HUF 950/$ 4

HUNGARIAN AGRICULTURAL RESEARCH

March 2020

Environmental management, land use, biodiversity

FROM CONTENTS

HERMAN OTTÓ INSTITUTE NONPROFIT LTD.

MAGYAR NEMZETI
VIDÉKI HÁLÓZAT

A Magyar Nemzeti Vidéki Hálózat (MNVH) célja a vidékfejlesztésben érintett kormányzati, önkormányzati és társadalmi szervezetek, szakmai testületek, gazdálkodó tevékenységet végző szervezetek információs és együttműködési hálózatba szervezése, és tevékenységük összehangolása a vidék társadalmi-gazdasági fejlődése, a felzárkóztatás, valamint a támogatási források hatékony felhasználása érdekében, továbbá az MNVH szolgáltatásainak széles körben történő hozzáférhetővé tétele.

Az MNVH szolgáltatásainak igénybevétele regisztráció alapján lehetséges. Bármely személy vagy szervezet – ide értve az együttműködéseket, vidéki fejlesztéspolitikai szerveződéseket is – jogosult regisztrálni.

Az MNVH operatív szerve az Állandó Titkárság, amelynek feladatait a Herman Ottó Intézet Nonprofit Kft. látja el.
Keressen minket bizalommal!

www.mnvh.eu / mnvh@hoi.hu

The road goes on.

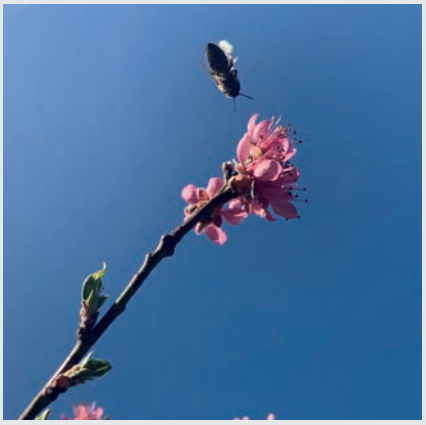
HERMAN OTTÓ INTÉZET NONPROFIT KFT.

SZÉCHENYI 2020

MAGYARORSZÁG KORMÁNYA

Európai Unió
Európai Mezőgazdasági Vidékfejlesztési Alap

A VIDÉKI TÉRSÉGEKBE BERUHÁZÓ EURÓPA



HUNGARIAN
AGRICULTURAL
RESEARCH

Environmental management, land use, biodiversity
March 2020 – Vol.29, No. 1.

Editor-in-chief:
András Béres (Herman Ottó Institute Nonprofit Ltd.)
Technical editor:
Nóra Koplányi (Herman Ottó Institute Nonprofit Ltd.)

Editorial Board
László Aleksza, Márta Birkás, Attila Borovics, Csaba Gyuricza, Zsolt Hetesi, László Jordán, Tamás Németh, Attila Rákóczi, Péter Sótonyi, András Székács, János Tardy, Béla Urbányi

Graphic designer
Ildikó Dávid
Cover photo:
Nóra Koplányi
Back cover:
Nóra Koplányi

Published by

H-1223 Budapest, Park u. 2. Hungary
www.agrarlapok.hu/hungarian-agricultural-research I info@agrarlapok.hu
Publisher: András Béres
Owner

MINISTRY OF AGRICULTURE

Editorial Office
Herman Ottó Institute Nonprofit Ltd.
H-1223 Budapest, Park u. 2. Hungary

Subscription request should be placed with the Publisher (see above)
Subscription is HUF 3900 (only in Hungary) or $16 early plus $5 (p & p) outside Hungary
HU ISSN 1216-4526

THE EFFECT OF SAMPLE SIZE ON WILDIFE DAMAGE ESTIMATIONS IN MAIZE (*ZEA MAYS*)

IMRE **KOVÁCS**[1]- GERGELY **SCHALLY**[1]- SÁNDOR **CSÁNYI**[1]- NORBERT **BLEIER**[1]

[1]Szent István University, Faculty of Agricultural and Environmental Sciences, Department of Wildlife Biology, H-2100 Gödöllő, Hungary, Páter K. str. 1.
Corresponding author: Imre Kovács, email: Imre.Kovacs@hallgato.szie.hu; tel.: +3628/522000 (1871)

ABSTRACT

Where the wildlife damage to agriculture is managed with the aid of a compensationsystem, the amount of payment is often determined by field damage evaluation, but there is little statistically sound information on the different sampling methods. In this study, we tested the Grid Arrangement Method (GAM) with four different sampling plot densities, in GIS environment. Besides the accuracy [Mean Squared Error (MSE) and Standard Error (SE)] and bias [and Percentage Relative Bias (PRB)], the effects of three factors (sampling plot density, spatial distribution of the damage, true damage rate) on the sampling results were examined. Simulations were conductedwith four different spatial damage patterns [random, aggregated in one and two field edges (DAinE-1, DAinE-2),aggregated in patches (DAinP)] and four levels of damage (10%, 30%, 50%, 70%) in a maize (*Zea mays*) field model with an area of 10 ha.
According to our results, the highest biases were obtained by the 40 rows × 40 m plot density samplings. In terms of spatial damage distribution, the highest biases of the individual samplings were found in the case of DAinP. Considering the calculated parameters, the poorest values originated from the 40 × 40 plot density. The highest MSE and bias occurred at the 50% - DAinP damage rate – spatial distribution combination, while the poorest SE and PRB were found in the case of the 30% - Random and the 10% - DAinE-1 combination, respectively. The SD of the bias showed differences among the groups in the case of each factor, while we found differences among the medians only when the bias was grouped by spatial distribution or true damage rate.
Based on our findings, and considering the labour requirements and expert fees of the samplings with different plot densities, moreover the average yield and market price of the maize, we concluded that, the 20 rows × 20 m sampling plot density could be optimal to choose among the examined ones.

Keywords: human-wildlife conflict, crop damage, damage estimation, sampling, maize,GIS simulation

INTODUCTION

Agricultural damage caused by wildlife results in significant economic losses in many countries (Conover 2002,Maillard et al. 2010,Putman 2010, Csányi 2019), andoften leadsto conflicts between farmers and game managers (Bleier 2014). In Hungary [among other countries, e.g. France (Maillard et al. 2010), Poland (Frackowiak et al. 2013) and Slovakia (Findo&Skuban 2010)], it is the responsibility of game managers to compensate (pay) the damage caused by game species (Bleier et al. 2012a,b). According to Act LV., 1996: Act on Game Conservation, Management and Hunting, the level of the damage is estimated by accredited experts, however there are no prescribed estimation methods that would be obligatory to use. Due to the lack of studies on the performance(accuracy and bias) of the different sampling principles, expertsare often unable to base their work on scientific results. Our goal is to help experts in making evidence-based decisionsby designing computer simulations in a geographic information system (GIS) for maize (*Zea mays*) damage.
Maize can be considered one ofthe most important cultivated plants regarding the occurrence ofcrop damage, by the foraging behaviour of wildlife (Hygnstromet al. 1991, Herrero et al. 2006, MacGowan et al. 2006; Bleier et al.2012a), and also with the remarkably large sown area (Bleier et al. 2012a), which was 955,881 ha (22% of the total arable land) in 2018, in Hungary (Hungarian Central Statistical Office 2020).
Previously, we demonstrated how GIS simulation is a suitable toolfor testing the sampling methods used to assess wildlife damage tocrops (Kovács et al. 2020). In the present study, we aimed to examine the performance of the Grid Arrangement Method (GAM) that was initially developed for researchpurposes (Bleier et al. 2017).Our

questions were the following: (1) How accurate and biased is the GAM sampling when different sampling plot densities are used? (2) How do the different factors (sampling plot density, spatial distribution of the damage, true damage rate) affect the estimation results?

MATERIAL AND METHODS

Maize field models

We created 16 maize field models (each with an areaof 10 ha and 2:1 side ratio) in Quantum GIS 2.18 Las Palmas (QGIS Development Team, Open Source Geospatial Foundation Project). Four spatial damage patterns [random, aggregated in one and two field edges (DAinE-1,DAinE-2) aggregated inpatches (DAinP); as shown in Figure 1] and four damage rates (10%, 30%,50%, 70%) were established.

In each maize model, we set 76.2 cm row width and 17.57 cm plant spacing, thus 748,524 points represented the plants. Wedeleted a randomly selected 10% of the points to simulate the incompletegermination (Ross et al. 2010), then used the remaining 673,672 points to calibrate the simulated wildlife damage in each field model.

The random damage pattern was created through random selection of points. The patches of aggregated damage were also allocated randomly (in terms of the number, shape, area and location of the patches). Inside the patches,all the plants were marked as damaged.

Earlier studies have reported that the forest cover has a significant impact on the intra-field spatial pattern of agricultural damage caused by wild ungulates (Linkie et al. 2007, Cai et al. 2008, Ucarli 2011,Hofman-Kamińska&Kowalczyk 2012, Bleier et al. 2017).The main conclusion is that the level of the damage decreases with increasing distance from the forest or forest edge (Wywialowski 1996, Naughton-Treves 1998, Thurfjell et al. 2009,Bleier et al. 2017, Bobek et al. 2017).

