range. The problem is handled on the basis of revealed symmetric comparative advantage (RSCA) developed by Dalrum et al. (1988).

$$RSCA = \frac{(B+1)}{(B-1)} \qquad (6)$$

The Balassa index was criticised from many aspects, see for example Fertő 2003, Fertő et al. 2005, or Jámbor et al. 2012. The critical approach can be the consequence of the wide-range application of the index, even in international environment, where it served the comparison of very heterogeneous features and market regulators. In our opinion, in case of EU27 countries, (1) the geographical proximity, (2) similar macro-economic conditions, and (3) the nearly identical or simultaneously concluded trade policy agreements in more countries result that the predictability and applicability of the index can be regarded clearly sound. Owing to the limits of the present study and the high number of reference points, we updated the index and adjusted the *B* value with weighted average on the basis of the role of each product group in the export turnover at national level, and the sum of these was calculated, according to the following formula:

$$B_1 = \sum \frac{x_{ij}}{\sum_j X_{ij}} * B_i \qquad (7)$$

Where *x* is the export, *i* is the product group, *j* is the examined country. Subsequently x_{ij} is the product-level export of the given country, $\sum_i X_{ij}$ is the total export, and B_i is the Balassa index of *i* product group.

FINDINGS

Concerning foreign trade, it is obvious that the EU membership has resulted dynamic expansion in V4 countries. The foreign trade growth and - in some cases and regarding some product groups - the decline can be observed in the whole foreign trade turnover of agricultural products (within and beyond EU27) The question is, to what extent can it be due to the expansion potential on the market of the examined countries.

In order to answer the question, it is expressed in

Table 1. Export growth rate in country groups in case of total export (extra EU27) * (2001-2011)

In EU15 relation											
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Czech Rep.	41%	100%	18%	58%	43%	50%	50%	50%	25%	18%	34%
Hungary	58%	100%	100%	86%	47%	32%	52%	25%	17%	16%	44%
Poland	46%	74%	66%	76%	61%	58%	69%	50%	10%	59%	44%
Slovakia	36%	3%	0%	52%	36%	11%	29%	12%	-100%	-20%	21%
In V4 relation											
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Czech Rep.	49%	100%	5%	44%	42%	61%	45%	44%	67%	63%	55%
Hungary	-3%	100%	-26%	22%	17%	35%	14%	21%	16%	39%	38%
Poland	9%	32%	6%	14%	16%	21%	9%	19%	19%	10%	12%
Slovakia	60%	88%	48%	47%	56%	75%	76%	61%	100%	94%	75%

Source: own work on the basis of EUROSTAT 2012a

Note: * For reasons of simplicity and applicability, the extreme values were indicated as 100% and -100% in some cases.

[10] If $x_{ij} / \sum_j x_{ij} = 1$ we speak about monopoly, the product is supplied only by the examined country.

[11] The actual upper limit $\sum_i \sum_j x_{ij} / \sum_i X_{ij}$ holds to infinity if $\sum_i X_{ij}$ holds to zero, that is the economic weight of the country is not significant regarding the export. (Poór, 2010)

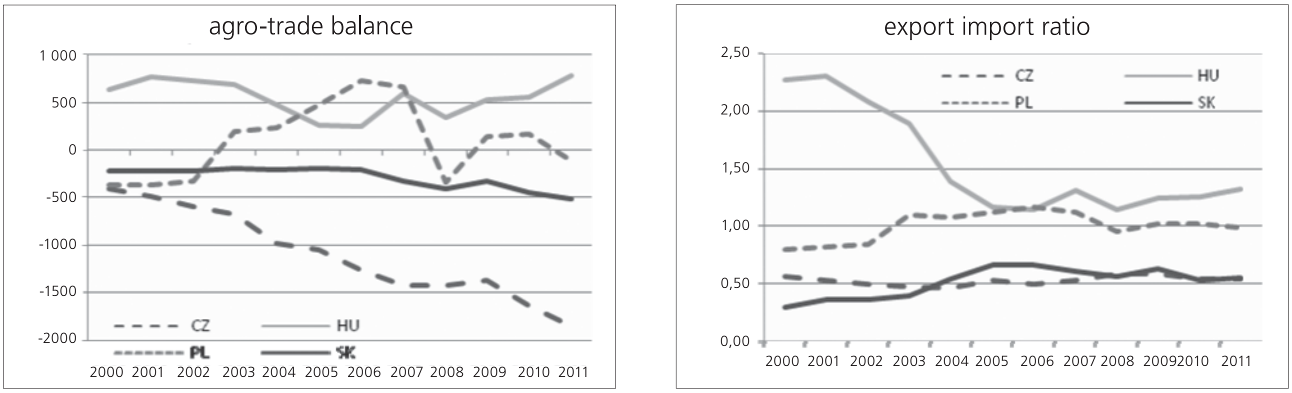


Figure 2. Agro-trade balance and export-import ratio of Visegrad countries with EU15 (2000-2011; at current prices, million euro)
Source: own work on the basis of EUROSTAT 2012a