For damage aggregated along one or two field edges, three level buffer zones [with a width of 44.7 m (20% of the field width) in the case of each level] were used on one single or two adjacent sides of the field. To simulate the effect ofa neighbouring forest, 80% of the total damage was generated by random selection closest to the field edge. Where the first level of the buffer zone (closest to the field edge) contained more points than the 80% of the damage, the remaining 20% was distributed on the rest of the field. Where the 80% of the damaged points exceeded the total number of points in the first

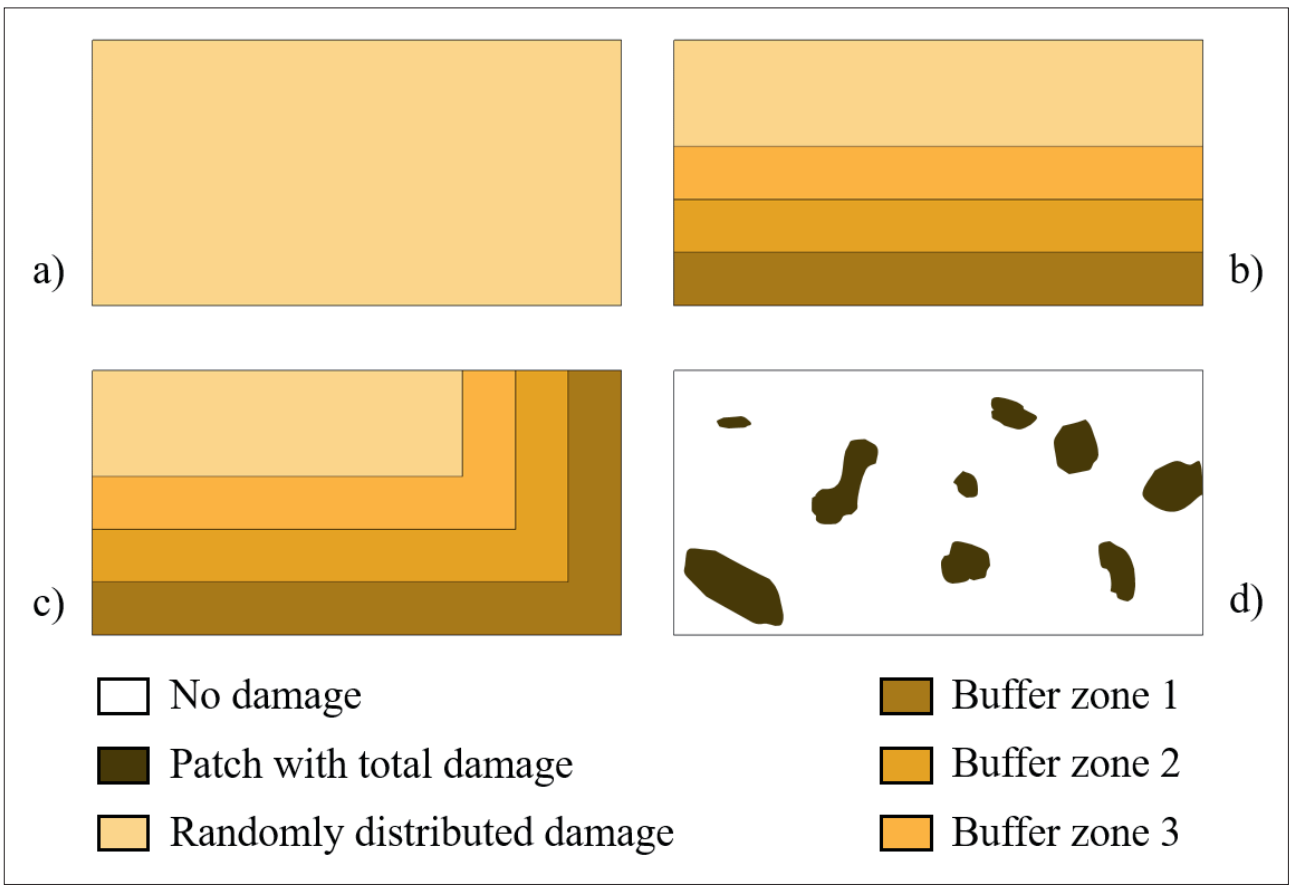


Figure 1. Simulated patterns of damage distribution: random (a), aggregated along one and two field edges - DAinE-1 (b) and DAinE-2 (c), aggregated in patches - DAinP (d)

Table 1. Parameters of the GAM samplings in our present study				
Sampling plot density	**5 × 5**	**10 × 10**	**20 × 20**	**40 × 40**
Observed rows	each 5th	each 10th	each 20th	each 40th
Sampling plot distance (m)	5	10	20	40
Number of sampling plots	5,310	1,350	345	96
Distance covered by observer (km)	26.6	13.6	6.9	3.8

buffer zone, we set 100% damage in the first zone, then distributed the rest of the buffer damage in the second zone (in case of 100% damage in the second zone we used the third zone, as well).

Sampling

In the sampling setup of the Grid Arrangement Method (GAM), we simulated that the observer walked along certain maize rows, and allocated one sample plot at equal distances (Table 1).

The plots were 1 m long segments of a maize row, where the total number of the plants and the damaged plants were recorded. The damage rate was calculated as $(\sum DP/\sum TP)\times 100$, where *DP* was the number of damaged plants recorded and *TP* was the total number of individual maize plants observed.

In order to simulate the differences in the samplings conducted by different observers, we executed five repetitions of the samplings. To repeat the sampling, we relocated the plots (moved each of them with the same distance and direction, thus we were able to keep the original spatial pattern of the sampling).

Statistical analysis

We evaluated the accuracy of the estimations by the Mean Squared Error (MSE): $E\left[(\hat{k}-k)^2\right]$, where $\hat{k}$ was the estimated damage rate, k was the true damage rate and $E[X]$ was the expected value of the variable. We described the sampling distribution of the estimations by the Standard Error (SE): $\sqrt{var(\hat{k})}$, where $\hat{k}$ was the estimated damage rate. In the case of MSE and SE, the lowest values indicated the best estimation results. We also calculated the bias, that showed the difference between the expected and the true value of damage rate: $E(\hat{k}-k)$,where $\hat{k}$ was the estimated and k was the true damage rate. To quantify the difference between the estimated and the true damage rate compared to the latter, we calculated the Percentage Relative Bias (PRB) as $(\hat{k}\text{-}k/k)\times 100$, where $\hat{k}$ was the estimated and k was the true damage rate. Before calculating means, the normality of the data in each repetition group was tested with Kolmogorov-Smirnov test.

The bias of the individual estimations can be converted directly to crop market price, hence we examined this parameter in further statistical analyses. The bias values grouped by the three factors (sampling plot density, spatial distribution of the damage, true damage rate) have not met the requirements of parametric tests, therefore we compared the medians with Kruskal-Wallis test and the standard deviation (SD) with Bartlett's-test. The statistical analyses wereperformed inInStat v3.05 (GraphPad Software Inc.).

RESULTS

Sampling results from the individual estimations are represented in Figure 2. Overall, in most cases (64.1% of the 64 repetition groups), we observed under- and also overestimations within the five repetitions of one sampling. The sampling resulted in consistent underestimations (when each five repetitions resulted in lower estimated value than the true damage rate) in 14 cases (21.9%), while consistent overestimations occurred in 9 cases (14%).

The largest differences between the true and estimated damage rates were obtained by the 40×40 plot density samplings. In terms of spatial damage distribution, the highest biases of the individual samplings – within the plot densities – were found where the damaged plants were aggregated in patches.

Considering the calculated parameters, the poorest values originated from the 40×40 plot density. The highest MSE and bias occurred at the 50% - DAinP damage rate – spatial distribution combination, while the poorest SE and PRB were found in the case of the 30% - Random and the 10% - DAinE-1 combination, respectively.

Regarding the spatial distribution of the damage, the medians of the bias showed difference (KW=68.517; P<0.0001). Moreover, we found remarkable differences among the SD of the groups (Bartlett stat. = 81.985; P<0.0001). According to the Dunn's post hoc test, the SD of the DAinP distribution differed from every other spatial distribution.

When grouped the bias by the true damage rate, we found differences among the medians (KW=23.894; P < 0.0001), and also among the SDs of the bias (Bartlett stat. =44.805; P<0.0001).

In the case of sampling plot densities, the medians of the bias showed no difference (KW = 5.361; P = 0.1472). However, we found remarkable differences among the SD of the groups (Bartlett stat. =1023.5; P<0.0001). With decreasing the plot density, the SD of the bias increased (Figure 3).