percentage, how the change in case of each country group contributed to the changes observed in frames of the expansion of total trade turnover.

On the basis of the data of $MR_{E/I,}$ index (formula 1), it can be concluded that in case of total export, the expansion of turnover was decisive in regards to EU27. The strongest was Slovakia, because in their case, 93% of the export growth went to the markets of EU27. The value of the Czech Republic was lower (87%), the next in rank is Hungary (77%), then Poland (71%). The same value increased again by 3% in the average of the period following the accession, in case of all countries. Thus it can be declared that in case of the examined countries, the markets of the European Union enabled the expansion. In other approach, the common internal market had a considerable impact on trade improvement, which also resulted the concentration of common markets from the aspect of the V4. (Vásáry et al. 2012)

If the research is extended, it can be seen in regards to EU15 and V4 that the growth is very strong on the market of the old member states. (Table 1) In some cases the expansion of turnover exceeded 100% (2002, CZ, HU) which was due partly to the low pace changes of annual base value mentioned above, partly to the fact that the expansion of turnover on the markets of EU15 could, in total, adjust the decline appearing on other markets (e.g. extra EU27).

Considering the results, it is confirmed that the accession to the EU in 2004 resulted sound and strong growth in market expansion. The best values were observed in case of Slovakia. It leads to the conclusion that as the result of the permanent – and in some years even – expansion of the low base, the value of growth steadily increased and the market relations were less affected.

Reviewing the agro-trade balance (formula 2), the situation of Visegrad countries is much clearer (see Figure 1). In general, it can be declared that the balance of Hungary remained permanently in the positive range, in spite of the fact that a stronger decline could be observed after 2004. In case of Poland, the balance of the index improved after the accession, while in case of the other two countries, the integration has further worsened the negative value of the index. The export-import ratio has changed similarly.

The tendencies of export-import ratio[12] gave interesting

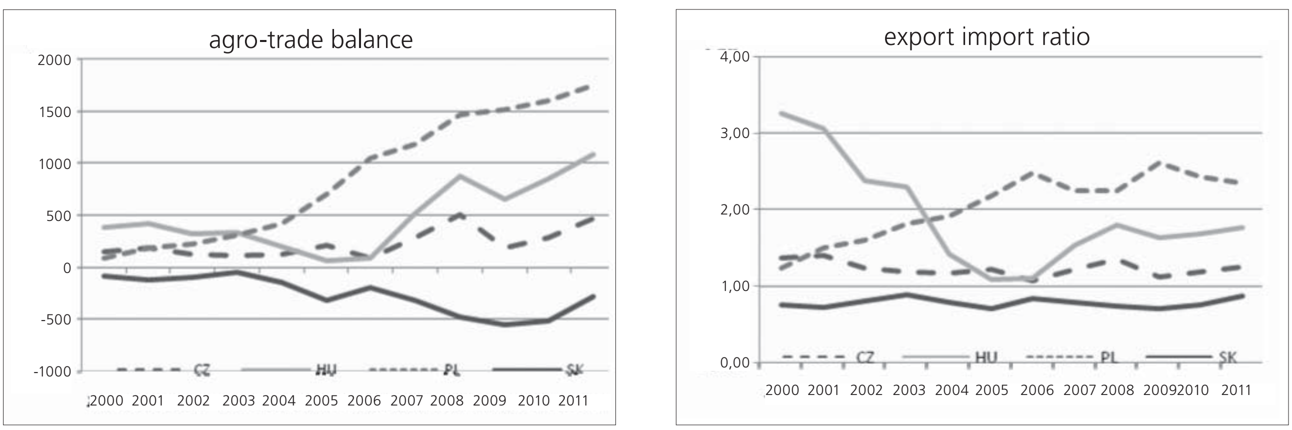


Figure 3. Agro-trade balance and export-import ratio of Visegrad countries with EU12 (2000-2011, at current prices, million euro)
Source: own work on the basis of EUROSTAT 2012a

[12] It should be noted for the application of the ratio that the decline of demand and import can also distort the value of the index.

Table 2. Herfindahl–Hirschman-index values in V4 countries in regards to export turnover with some countries and country groups (2000-2011)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Czech Republic											
HU	0,1072	0,0893	0,0850	0,0862	0,0817	0,0747	0,0840	0,0946	0,0928	0,0898	0,0885
PL	0,1336	0,1142	0,1469	0,1850	0,1223	0,0856	0,0738	0,0765	0,0847	0,0785	0,0741
SK	0,0780	0,0729	0,0820	0,0816	0,0672	0,0705	0,0710	0,0711	0,0682	0,0715	0,0664
EU27	0,0679	0,0675	0,0689	0,0673	0,0694	0,0652	0,0694	0,0694	0,0656	0,0658	0,0632
EU15	0,1062	0,1015	0,0902	0,0746	0,0911	0,0892	0,0902	0,0918	0,0874	0,0889	0,0795
EU12	0,0673	0,0642	0,0723	0,0759	0,0643	0,0621	0,0626	0,0639	0,0618	0,0620	0,0598
V4*	0,0678	0,0654	0,0738	0,0776	0,0635	0,0619	0,0620	0,0634	0,0617	0,0626	0,0604
Hungary											
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CZ	0,0809	0,0861	0,0908	0,1041	0,0869	0,0908	0,0893	0,0816	0,0897	0,0835	0,0828
PL	0,0878	0,1002	0,0860	0,1029	0,1051	0,1300	0,1156	0,1199	0,1522	0,1108	0,1032
SK	0,0794	0,1193	0,0770	0,0758	0,0758	0,0880	0,1164	0,0892	0,0974	0,0853	0,0990
EU27	0,0973	0,1035	0,0954	0,0913	0,0873	0,0884	0,0818	0,1167	0,0971	0,0905	0,0906
EU15	0,1347	0,1309	0,1141	0,1077	0,1010	0,1012	0,0968	0,1347	0,1084	0,1111	0,1088
EU12	0,0722	0,0847	0,0790	0,1000	0,0773	0,0809	0,0748	0,1045	0,0998	0,0790	0,0803
V4*	0,0731	0,0794	0,0760	0,0814	0,0820	0,0873	0,0831	0,0845	0,0930	0,0732	0,0799
Poland											
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CZ	0,1175	0,1130	0,1047	0,1032	0,0929	0,0953	0,0905	0,0868	0,0871	0,0932	0,0935
HU	0,1503	0,1386	0,1253	0,1281	0,1050	0,0969	0,0932	0,0911	0,1038	0,1245	0,0913
SK	0,1336	0,1334	0,1202	0,1150	0,0924	0,1036	0,1019	0,0864	0,0793	0,0893	0,0977
EU27	0,0770	0,0727	0,0757	0,0787	0,0708	0,0757	0,0776	0,0768	0,0760	0,0721	0,0732
EU15	0,0975	0,0871	0,0874	0,0896	0,0760	0,0798	0,0822	0,0809	0,0802	0,0726	0,0737
EU12	0,0926	0,0932	0,0931	0,0885	0,0817	0,0818	0,0793	0,0778	0,0755	0,0810	0,0832
V4*	0,1230	0,1167	0,1043	0,1023	0,0901	0,0875	0,0833	0,0800	0,0796	0,0876	0,0903
Slovakia											
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CZ	0,0747	0,0783	0,0791	0,0877	0,0851	0,0838	0,0770	0,0782	0,0745	0,0726	0,0684
HU	0,1342	0,1012	0,0887	0,1028	0,0952	0,0930	0,0853	0,0858	0,0886	0,0866	0,0964
PL	0,1907	0,2278	0,2008	0,1965	0,1518	0,1395	0,1809	0,1419	0,1124	0,1250	0,0993
EU27	0,0651	0,0683	0,0685	0,0701	0,0731	0,0756	0,0756	0,0780	0,0727	0,0711	0,0742
EU15	0,1141	0,1321	0,1091	0,0809	0,0892	0,0910	0,0928	0,1080	0,1122	0,1166	0,1011
EU12	0,0701	0,0728	0,0742	0,0782	0,0786	0,0751	0,0741	0,0746	0,0689	0,0651	0,0716
V4*	0,0696	0,0721	0,0739	0,0775	0,0806	0,0747	0,0740	0,0753	0,0686	0,0653	0,0717

Source: own work on the basis of EUROSTAT 2012a
Note *: Under V4, we mean the turnover within the country group, which is realized with the other three partners.

result in regards to trade processes. (Formula 3) On the basis of values in Figure 2 it can be observed that in Hungary the value of the ratio decreased – in other words the values of export and import come closer - in the examined relation, but the export dominance could be maintained. The accession had a strong influence and the value of the index increased, too, because the value of exported goods grew due to the emerging new markets.