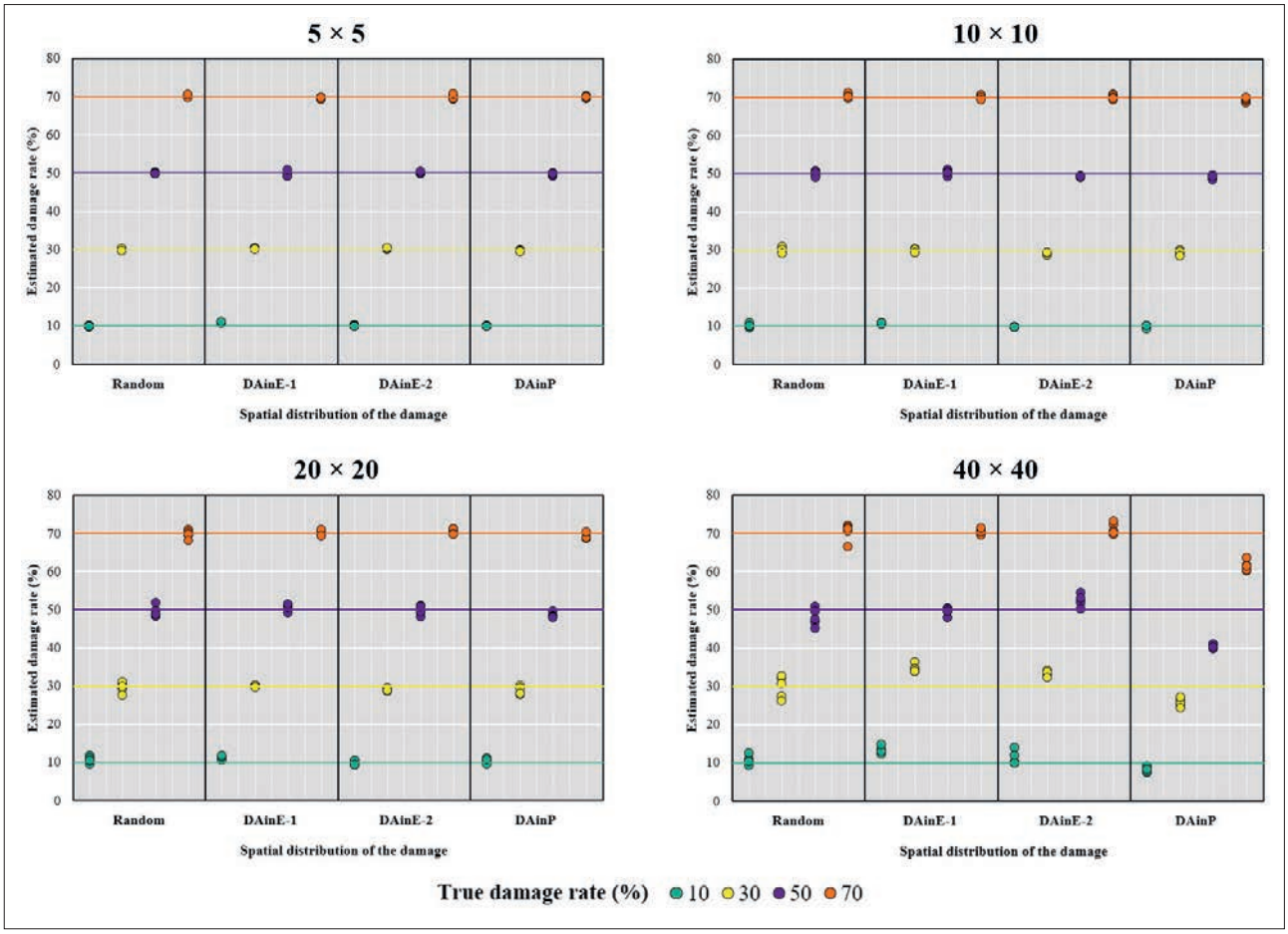


Figure 2. Damage estimations obtained by the examined sampling plot densities

Table 1. Calculated parameters (MSE, SE, bias, PRB) of the examined sapmlings (the bar lengths serve for comparison within the parameters)

Damage distribution		Random				DAinE-1				DAinE-2				DAinP			
True damage rate (%)		10	30	50	70	10	30	50	70	10	30	50	70	10	30	50	70
MSE	5 × 5	0.0	0.1	0.0	0.1	0.8	0.1	0.5	0.2	0.0	0.1	0.1	0.3	0.0	0.1	0.2	0.1
	10 × 10	0.2	0.4	0.4	0.3	0.7	0.2	0.3	0.2	0.1	1.0	0.7	0.3	0.1	0.8	1.3	0.7
	20 × 20	0.9	1.6	2.0	0.9	1.5	0.0	1.2	0.3	0.3	1.0	1.2	0.6	0.4	2.6	2.7	1.2
	40 × 40	1.9	6.7	8.4	4.2	11.5	22.7	0.9	0.6	3.9	10.1	7.6	3.0	3.3	19.4	87.9	74.8
SE	5 × 5	0.2	0.2	0.2	0.3	0.1	0.1	0.7	0.2	0.1	0.2	0.3	0.5	0.1	0.1	0.3	0.3
	10 × 10	0.5	0.7	0.7	0.5	0.2	0.4	0.6	0.5	0.1	0.2	0.2	0.6	0.3	0.6	0.5	0.5
	20 × 20	0.8	1.4	1.4	1.0	0.4	0.2	0.9	0.6	0.6	0.4	1.2	0.6	0.6	1.0	0.7	0.7
	40 × 40	1.2	2.9	2.3	2.3	0.9	0.9	0.9	0.6	1.7	0.8	1.6	1.5	0.7	1.1	0.5	1.4
bias	5 × 5	0.1	-0.1	-0.1	0.1	0.9	0.3	-0.3	-0.4	0.2	0.2	0.0	-0.1	0.0	-0.3	-0.4	-0.1
	10 × 10	0.2	-0.2	0.0	0.3	0.8	-0.2	0.2	0.1	-0.3	-1.0	-0.8	0.1	-0.1	-0.7	-1.1	-0.7
	20 × 20	0.6	-0.3	-0.6	-0.3	1.2	0.0	0.7	0.1	-0.2	-0.9	-0.2	0.5	0.4	-1.3	-1.5	-0.9
	40 × 40	0.9	-0.1	-2.1	0.3	3.3	4.7	-0.4	0.5	1.2	3.1	2.4	1.1	-1.7	-4.3	-9.4	-8.6
PRB	5 × 5	0.6	-0.4	-0.2	0.1	8.6	0.9	-0.7	-0.6	1.5	0.7	0.0	-0.2	-0.2	-1.0	-0.7	-0.2
	10 × 10	1.7	-0.6	-0.1	0.4	7.9	-0.5	0.4	0.1	-2.8	-3.2	-1.6	0.1	-0.6	-2.3	-2.1	-1.0
	20 × 20	6.1	-1.1	-1.1	-0.5	11.6	-0.2	1.4	0.1	-1.8	-3.1	-0.5	0.8	3.9	-4.5	-3.1	-1.3
	40 × 40	8.6	-0.4	-4.2	0.5	32.8	15.6	-0.8	0.7	12.1	10.3	4.7	1.6	-17.2	-14.3	-18.7	-12.2

Only positive values are possible Positive difference Negative difference

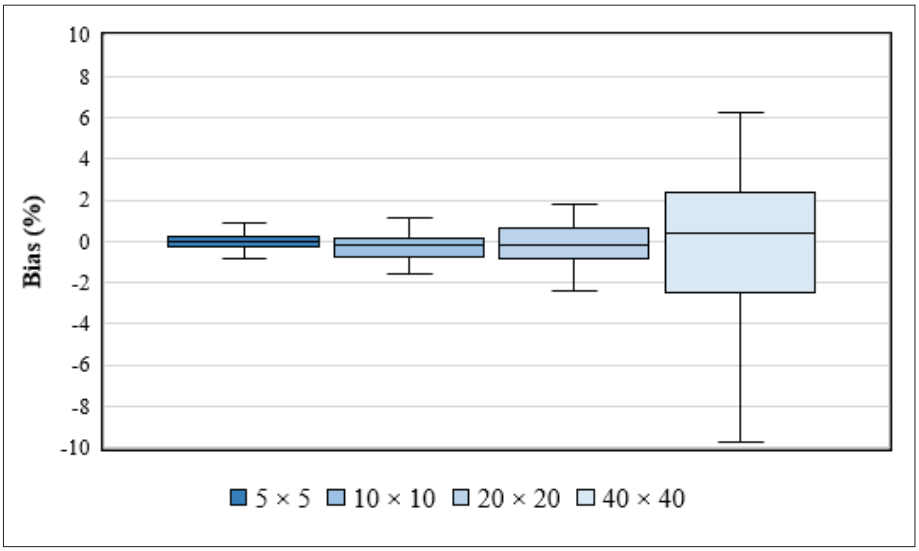


Figure 3. The distribution of the bias, grouped by the sampling plot density

DISCUSSION

In our previous work (Kovács et al. 2020), the 5×5 GAM sampling provided the best quality results, compared to another game damage estimation method that utilised quadrats with an area of 10 m^2,allocated according to three different patterns. On the other hand – considering the practical approach –, we questioned the necessity of such expected accuracy and low bias, because of the high labour requirements that result in a time-consuming and hence expensive sampling.

Calculating with a convenient walking speed (1.4 m/s; Browning et al. 2006) and 20–30 s spent at a sampling plot as an approximation [being aware that both values can be affected by certain conditions, see Kovács et al. (2020)], sampling the maize field simulated in the present study would take the following time with the different sampling plot densities: 39.8–54.6 h (5×5),12.8–16.5 h (10×10), 4.6–5.6 h (20×20), 2.0–2.3 h (40×40). If the expert aims to complete the estimation in one day, the two higher plot densities appear to be impractical, therefore only the 20 × 20 and 40 × 40 samplings can be performed.

Regarding the fee paid to experts,a minimum value of 4,000 HUF/h (approx. 12 €/h) is determined by law [Order 3/1986 (II. 21.) of the Ministry of Justice] for lawsuit cases, but experts are entitled to request a higher fee. This means that the minimal cost of the 20×20 and 40×40 samplings would be approx. 55.2-67.2 € and 24-27.6 €, respectively (the cost of the yield estimation and the data processing is not included).According to the Hungarian Central Statistical Office (2020), the average maize yield was 8.05 t/ha, while the average selling price was 44,725 HUF/t(approx. 133 €/t) in 2019. Based on these data, and taking our simulated maize field as an example, 1% difference in the estimated wildlife damage can cause approx. 107 € difference in the estimated value of the yield loss caused by game animals.

CONCLUSIONS

To draw the main conclusion of the current GIS simulations, we suggest to pay special attention to the DAinE-1 and DAinE-2 spatial distributions, as those are probably the closest to a real game damage scenario (Wywialowski 1996, Linkie et al. 2007, Naughton-Treves 1998, Cai et al. 2008, Thurfjell et al. 2009, Ucarli 2011, Hofman-Kamińska&Kowalczyk 2012, Bleier et al. 2017,Bobek et al. 2017). Beside the results regarding those spatial distributions and the fees of the different samplings, we can conclude that the improvement towards a less biased sampling could be higher than the increase in the fee of the expert, if we choose the 20×20 plot density over the 40×40. This suggests that, according to the present results, the 20×20 sampling plot density could be the most beneficial to choose among the examined ones.