The „opening of borders" in 2004 has resulted that the export activities of V4 towards EU12 increased significantly, thus improving both the balance and the ratio values. The situation of Poland is noticeable, because they jumped high at the start in 2004 and gradually improved their export position compared to V4 countries. Parallel with this, Hungary and the Czech Republic could also show considerable activity in the markets of each other, but Slovakia clearly got stuck in this process and could not really increase its foreign trade activities in relation to the 12 countries.

From the review of individual countries, it is obvious that the product structure concentration in case of export can also be due to the impacts of EU membership. In order to measure it, it is worth examining the ratio of products in foreign trade turnover. Herfindahl-Hirschman index

Table 3. Aggregated values of RSCA index examined in some relations of V4 countries, (2000-2011)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2000-2011	2004-2011
Czech Republic														
HU	0,243	0,220	0,172	0,114	0,092	0,116	0,119	0,149	0,167	0,149	0,142	0,147	-0,096	0,055
PL	0,215	0,188	0,210	0,248	0,186	0,128	0,100	0,079	0,112	0,096	0,087	0,086	-0,129	-0,099
SK	0,140	0,115	0,098	0,101	0,092	0,117	0,090	0,104	0,104	0,134	0,087	0,087	-0,053	-0,006
EU27	0,012	0,013	0,009	0,009	0,004	0,003	0,002	0,001	0,001	0,001	0,001	0,001	-0,011	-0,003
EU15	0,099	0,070	0,059	0,052	0,043	0,043	0,029	0,037	0,047	0,048	0,038	0,046	-0,053	0,003
EU12	0,065	0,069	0,056	0,046	0,042	0,064	0,036	0,041	0,050	0,059	0,037	0,039	-0,026	-0,003
V4*	0,065	0,072	0,057	0,057	0,044	0,067	0,037	0,044	0,053	0,064	0,043	0,045	-0,020	0,000
Hungary														
CZ	0,256	0,324	0,223	0,215	0,239	0,251	0,267	0,280	0,270	0,247	0,174	0,151	-0,105	-0,087
PL	0,166	0,218	0,179	0,200	0,201	0,251	0,173	0,102	0,119	0,134	0,118	0,100	-0,066	-0,101
SK	0,135	0,154	0,154	0,158	0,166	0,155	0,206	0,168	0,120	0,140	0,128	0,127	-0,008	-0,039
EU27	0,013	0,010	0,010	0,009	0,006	0,007	0,004	0,002	0,002	0,002	0,003	0,005	-0,008	-0,001
EU15	0,069	0,043	0,038	0,045	0,026	0,027	0,024	0,028	0,025	0,024	0,022	0,024	-0,046	-0,003
EU12	0,097	0,085	0,083	0,095	0,080	0,069	0,073	0,057	0,052	0,048	0,034	0,033	-0,064	-0,047
V4*	0,155	0,179	0,153	0,143	0,163	0,177	0,165	0,132	0,100	0,104	0,078	0,063	-0,092	-0,100
Poland														
CZ	0,194	0,178	0,165	0,152	0,099	0,078	0,071	0,051	0,066	0,078	0,065	0,082	-0,112	-0,017
HU	0,295	0,275	0,236	0,266	0,209	0,210	0,184	0,179	0,174	0,174	0,114	0,094	-0,200	-0,115
SK	0,247	0,261	0,208	0,207	0,111	0,094	0,100	0,076	0,076	0,090	0,076	0,082	-0,165	-0,029
EU27	0,028	0,025	0,016	0,020	0,005	0,005	0,008	0,004	0,002	0,004	0,003	0,004	-0,024	-0,001
EU15	0,088	0,078	0,058	0,053	0,023	0,022	0,024	0,016	0,010	0,008	0,009	0,010	-0,079	-0,013
EU12	0,153	0,144	0,120	0,105	0,082	0,070	0,051	0,043	0,038	0,056	0,052	0,058	-0,096	-0,025
V4*	0,204	0,193	0,164	0,165	0,110	0,095	0,072	0,061	0,066	0,073	0,061	0,066	-0,138	-0,044
Slovakia														
CZ	0,080	0,076	0,059	0,069	0,056	0,052	0,054	0,040	0,042	0,093	0,071	0,094	0,014	0,038
HU	0,204	0,171	0,105	0,139	0,051	0,067	0,074	0,041	0,076	0,052	0,042	0,045	-0,159	-0,006
PL	0,308	0,350	0,330	0,312	0,226	0,203	0,211	0,197	0,187	0,148	0,119	0,119	-0,189	-0,107
EU27	0,007	0,007	0,006	0,005	0,003	0,001	0,001	0,000	0,000	0,000	0,000	0,000	-0,007	-0,003
EU15	0,205	0,192	0,167	0,140	0,096	0,058	0,054	0,071	0,088	0,079	0,056	0,056	-0,149	-0,040
EU12	0,029	0,038	0,023	0,017	0,020	0,016	0,012	0,013	0,013	0,013	0,006	0,005	-0,023	-0,015
V4*	0,031	0,038	0,025	0,022	0,024	0,016	0,010	0,013	0,013	0,014	0,009	0,011	-0,020	-0,013