ACKNOWLEDGEMENTS

This work and the authors were supported by the Ministry of Human Capacities through the National Talent Programme (Human Capacities Grant Management Office -NTP-NFTÖ-16-0523) and by the EFOP-3.6.3-VEKOP-16-2017-00008 project (co-financed by the European Union and the European Social Fund).

REFERENCES

1. Conover, M.R. 2002. Resolving human-wildlife conflicts: The science of wildlife damage management. Lewis Publishers, Boca Raton, USA.
2. Maillard, D. - J.M. Gaillard- M.Hewison - P.Ballon - P. Duncan - A.Loison - C.Toigo - E.Baubet - C.Bonenfant - M.Garel - C.S.Andrieux 2010. Ungulates and their management in France. In: Apollonio, M. - R. Andersen - R. Putman (Eds.), European Ungulates and their Management in the 21st Century. Cambridge University Press, Cambridge, UK, pp. 441–474.
3. Putman, R. 2010. Ungulates and their management in Great Britain and Ireland. In: Apollonio, M. - R. Andersen - R. Putman (Eds.), European Ungulates and their Management in the 21st Century. Cambridge University Press, Cambridge, UK, pp. 129–164.

4. Csányi, S. (ed.) 2019. Vadgazdálkodási Adattár - 2018/2019. vadászati év. Országos Vadgazdálkodási Adattár, Gödöllő, 66 pp. [in Hungarian]
5. Frackowiak, W. -GorczycaS. - D.Merta - M.Wojciuch-Ploskonka 2013. Factors affecting the level of damage by wild boar in farmlands in north-eastern Poland. Pest Management Science 69: 362–366.
6. Findo, S. - M.Skuban 2010. Ungulates and their management in Slovakia. In: Apollonio, M. - R. Andersen - R. Putman (Eds.), European Ungulates and their Management in the 21st Century. Cambridge University Press, Cambridge, UK, pp. 262-290.
7. Bleier, N. - R.Lehoczki - D.Újváry - L.Szemethy - S. Csányi 2012a. Relationships between wild ungulate density and crop damage in Hungary. Acta Theriologica 57: 351–359.
8. Bleier, N. - L.Szemethy - J.Galló - R. Lehoczki - S. Csányi 2012b. An overview of damages caused by big game to agriculture. Hungarian Agricultural Research 21: 9–13.
9. Hygnstrom, S.E. - J.R.Hygnstrom - K.R.VerCauteren - N.S. Foster - S.B.Lembezeder - D.J.Hafer 1991. Effects of chronological deer damage on corn yields. Eastern Wildlife Damage Control Conferences 5: 65.
10. Herrero, J. - A.García-Serrano - S. Couto - V.M.Ortuno - R.García-González 2006. Diet of wild boar Sus scrofa L. and crop damage in an intensive agroecosystem. European Journal of Wildlife Research 52: 245–250.
11. MacGowan, B.J. - L.A.Humberg - J.C. Beasley - T.L.DeVault - M.I.Retamosa - O.E. Rhodes Jr. 2006. Corn and soybean crop depredation by wildlife. Purdue University, Department of Forestry and Natural Resources Publication FNR-265-W
12. Hungarian Central Statistical Office 2020. Agricultural census. Available at: http://www.ksh.hu/agricultural_census_long_time_series_tables Accessed 08 March 2020
13. Kovács, I. - B.Tóth - G. Schally - S. Csányi - N. Bleier(2020): The assessment of wildlife damage estimation methods in maize with simulation in GIS environment. Crop Protection 127
14. Bleier, N. - I. Kovács - G. Schally - L.Szemethy - S. Csányi 2017. Spatial and temporal characteristics of the damage caused by wild ungulates in maize (Zea mays L.) crops. International Journal of Pest Management 63: 92-100.
15. Ross, J. - G. Huitink - P. Tacker 2010. Cultural practices. In: Espinoza, L. - J. Ross (Eds.), Corn production handbook. University of Arkansas, USDA and County Governments Cooperating, Little Rocks, Arkansas, USA, pp. 7-11.
16. Linkie, M. - Y.Dinata - A.Nofrianto - N. Leader-Williams 2007. Patterns and perceptions of wildlife crop raiding in and around Kerinci Seblat national park, Sumatra. Animal Conservation 10: 127–135.
17. Cai, J. - Z. Jiang - Y. Zeng - C. Li - B.D. Bravery 2008. Factors affecting crop damage by wild boar and methods of mitigation in a giant panda reserve. European Journalof Wildlife Research 54:723–728.
18. Ucarli, Y. 2011. Effects of wild boar (Sus scrofa) on farming activities: A case study of Turkey. African Journal of Biotechnology 10: 8823–8828.
19. Hofman-Kami ska, E. - R. Kowalczyk 2012. Farm crops depredation by European bison (Bison bonasus) in the vicinity of forest habitats in northeastern Poland. Environmental Management 50: 530–541.
20. Wywialowski, A.P. 1996. Wildlife damage to field corn in 1993. Wildlife Society Bulletin 24: 264–271.
21. Naughton-Treves, L. 1998. Predicting patterns of crop damage by wildlife around Kibale National Park, Uganda. Conservation Biology 12: 156–168.
22. Thurfjell, H. - J.P. Ball - P.A.Ahlén - P.Kornacher - H.Dettki - K.Sjöberg 2009. Habitat use and spatial patterns of wild boar Sus scrofa (L.): agricultural fields and edges. European Journal of Wildlife Research 55: 517–523.
23. Bobek, B. - J.Furtek - J.Bobek - D.Merta - M.Wojciuch-Ploskonka 2017. Spatio-temporal characteristics of crop damage caused by wild boar in north-eastern Poland. Crop Protection 93: 106-112.
24. Browning, R.C. - E.A. Baker - J.A. Herron - R.Kram 2006. Effects of obesity and sex on the energetic cost and preferred speed of walking. Journal of Applied Physiology 100: 390–398.

DEVELOPMENT OF ENVIRONMENTAL OLFACTOMETRY I.

ANDRÁS **BÉRES**[1]–NÓRA **KOPLÁNYI**[1] – ORSOLYA **JÓZSA**[1]- ZSOLT **VARGA**[2]

[1]Herman Ottó Institute Nonprofit Ltd., 1123 Budapest, Hungary
[2]Szent István University, 2100 Gödöllő, Hungary
Corresponding author: András Béres, E-mail: beres.andras@hoi.hu

ABSTRACT

Some of the production and technological activities involved in the emission of air pollutants can pollute the environment with odors. The resulting environmental pressure, the irritating odor effect caused by the odor emission around the source is one of the most difficult to measure, assess and control in terms of air pollution. Research into the causes of environmental disagreeable odor, its effects on humans, and its potential for odor measurement has a history of centuries. In our two articles on environmental olfactometry, we present the most important knowledge and practical applications that are currently available. In this article we discuss the most important aspects of human smell, the effects of disagreeable environmental odors and with its judgement, presented by the standardized method of olfactometry.

Keywords: odor measurement, odor sampling, odor annoyance

INTRODUCTION

From the surrounding environment information and stimuli reach us through our senses. In the classical sense, humans have five organs and senses: sight – eyes, hearing – ears, taste – tongue, touch – skin and smell – nose. According to the available study results, the rate of obtaining information through our senses is significantly different. Most imformation about our environment is acquired through vision (83%), followed by hearing (11%), smell (3.5%), touch (1.5%) and taste (1%) (Sekuler and Blake, 2000). For a long time, science has not dealt deeply with smell, despite our vital sensation. The nose, the sense of smell, filters, warms and humidifies the air. It works in parallel as an air conditioner to ensure that the right quality of air enters to the lungs. The detection of odorants in the inhaled air begins at the back of the nose, where most of the inhaled air flows at lower speeds, but the process of smelling is also closely related to breathing, which is one of our most important life functions. However, olfactory researches have great importance today, as evidenced by the 2004 Nobel Prize awarded to Richard Axel and Linda B. Buck for their pioneering achievements in the construction and function of the olfactory system (Buck and Axel, 1991, Honti and Vécsei, 2005).

The sense of smell, which has lost its importance in the human development, is one of our oldest senses (AGU, 2007), during the evolution our responsible senses evolved before the appearance of sight and hearing (Lou, 2011). This basically shows that the nervous paths from this organ run into the ancient parts of the brain where the stimuli are processed and evaluated (Vroon et al., 2005). Recent researches have shown that ancient mammal's brain structure development began after an increase in the brain's olfactory area (Rowe et al., 2011). It is also important to note that the sense of smell and the importance of the sense of smell is that our sensory senses, the nose, are constantly "active" and cannot be "turned off" like closing our eyes (AGU, 2007).

Scents surround us everywhere, whether in our homes or in our gardens, whether in a residental area, in an urban setting or whether on a trip to the countryside or in an intensively cultivated environment outside the settlements. The odors we perceive provide us with important information, fundamentally affecting our sense of hunger, our eating habits, our choice of partner and sometimes we may also be aware of dangers (Béres et al., 2014). The brain center of smelling is conntected to the amygdala (the amygdala: an almond-shaped neuron formation in the deep temporal lobe that is part of the limbic system that coordinates behavior, long-term memory and emotions) where emotions are born and embodied. Therefore emotions and smells interact with each other (Winston et al., 2005, Klinke and Silbernagel, 2003, Zimmer, 1987), therefore an unexpected quantity or quality of odor effect from our surroundings can trigger intense emotional reactions and memories. Nowadays, in many cases, these odors in our environment that we are regarding as irritat-

ing, receiving as unknown and interfering with our daily routine and our peace of mind. This is due to the fact that the evolution of human civilization has fundamentally changed our relationship to smells, which a man who lived in the last century, considered the smell of his surroundings as natural, but today it is already a disturbing and disgusting smell. Of course this change is also closely related to the increase in our sensivity to the environmental pressures we face. But the problem of environmental odors plays an important role in the development of small towns and villages in Hungary, for example in the last decades the "urbanization" process, the socio-economic changes and the significant changes in the composition of the population (Béres, 2014). This can also cause the formerly natural odors to be considered stinking and disturbing as a result of moving away from nature and their natural way of life (Nicell, 2009, Alapvető Jogok Biztosának Hivatala, 2012).