Source: own work on the basis of EUROSTAT 2012a

Note *: Under V4, we mean the turnover within the country group, which is realized with the other three partners.

is applied in the economic analysis for measuring the concentration of markets.

The values of countries (CZ, HU, SK, PL) and country groups (EU27, EU15, EU12 and V4) involved in the examination are listed in Table 2. It was a priority in the construction of the table that the degree of concentration is determined not only for country but for all the countries concerned. Thus the comparability of states could be based.

The values of the table clearly confirm that the export cannot be regarded as concentrated in any of the countries. It does not appear in the average of individual product categories that the examined markets have exclusive role. It meets the preliminary expectations because - especially in case of easily substitutable products - the strong competitive impacts are against market concentration thus strengthening the interests of consumers. The strongest values could be observed in the Czech-Polish, Slovak-Polish and Hungarian-Polish relations. In case of the former, it concerned the period before the accession – when trade treaties were used for protection and/or support – while in case of the latter it concerned the era after the accession. It can be concluded that the EU integration has significantly restructured the introduction of products on the market owing to the changes of trade barriers as well as the strengthening process of trade creation or, in some cases, trade diversion. The figures also indicate a concentration evolving on geographical basis. In case of 3 countries (CZ, HU, SK) out of the examined four, the values in relation to EU12 and V4 strongly converge with each other, which means that in their case, the geographical conditions and location considerably affect the export of agricultural products, that is the turnover beyond V4 has only a slight impact on the concentration of product groups.

Basically, trade within region is typical in these countries. Substantial differences between EU12 and V4 values can be seen only in case of Poland, probably due to the strong and traditionally determinant presence in relation to Baltic states. In addition to the analysis of concentration, important information can be collected from the values of general competitiveness of individual products and countries. There are quite a few indices and evaluations for the quantification of comparative advantages. In this regard, the index applied in analysis is related to Béla Balassa. A lot of versions of the index have been created during the last decades. In the current work, the original formula is used for examining the impacts on competitiveness in connection with the turnover of V4. Following the correction of asymmetric disproportion of Balassa index, the RSCA indicator gives comparable values. Aggregated values were needed for the country-level comparison. The values by the individual countries were received on the basis of RSCA values aggregated according to the weight of product groups within total trade turnover. The values of RSCA index corrected at country level are listed in Table 3 which clearly shows how competitiveness changed at country level.

In regards to the examination of countries, higher values can be observed in the period before EU accession due to the more efficient market protection measures. In addition to this, it is true for all the countries that the gradually introduced trade policy facilitations, preparation for EU membership and the consequent changes of trade relations resulted the reduction of the index value year by year until it was stabilized at a low level. In other words the competitiveness – or at least the market dominance – decreased in relation to markets.

It is clearly evident that nearly the same value changes can be observed in case of CZ and SK in the turnover of V4 countries among each other. In case of PL[13] and HU, the decline was more significant, but these two countries show similar tendencies. Towards EU15, due to the formerly stronger relations, the competitiveness declined less compared to CZ and SK. In case of EU12 the process is just the opposite: the Hungarian and Polish values are worse than those of the other two countries. It can be explained by the stronger relations maintained by HU and PL with EU15 countries, while CZ and SK products were more popular in EU12 relation.