Facilities emitting various air pollutants and odors (including farms in particular) have effects on the environmental air – given the high incidence of household complaints - and especially their environmental odor is of great importance.

ASSESSMENT OF ODORS, DISTURBING EFFECTS

During inhalation of certain gases and vapours we sense the characteristic odor of the substance. For a substence to cause odor (sensing its presence withsensory organs), it must have a minimum concentration, be soluble in water or fat, and belong to an „odorexporter" chemical group (Steinheider, 1997, Plattig, 1994). Odor is a material property that we perceive through our olfactory organs, and perception is a complex physiological process in which the stimuli in the olfactory organs are transmitted to the brain by the nerves. The sense of smell and the reactions that occur are associated with emotions and memories and can often be explained by them. Smells and fragrances often resemble a place where the smell was felt or an activity when that smell was in the air. Later these pleasant or unpleasant memories will often determine how we respond to each odor that appears. Typically a person can distinguish between 10,000 odors, but this skill can be increased by practice (Boeckh, 1972, Béres et al., 2014). However, if a strong, long-lasting odor is detected, adaptation may occur, which results in a decrease in the extent of the sense of smell (Burdach, 1987, Béres, 1997, Béres et al., 2014).

The fact that different people perceive and react to the same odor at the same substance at different concentrations reflects the fact that this organ is very different for each person.
The resulting sense of smell is fundamentally influenced by the olfactory ability, age, sex, health, and neurological status of the person concerned (Kastka, 1986, Shusterman, 1992), but the environmental parameters are also determinant (temperature, air humidity) (Burdach, 1987).

In practice, the odors that affect us are typically not triggered by a substance, but are usually a mixture of a huge amount of odorous substances. Not only the intensity of the odor but primarily also the quality of the odor depends on the composition of the mixture (Béres, 1997). From the point of view of immission, the smells that exert their effects at „bad times" prove to be bothersome and distressing: for example, when a family sits in the garden after a lunch (Oldenburg, 1990). However, the person doing his/her job does not react so strongly to unpleasant odors (Hangartner, 1983). The aforementioned individual characteristics (age, sex, sense of smell and neurological status) have a significant influence on the reaction to smell: while one person doesn't feel anything, the other person feels "poisoned". In the latter case, symptoms of stress may occur, which reflect that the person concerned is no longer tolerated by the particular ‚odor pollution' or unable to process its effects (Hangartner and Kastka, 1986).

Disturbing, sometimes odorous gases of the environment include for example aldehydes, mercaptans, ketones, amines, small-molecule fatty acids, esters, organic acids, simple and aromatic sulfur compounds (Lais, 1996, AUG, 2007). There is a large number of odors in enviromental air that are typically released only in small quantities but even at very low concentrations these can cause a significant odor effect in the environment around the source of the odors. During the tests on odors – as a result of sensory tests performed in paralell with instrumental concentration measurements (by classical analytical methods, chromatographic measurements) - for a large number of odors, their odor threshold, which is the concentration of odor that a person with an „average nose" can already detect, has been defined (Béres, 1997). During the tests it was also found that the amount of odor produced by the mixture of odorants cannot be characterized by the concentration of the individual constituents. In determining the odor-inducing ingredients, more than 400 types of odorous compounds were isolated in animal husbandry only (Lais, 1996). The complex mixture of these as odorants generally results in odor from various sources, but it is not known how the components of the mixture interact (for example how they interact with each other synergistically). The odor threshold concentration of some odors may be very low (for mercaptans this value is 0,002-0,005 ppm) (Béres, 2000). Table 1 shows some odorants, the type of their odor and the odor threshold that they cause (Béres, 2000).

Table 1. Type of odors and their odor thresholds

Compound	Odor treshold (ppm)	Type of odorant
Allyl-mercaptan	0,005	Garlic-like
Ammonia	20	Spiky
Krotyl-mercaptan	0,002	Ferret odor
Hydrogen-sulfide	0,1	Addled egg
Methyl-sulfide	0,002	Rotten vegetables
Pyridine	5	Irritate
Skatole	3	Faeces
Thiophenol	0,005	Nausea

Already in the mid-18th century, the disturbing, fear-provoking effects of the surrounding odors were studied with scientific sophistication, the effects and the factors affecting them were also recorded (Corbin, 1984). Based on the results of investigations and observations on odors and disturbing environmental odors, some of the effects on the inhabitants living in the vicinity of the source have been described and the reactions triggered, the most typical of which are the following (Béres, 1997, Schiffman, 1998, AUG, 2007):

- eye, nose and throat irritation;
- change in respiratory rate, rapid breathing, sickness, nausea, vomiting;
- decreased food and fluid intake;
- headache, restlessness, sleeping disorder;
- allergic reactions;
- neurological, physical reactions;
- deterioration in the quality of life, evolvement of feeling fear;
- conflict with the owner or operator of the odor emitting source;
- other disturbances in normal life (absence of guests, disruption of leisure time at home).

These reactions - similarly to the sense of smell itself - are highly dependent on the individual characteristics and subjective sensitivities of the person described above. Summarizing the effects and reactions presented, it can be generally concluded that odoriferous substances do not generally cause any direct illness or damage to health, but that they may adversely affect a person's well-being through the reactions they cause (Matzke, 1986). Parallel to the study of the effects of odors, there was also a need to determine and measure the intensity and type of odors.

OLFACTOMETRY - PROBLEMS AND APPLICATIONS OF THE CLASSICAL ANALYTICAL METHOD

As described earlier in the studies on odors - with instrumental concentration measurements (by classical analytical methods, chromatographic measurements) as a result of parallel organoleptic examinations - for a large number of odors their odor thresholds have been defined. Classical organic analytical odor analysis uses sorption sampling, separation of the components by gas chromatography, and qualitative and quantitative analysis of the components using a flame ionisation detector or mass spectrometer (Beres, 1997). However during the examinations it was also found that the strength, intensity and type of the resulting odor cannot be characterized by the concentration of the individual constituents in the case of a mixture of odoriferous substances (Bueb and Melin, 1987, Güdelhöfer et al., 1995, Hangartner, 1987, Missfeld, 1973):

- classical analytical tests take a long time, but results in odor disputes should be rapidly required in practice;
- the material and instrumentation requirements of the tests make them expensive, which is enhanced by the fact that they can only be performed under laboratory conditions;
- the sensitivity of analytical methods is sometimes low, and the concentration of individual components is often below the measurement limits of the methods used;
- very low odor thresholds and complex mixtures make the separation, identification and quantification of individual components very difficult;
- the concentration of the components cannot be used to conclude the type and magnitude of the actual odor, the effects on humans and their quantity (for example, synergistic effects of gases are not known).

Based on the above, the analysis of the odors is difficult because the analysis by component only determines the chemical composition and does not provide information on the type and concentration of the odor and the subjective sense of smell it produces. However, these analytical tests are suitable for the preparation of fingerprint chromatograms specific to the odor source, facilitating source identification in the case of complaints of disturbing environmental odors (Jeltes, 1974, Béres and Ágoston, 2008, Béres et al. 2014). By analyzing the most common emission sources with high-sensitivity chromatography, we can identify the pollutants specific to each source and, more importantly, determine the database of their proportions (chromatogram storage). According to the database, a chromatogram taken from an immission study can be used to assign odor in ambient air to one or other source („fingerprint" chromatogram). The method allows the identification of the source of the odor that causes the odor problem, even with very similar sources, using appropriate chromatographic parameters.Practical experience shows that the solid phase sorption sampling procedure and the thermal desorber sample preparation can be used effectively in this assay (TD-GC-MS method) (Béres et al. 2014).

Due to the above-mentioned problems with classical analytical tests, the organoleptic test based on human olfactory ability has proved to be the most appropriate for determining the „greatness" of the odor.In these tests, the „detector" is the human nose itself. The test does not measure the concentration of the components but evaluates the "smell effect" of the odor mixture (Béres, 1997).

METHOD OF ODOR MEASUREMENT, THE OLFACTOMETRY

The olfactometry, which is currently accepted and applied in environmental odor measurement, has been adopted in the field of environmental protection by the method and tool used in medicine. Hendrik Zwaardemaker developed and published the method of odor measurement, olfactometry and measuring equipment for the examination of olfactory sensitivity, that is for medical purposes (Noyons, 1931). This method of measurement and measurement device have been adopted by specialists in odor measurement for objective odor measurement.

Hendrik Zwaardemaker (1957-1930) was a Dutch psychologist, otolaryngologist and radiologist, from 1897 to 1927 professor of experimental psychology at the University of Utrecht.He studied in depth the physiological and psychological characteristics of human sense of smell and the issues of altered sense of smell (for example anosmia). In addition to the field of olfaction, he has done significant work in the field of human hearing and speech, but he also studied the functioning of the human heart, for example by examining the hearts of eels and frogs. He discovered that potassium salts and certain radioactive elements stimulate the functioning of the heart. In 1987, he developed an olfactometer to test human olfactory capacity, but his name is associated with certain basic aromas (ether, aromatic, balsam, etc.) and the so-called and discovering odor pairs (Zwaardemaker pairs): based on this, the odor of some interfering odors can be reduced or prevented by using volatile oils(e.g. ammonia - rose oil) (Noyons, 1931). His main work was „The Psychology of Smell" in 1895 (Zwaardemaker, 1895).

The first olfactometer developed by Zwaardemarker (Figure 1.) consisted of three parts: an odorless glass tube, open at both ends, fitted at one end to the human nose; a rubber cylinder, closed at one end and located outside the glass tube, which is movable back and forth and which is fitted to the glass tube with its open end and coated on its inner surface with an odorous substance (e.g.garlic); and a wooden sheet that covered the person examined from the glass tube and the rubber cylinder placed on it. The examining person inhaled the air in the glass tube through his nose until he smelled the odor applied. During inhalation, the outer, odor-treated, inner-surface-driven cylinder displaced the glass tube characterized the extent of displacement of the person's sense of smell:the more sensitive the smell was, the smaller was the displacement rate.

Zwaardemaker later improved his olfactometer to examine the odor threshold, odor response time, odor adaptation characteristics, and also examined the characteristics relating to the odor neutralization of certain substances(Finger, 1994).

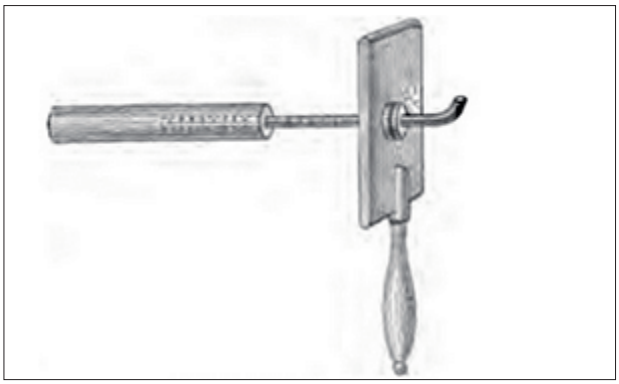


Figure 1. Zwaardemaker's olfactometer *(Zwaardemaker, 1895)*

OLFACTOMETERS USED IN THE ENVIRONMENTAL ODOR MEASUREMENT

In the field of environmental protection, the olfactometers used today for environmental odor measurement are based on the principle of the Zwaardemaker olfactometer. The olfactometer used is a precision gas mixing device whose sensor is the human nose. The olfactometer dilutes the odor air (odor sample) to be tested with odor-free air, until the odor is detected in the nasal mask trained to detect the mixture. Decreasing dilution eliminates the possible fatigue of the nose. The odor threshold of different odors and the amount of odor concentration can be determined with the measuring device (Béres, 1997). In modern olfactometers, dynamic olfactometry is used to mix odor samples with a constant volume of odorless air until the person measuring the nose senses the appearance of the odor. When the odor appears in the nasal mask as indicated by the nose signal, the odor intensity ratio, which is the odor concentration of the odor sample, is determined based on the ratio of odorless air and the odor sample flow rate (dilution ratio). The odor measure is the odor unit (OU/m^3), which expresses the odor of the odorous air by giving the dilution ratio at which the smell of contaminated air is still / already perceptible. (Béres, 1997, Béres et al. 2014a).
The first olfactometer in Europe for environmental odor measurement was developed in 1973 by Heinrich Man-

nebeck at Christian Albrecht University in Kiel, in Germany there is a long history of research into the study and regulation of disturbing environmental odors. Research has also begun in the United States to develop an objective odor measurement method and the first laboratory olfactometer has been developed (Mills et al., 1963).

The first portable Mannebeck olfactory polymer could be simultaneously evaluated by one person at the site of odor measurement (at the source of the odor) or in laboratory conditions; however, several (even eight) persons took part in the measurement, the measurement result being determined by the average of the responses (individual odor threshold values determined by the measuring persons) of the persons participating in the measurement. Odor measurement is controlled by the test's administrator, who is responsible for sample handling, setting of dilution ratios, recording and processing of responses given by measuring person. Mannebeck has continually improved the TO series-labeled olfactometer within Ecoma GmbH (Römermann and Schlieper, 2007), and variants have been released and can be used worldwide by four people at a time, these olfactometers are computer-controlled. The first computer-controlled olfactometer, the Olfaktomat, was created by the Dutch van Harreveld in collaboration with Project Research Amsterdam and Neomat in 1987 (van Harreveld et al, 1999) in the Netherlands, where researchers also dealt with it.

Along with the development of odor measurement, the process of standardizing the measurement method has begun in Europe, with the first standards and pre-standards appearing in Germany, France and the Netherlands(VDI, 1980, AFNOR, 1981, NVN, 1987). In 1985, Hungary was also one of the first to issue a measurement guideline for the method of odor measurement by dynamic olfactometry(MSZ, 1985). Finally, in 2003, after nearly 10 years of preparatory work, the European Union standard for odor sampling and odor measurement, the characteristics of sampling and measuring instruments, measuring conditions and the selection of measuring personnel was published and introduced in Hungary (MSZ, 2003).

An important issue in odor measurement is the examination and continuous monitoring of the smellers' ability to smell(Zarra et al., 2018). Persons participating in the measurement shall undergo, prior to the measurement, a selection process as described in the Standard for the Measurement of Odor, during which their olfactory capacity shall be checked: persons who are hypersensitive to the sense of smell or persons with reduced sense of smell shall not take part in the measurement(MSZ, 2003).In addition, there are a number of other requirements that are met by person under examination (must be a certain age, should have independent capacity to act, shall have no colds, should not use cosmetics on the day of the measurement, should not consume very spicy food, etc.)During odor measurement, the diluted odor sample is evaluated by several (at least four) persons, each odor sample is measured in three replicates (Figure 2.).The relevant standard also contains requirements for the measuring room (eg. odor-free room with an adequate ventilation, air temperature, humidity, the lighting of the room, noise pollution) (Béres et al., 2014b). Currently, these methods described in this standard are used worldwide in the field of odor sampling and odor measurement, sometimes adopting the European Union standard without modification.

The development of olfactometers has continued unbroken in recent times. The main direction of development is still the increase of the objectivity of measurement.

In the case of modern olfactometers used nowdays the dilution of the samlpes and the adjustment of the dilution ratio are not done manually, it is not the task of the test leader. The dilution ratios are set by computer controlled flow control valves. The measurement can be carry out at the same time by 6-8 people. In case several devices are used in the standard described method, it is called the forced choice method. The measurer must choose from several (2-3) nasal masks, in which he/she can detect the appearance of the odor, as in some nasal masks only an

Figure 2. The dinamic olfactometer and persons involved in the measurement *(Béres et al., 2014b)*

odorless diluiton gas will be given for evaluation; it can also be used to continuously check the correctness of the measurer's response.
Periodically, during measurement at unknown times, also to check the correctness of the answers - the measurer will give an odorless dilutent (so-called blank) in the dilution line for evaluation in the nasal mask (Béres at al., 2014b).
If the measurer gives a positive response to the blank at a specified rate higher than the standard (typically more than 20%), his answers shall be excluded from the evaluation to determine the result of the measurement (MSZ,2003).

THE ODOR SAMPLING

One of the most important elements of odor measurement is the sampling of the gas (e.g. room air, ambient air) or gas stream (e.g. odor polluted air leaving the source into the environment through a chimney) to be tested for odor concentration (so-called odor sampling). Odor sampling is similar to air sampling, which is classically used in ambient air and emission sources for air quality and emission tests, and means the extraction of an analysed gas or part of a gas stream under controlled conditions and its delivery to the measuring equipment, supplemented, if necessary, by the collection, storage and transport of the sample. During odor sampling, the specific characteristics of the odor source, the gas to be sampled, the odor sample and the odor measurement shall also be taken into account when designing and applying the sampling method used (MSZ,2003).

As previously described, the measurement standard sets strict requirements for air quality, room lighting and noise pollution in the room where the odor measurement takes place (MSZ, 2003), so the odor measurement can only be performed under suitably constructed, regulated and documented laboratory conditions. Sampling related odor measurement can be performed by dynamic and static methods (MSZ, 2003).
When using the dynamic sampling method, the air sample for odor measurement is delivered directly from the sampling source through a suitable sampling and piping system to the olfactometer near the sampling. In this case, the room where the odor measurement takes place is a so-called mobile odor laboratory (eg. a room in the body of a lorry) (Capelli et al., 2013).
If static sampling is used, the odor sample taken from the source is collected (typically in a special odor sampling bag) and then the sample is transported to the odor measurement site, the odor measuring laboratory. The conditions of transport and storage of odor samples are strictly regulated according to the description of the relevant standard, during these operations situations that adversely affect the condition of the odor sample (e.g. extreme temperature, exposure to sunlight) must be avoided. (MSZ, 2003, Capelli et al., 2013, Béres et al., 2014b)
Only devices (e.g. sampling pump) and materials (e.g. pipelines, sampling bags) that do not adversely affect the representativeness of the sample may be used during odor sampling and collection and storage of the sample.
For some sampling sources, due to the high temperature and humidity of the sampled gas or gas stream, it may be necessary to use a predilution sampling probe to dilute the sample with an odorless dry gas (e.g. nitrogen gas) to reduce temperature and relative humidity to avoid condensation during sampling. If, due to the dust content of the gas to be sampled, there is contamination or clogging of the equipment used during sampling and measurement, the sample gas must be cleaned of solid contaminants by using a glass fiber filter (MSZ, 2003, Capelli et al., 2013, Béres et al., 2014b).
The equipment to be used for sampling, its material quality, the sampling method, the requirements for the implementation of sampling, storage and transport of samples are dealt with in a separate chapter and annex of the relevant odor measurement standard. (MSZ, 2003)