The picture is more sophisticated in regards to pairs of countries. Concerning the whole period the greatest decline in competitiveness could be observed in the relation of PL and HU. The value of index dropped almost to its third. In addition to this, the strongest deterioration was seen in the Slovak-Polish, Polish-Slovak and Slovak-Hungarian relation. It is very interesting that the Slovak and Polish relation mutually declined. It can be presumed that the possibility and consequence of market opening, the often parallel processes of trade diversion and trade creation resulted an almost identical agricultural foreign trade structure in the two countries.

It is a fact that the tendencies of competitiveness restructured the most during the times before EU accession. Following the accession, no substantial restructuring could be detected in most of the countries. There are, of course, some exceptions, because the Czech-Hungarian relation turned and resulted the greatest change of value. In this regard, the Slovak-Hungarian and Polish-Slovak turnover should also be mentioned because significant restructuring (sometimes 80% (PL-SK) or 90% (SK-HU) compared to the value of the whole period) could be observed even after EU accession.

By comparing competitiveness on the basis of RSCA index, improvement or comparative expansion could be detected only in case of CZ-HU relation after the accession and in case of SK-CZ relation during the whole period. Essentially – as regards competitiveness – the membership was advantageous only in these relations.

CONCLUSIONS

Our examinations have demonstrated that the value and volume of agricultural foreign trade turnover of V4 countries has substantially expanded due to the changes which have occurred in the last 12 years. Within this, the expansion on the market of the EU27 is determinant and also enforced by the favourable tendencies that could be seen on EU15 and V4 markets. The analysis has also pointed out that the trade balance had positive tendency only in case of Hungary and Poland, while in the turnover within V4 only Slovakia could present negative, although improving, values. The mutual trading of goods within Visegrad countries had key role in the expansion of trade turnover. It can also be concluded that the market concentration in case of some products and some countries decreased owing to the impact of common internal market and the strengthening of internal market competition. As regards the examined relations, it was confirmed that this process was associated with the decline of comparative advantages and the strong convergence of values in case of some relations. It should be noted that the period of time preparing for common market operation prior to the accession considerably affected the values.

[13] In case of Poland it should be noted that its competitiveness is strongly affected by the internal consumption, stable macro-economic and budget situation, as well as German and Ukrainien relations which are determinant and permanently expanding in regards to trade. All these result that the pace of general convergence of Polish economy is outstanding in V4 comparison. (Kerner, 2012) Its round effect is very positive in trade processes, too, althought the pace of competitiveness became slower in the examined relation but it is counterbalanced by the expanding foreign trade volume, the stabilization of markets and the expansion on them.

In spite of the generally increasing trading activity, the comparative values improved only in case of Slovakia and the Czech Republic for the whole period, while the value of competitiveness decreased in the other relations. Thus the EU membership has created market and a number of possibilities, but – according to our examinations – these could not help to improve the values of competitiveness of countries.