One of the most important tools used in odor sampling is the so-called odor sampler based on the lung principle of operation. In this application, the empty sampling bag is placed in a portable container. A vacuum is created in the container by a pump, the gas sample from the gas to be sampled flows into the sampling bag due to the resulting pressure difference without contact with the pump.(Figure 3.) (MSZ, 2003) The odor sampler based on

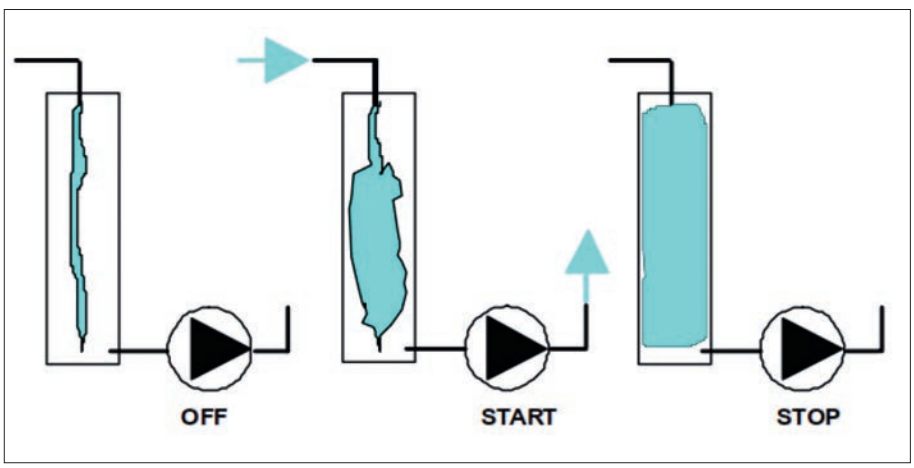


Figure 3. Scheme of sampling by means of vacuum pump – lung method *(Capelli et al., 2013)*

the principle of operation of the lung is well suited for sampling from any odor source. In the case of point sources, the odor emission of the test source can be determined by measuring the odor concentration of the tested gas sample and the volume flow of the gas stream leaving the point source (SZE/h ; SZE/s).

In the case where the sources are buildings, the determination of the amount of odor emission is more uncertain, because at these sources it is difficult to measure the volume flow of exhaust odor polluted air (building source: a building, room from which polluted air leaves through openings and open boundary surfaces). At these sources, the amount of odor emission can be determined by taking into account the odor concentration of the odor samples taken in the building or room and the amount of odor polluted air leaving the building or room determined by technical estimation and calculation (air exchange) (Bokowa and Liu, 2008).

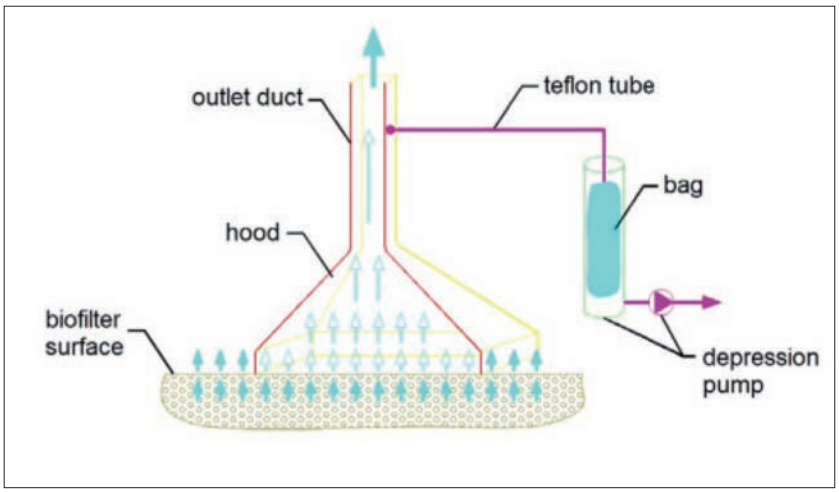


Figure 4. Scheme of sampling from an active surface source by static sampling hood *(Capelli et al., 2013)*

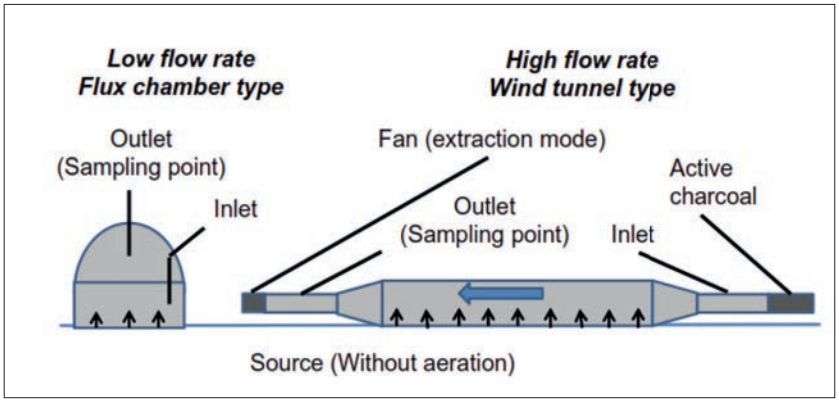


Figure 5. Aerated sampling hood devices (flux chamber and wind tunnel types) for passive area sources (*Guillot, 2012*)

At surface sources, the implementation of odor sampling is already much more complex. The examined surface source can be the so-called an active surface source in which the odor emitter surface passes through a direct gas stream, such as the surface of a biofilter or aerated compost prism; but it can also be a so-called passive surface source, in which no direct gas flow passes through the surface, such as a non-aerated compost prism or the open surface of a landfill.

For active surface sources, a static sampling bell is placed on the surface of the source, which collects the odor-contaminated air flowing out of the surface into an exhaust air duct. The source area covered by the static sampling bell is at least 0.5-1 m^2, odor sampling can take place from the bell outlet air duct, and the climatic characteristics of the sampled gas (temperature, humidity) can also be determined here (Figure 4). (MSZ, 2003, Capelli et al., 2013, Béres et al., 2014b)

In the case of passive surface sources, an aerated sampling bell shall be used for sampling (Figure 5).

Odorless air is introduced into the aerated sampling bell at a specified rate and flows over the surface of the surface source to be sampled, trapping odors exiting the surface. Odor sampling can take place from the bell outflow air duct.

In the case of sampling with sampling bells, the specific odor emission of the surface source, measured in OU / $m^2 \times s$, can be determined by knowing the specified odor concentration, bell surface, source surface and air volume flow. (MSZ, 2003, Capelli et al., 2013).

REFERENCES

1. AFNOR (1981) X-43-101. Method of the Measurement of the Odor of a Gaseous Effluent. Bureau de Normalisation, Paris
2. AGU (2007) Ärztinnen und Ärzte für eine gesunde Umvelt: Medizinische Faktoren zur Beurteilung von Geruchsimmissionen. Leitfaden im Auftrag des Landes Steiermark. AGU, Wien http://www.aegu.net/pdf/LeitfadenGeruch.pdf (Retrieved: 14.08.2019)
3. Alapvető Jogok Biztosának Hivatala (2012): Beszámoló a jövő nemzedékek országgyűlési biztosának 2011. évi tevékenységéről. Budapest
4. Béres, A. (1997): Összefüggések a szagkibocsátás és a baromfitartási technológiák között. Doktori értekezés, Gödöllő
5. Béres, A. (2000): Szag és csökkentése. – In: Barótfi, I. (Szerk.) Környezettechnika. Mezőgazdasági Szaktudás Kiadó, Budapest
6. Béres, A. (2014): Az állattartás környezeti szaghatása, a szagvédelmi szabályozás lehetséges módszerei. – GRADUS 1(2): pp. 147-152
7. Béres, A., Ágoston, Cs. (2008): A szag, mint környezeti probléma. – Biohulladék Magazin 3(3-4), pp. 18-23
8. Béres, A., Ágoston, Cs., Lovrityné, K.B. (2014a): Szagvédelmi kézikönyv. Magyar Mérnöki Kamara Környezetvédelmi Tagozat,
9. http://www.kvtagozat.hu/pictures/Szagvedelmi_kezikonyv_2.veglegesvba.pdf (Retrieved: 14.08.2019)
10. Béres, A., Gulyás, M., Aleksza, L. (2014b): Mezőgazdasági létesítmények szagterhelésének mérése. – Mezőgazdasági Technika 55(7): pp. 2-5
11. Boeckh, J. (1972): Geruch. – In: Physiologie des Menschen. Gauer, Kramer & Jung (Hrsg.) Urban & Schwarzenberg Verlag. München
12. Bokowa, A.H. (2010): The effect of sampling on the measured odour concentration. – Chemical Engineering Transactions 23, pp. 43-48
13. Bokowa, A.H., Liu, H. (2008): Techniques for odour sampling of area and fugitive sources. – Chemical Engineering Transactions 15: pp. 57-62
14. Buck, L., Axel, R. (1991): A novel multigene family may encode odorant receptors: a molecular basis for odor recognition. – Cell 65(1):175-87
15. Bueb, N., Melin, T. (1987): Biological and physicochemical waste gas treatment processes - comparison of processes and costs - chances for new technologies. – In: Dechema-congres Proceedings: Biological treatment of industrial waste gases. DECHEMA, Heidelberg
16. Burdach, K.J. (1987): Geschmack und Geruch. Hans Huber Verlag, Bern.
17. Capelli, L., Sironi, S., Del Rosso, R. (2013): Odor Sampling: Techniques and Strategies for the Estimation of Odor Emission Rates from Different Source Types. – Sensors 13(1): pp. 938–955
18. Corbin, A. (1984): Pesthauch und Blütenduft. Eine Geschichte des Geruchs. Verlag Klaus Wagenbach, Berlin
19. Finger, S. (1994): Origins of Neuroscience: A History of Explorations into Brain Function. Oxford University Press, New York
20. http://books.google.hu/books/about/Origins_of_Neuroscience.html?id=_GMeW9E1IB4C&redir_esc=y (Retrieved: 14.08.2019)
21. Güdelhöfer, P., Kretz, H., Jockel, W. (1995): Verfahren zur Feststellung und Bewertung von Geruchsemissionen aus verschiedenen Quellentypen. – Entsorgungs Praxis 11: pp. 42-47
22. Guillot, J.M. (2012): Odour measurement: focus on main remaining limits due to sampling. – Chemical Engineering Transactions 30: pp. 295-300
23. Hangartner, M. (1983): Bewertung von Geruchsemissionen. – Forum Städte-Hygiene 34: 106. p
24. Hangartner, M. (1987): Sensorische Geruchsmessung. – Sonderdruck aus Umweltschutz/Gesundhetstechnik 1: 4 p
25. Hangartner, M., Kastka, J. (1986): Grundlagen der Geruchsbewertung. – VDI-Berichte Nr. 561: pp. 427-437
26. Honti, V., Vécsei, L. (2005): A molekulák illata: élettani-orvosi Nobel-díj. – Természet Világa 136(1): pp. 10-16
27. Jeltes, R. (1974): Fingerprinting techniques as aids in the analysis of composite chemical pollutants in the environment. – Journal of Chromatographic Science 12(10): pp. 599-605
28. Kastka, J. (1986): Psychologie und sociologische Aspekte der Geruchswahrnehmung. Vortrag LIS-Lehrgang 614, Essen
29. Klinke R, Silbernagel, S. (2003): Lehrbuch der Physiologie. Georg Thieme Verlag, Stuttgart
30. Lais, S. (1996): Untersuchungen zur Reduzierung der Ammoniak- und Geruchsemissionen aus der Schweinehaltung durch biologische Abluftwäscher. Dissertation, Selbstverlag, Hohenheim
31. Luo, Z.X., Ruf, I., Schultz J.A., Martin, T. (2011): Fossil evidence on evolution of inner ear cochlea in Jurassic mammals. – Proceedings of Royal Society Series-B (Biological Sciences) 278: pp. 28-34
32. Mannebeck, H. (1974): A practical portable method of odour measurement. – Processing and management of agricultural wastes. Proceedings of Agricultural Waste Management Conference, Cornell University, Rochester, pp. 291-294
33. Matzke, U. (1986): Geruchsbelästigung und ihre immissionschutz-rechtliche Beurteilung in Nordheim-Westfahlen. – VDI-Berichte Nr. 561: pp. 522-532