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REFERENCES

1. Balassa B. 1965. Trade liberalisation and „revealed" comparative advantage. The Manchester School, Vol. 33. No. 2. 99–123.
2. Bartosova D. – Bartova L. – Fidrmuc J. 2008. EU Enlargement Implications on the New Member States Agri-food Trade. International Congress, August 26 – 29, 2008 Ghent, Belgium 44122, European Association of Agricultural Economists. http://ideas.repec.org/p/ags/ eaae08/ 44122.html
3. Bielik P. – Smutka L. – Horská H. 2012. Development of Mutual Agricultural Trade of Visegrad Group Countries, Visegrad Journal on Bioeconomy and Sustainable Development 2012/1 pp._2-11.
4. Bojnec Š – Fertő I. 2009. Agro-food trade competitiveness of Central European and Balkan countries. In: Food Policy, vol. 34, 2009, no. 5, p. 417 – 425. ISSN 0306-9192.
5. Dalum, B. – Laursen, K. – Villumsen, G. 1998. Structural Change in OECD Export Specialisation Patterns: De-Specialisation and 'Stickiness'. International Review of Applied Economics, Vol. 12. 423–443.
6. Drabik D. – Bartova L. 2008. Agri-food Trade Specialisation Pattern in the New EU Member States International Congress, August 26 – 29, 2008 Ghent, Belgium 44122, European Association of Agricultural Economists. http://ageconsearch.umn.edu/ bitstream/44124/2/261.pdf
7. EUROSTAT 2012a. International Trade, EU27 Trade Since 1988 by HS2 database, http://epp.eurostat.ec.europa.eu, 2012.08.16
8. EUROSTAT 2012b. Taxation trends in the European Union, Data for the EU Member States, Iceland and Norway, ISBN 978-92-79-21209-3 p. 274
9. Euvonal 2012. Az EU-ba történő áruszállításkor elég-e a szállítólevél vagy kell vámáru nyilatkozat is?http://www.euvonal.hu/index.php?op=kerdesvalasz_reszletes&kerdes_valasz _id=489, 2012.08.22
10. Fertő I. 2003. A komparatív előnyök mérése. Statisztikai Szemle, 81/ 4, p. 309–327
11. Fertő I. Hubbard L.I. 2005. Az agrárkereskedelem dinamikája – A csatlakozó országok esete Közgazdasági Szemle, LII. évf., 2005. január p. 24–38
12. Halmai P. (szerk.) 2007. Az Európai Uniós agrárrendszere, Mezőgazda Kiadó, Budapest p 402
13. Jámbor A. – Török Á 2012. Változások az új tagországok agrárkereskedelmében az EU-csatlakozás után, Statisztikai Szemle 2012 7-8 szám p. 632-651
14. Jámbor A. 2011. Az agrárkereskedelem változása Magyarország és az Európai Unió között a csatlakozás után Közgazdasági Szemle, LVIII. évf., 2011. szeptember (775–791)
15. Kerner Zs. 2012. Így hagynak le minket a lengyelek, Index, http://index.hu/ gazdasag/vilag/2012/08/23/igy_hagynak_le_minket_a_lengyelek/ 2012.08.23
16. Mészáros K. – Béres D.2011. A magyar marhahús versenyesélyei az EU-ban, Gazdálkodás 55. évf. 7. szám, pp.632-645
17. Mészáros K. 2012. A V4-es országok versenyesélyei a szarvasmarhahús külkereskedelmi forgalmazásában az EU27-ben In: LIV. Georgikon Napok, Pannon Egyetem Georgikon Mezőgazdaságtudományi Kar Keszthely, 2012.10.11-12. 2012. ISBN:978-963-9639-48-5
18. Miroslava Rajcaniova 2012. V4 food trade and market insights: from Economic Theory to Consumer's Reality In: Food Sciences & business Studies. Nitra: Slovak University of Agriculture, 2012. pp. 25-41 ISBN: 978-80-552-0815-2
19. NAV 2012. Tájékoztató az egyes gabonák, olajos magvak értékesítése esetén 2012. július elsejétől alkalmazandó fordított adózásról http://nav.gov.hu/magyar_oldalak/nav/ado/afa080101_hatalyos/ fordad_20120614.html 2012. 09.06
20. Poór J. 2010. Érték- és áralapú módszerek a külkereskedelmi versenyképesség mérésében a magyar hústermékek külkereskedelmének piacán Doktori (PhD) értekezés, Pannon Egyetem Keszthely
21. Qineti A. – Smutka L. 2012. The agrarian trade transformation in the Visegrad Countries. In Global commodity markets: new challenges and the role of policy : International Scientific Days 2012 05. 16-18, Nitra : Slovenská poľnohospodárska univerzita, 2012. s. 267--280.
22. Svatoš M. – Smutka L. 2010. Development of agricultural foreign trade in the countries of Central Europe. Agric. Econ. – Czech. 2010, 56, No. 5, pp. 163-175. ISSN: 0139-570X.
23. Takács-György K. – Takács I. 2012. Changes in cereal land use and production level in the European Union during the period 1999-2009, focusing on New Member States Studies In Agricultural Economics 114:(1) pp. 24-30.
24. United Nations 2006. Standard International Trade Classification Statistical Papers Series M No. 34/Rev. 4 ST/ESA/STAT/SER.M/34/REV.4
25. Vásáry M. – Kránitz L. – Baranyai Zs. 2012. Versenyképesség a Visegrádi országok agrárkereskedelmében In: LIV. Georgikon Napok, Pannon Egyetem Georgikon Mezőgazdaságtudományi Kar Keszthely, 2012.10.11-12. 2012. ISBN:978-963-9639-48-5pp. 1-10.