34. Mills, J.L., Walsh. R.T., Luedtke, K.D., and Smith, L.K. (1963): Quantitative Odor Measurement. Journal of the Air Pollution Control Association 13(10): pp. 467-475
35. Missfeld, B. (1973): Verfahren zur Ermittlung von landwirtschaftlichen Geruchsemissionen. – Landtechnik 9/10: pp. 284-285
36. MSZ (1985) 13–108–85. Technológiai légszennyezőforrások vizsgálata. Kellemetlen szagok küszöbhígítási értékeinek meghatározása dinamikus olfaktometriával. Magyar Szabványügyi Testület, Budapest
37. MSZ EN 13725:2003, Levegőminőség. A szagkoncentráció meghatározása dinamikus olfaktometriával. Magyar Szabványügyi Testület, Budapest
38. Nicell, J.A. (2009): Assessment and regulation of odour impacts. – Atmospheric Environment 43: pp. 196–206
39. Noyons, A.K.M (1931): Hendrik Zwaardemaker: 1857-1930. – The American Journal of Psychology 43(3), pp. 525-526
40. NVN (1987) 2820. Provisional Standard: Air Quality. Sensory Odour Measurement using an Olfactometer. Netherlands Normalization Institute, Delft
41. Oldenburg, J. (1990): Geruchs- und Ammoniakemissionen aus der Tierhaltung. – Staub-Reinhaltung der Luft 50: pp. 189-194
42. Plattig, K.H. (1994): Olfaktorische Diagnostik. – In: H. E. Wichmann, H. W. Schlipköter & G. Fülgraff (Hrsg.) Handbuch der umweltmedizin. ecomed Verlag, Landsberg
43. Römermann, H.D., Schlieper, M. (2007): Betriebshygiene: eine Einführung für Facility-Manager. Expert Verlag, Renningen
44. Rowe, T.B., Macrini, T.E., Luo, Z.X. (2011): Fossil Evidence on Origin of the Mammalian Brain. – Science 332: pp. 955-957
45. Schiffman, S.S. (1998): Livestock Odors: Implications for Human Health and Well-Being. – Journal of Animal Sciences 76: pp. 1343–1355
46. Sekuler, R, Blake, R. (2000): Észlelés. Osiris Kiadó Kft., Budapest
47. Shusterman, D. (1992): Critical review: the health significance of environmental odor pollution. – Archives of Environmental Health 47: pp. 76-87
48. Steinheider, B. (1997): Die Wirkungen von industriegerüchen als umweltstressoren. Deutscher Universitätsverlag, Wiesbaden
49. van Harreveld, A. P., Heeres, P., Harssema, H. (1999): A Review of 20 Years of Standardization of Odor Concentration Measurement by Dynamic Olfactometry in Europe. – Journal of the Air and Waste Management Association 49: pp. 705-715
50. VDI (1980) Richtlinien, (draft). Olfactometry, Odour Threshold Determination, Fundamentals. VDI 3881 Part 1-4. Verein Deutsche Ingenieure Verlag, Düsseldorf
51. Vroon, P., Van Amerongen, A., De Vries, H. (2005): A rejtett csábító (A szaglás pszichológiája). Korona Kiadó, Budapest
52. Winston, J.S, Gottfried, J.A, Kilner, Dolan, R.J. (2005): Integrated Neural Representations of Odor Intensity and Affective Valence in Human Amygdala. – The Journal of Neuroscience 25(39): pp. 8903-8907
53. Zarra T., Reiser M., Naddeo V., Belgiorno V., Kranert M. (2018): A Critical Evaluation of the Influence of Different Panel Composition in the Measurement of Odour Concentration by Dynamic Olfactometry, Chemical Engineering Transactions, 68, 1-6.
54. Zimmer, D.E. (1987): Riechen - Ein Wissenschaftsreport. – Zeitmagazin 44: 26. p
55. Zwaardemaker, H. (1895): Die Physiologie des Geruchs. Verlag von Wilhelm Engelmann, Leipzig, https://archive.org/details/diephysiologied00zwaagoog (Retrieved: 14.08.2019)

THE SUCCESS AND FAILURE FACTORS OF PASTA MANUFACTURING MICRO ENTERPRISES

ILONA **FEHÉR**

Szent Istvan University, Faculty of Economics and Social Sciences, SZIU Doctoral School of Management and Business Administration Hungary
e-mail: fehetili0223@gmail.com

ABSTRACT

The aim of the research is to formulate recommendations for local micro-enterprises, which will enhance their viable competitiveness.
Therefore, I have carried out case studies with some domestic and foreign (Italian, Romanian) micro-enterprises that are active in the pasta industry.
For the analysis, I compare several regional competitiveness models, the pyramid model, the tree model, the cylinder model, and the diamond model.
I am looking for an example of applying the diamond model in international literature after selecting the model. The results are compared in terms of asset supply, demand bargaining position, entrepreneurial strategy, economic environment, and the impact of random events, listing the success and failure factors experienced.
I recommend micro-enterprises to join the pasta value chain, because the horizontal and vertical network can protect them from the effects of the crisis. An important recommendation is the innovative strategy, for which product innovation is also a tool: innovation of flavours (exotic spices), raw material innovation (ancient cereal varieties, false cereals, insects), and ethno-cultural product innovation, varieties of folk cuisine pasta, - which can be proposed for micro-enterprises.

INTRODUCTION

The background of the research and its content

The study is centred around the topic of competitiveness at micro and small enterprises in the pasta industry, with special regard to the impact of consumer behaviour. The success and failure factors of small business competitiveness were also put in the limelight.
An unfavourable pasta market trend termed as 'brand cannibalism', refers to an increase in the market share of own label products of the retail chains. (Jelentés, 2016) As a result, the structure of the industry has been modified, global retail networking has intensified, and the importance of food chain has been stressed. (Lakner, 2017)
Pasta has always played an essential role as staple food in the consumption of households around the world. The dynamic development of the pasta industry is evidenced by the fact that the global consumption of pasta has almost tripled since 1974. (Doney, 2018)
The vast majority (94%) of the dry pasta sector in Hungary - in terms of company size - employs more than half of the employees in the sector, including micro and small enterprises. (Székelyhidi, 2016)
Regarding the trends in the global pasta market, growth is expected to be 5.85% between 2019 and 2023. The market is driven by the growth of the working population, the need for convenience foods and the changing consumer lifestyle. (Pasta Market Growth Report, 2019). As for the segmentation of pasta products, market growth is expected in functional food, organic pasta may dominate the market due to rising demand, and the market of chemical-free foods for health-conscious consumers is also increasing. (Maharashtra, 2017)
In the paper, the competitiveness of the micro enterprises was analysed based on Porter's diamond model. After the material and method part, the case studies prepared in the Hungarian and foreign region are evaluated together with the research hypotheses test. Recommendations are made for small business development, which can hopefully be utilized at an international level.
The research is directed at the competitiveness situation of small businesses as well as that of the dry pasta industry while in the primary research the competitiveness factors of entrepreneurs were compared with the help of national and international best practices.

In line with the research objectives the following hypotheses were drafted.

Hypotheses H1-H6 on the supply side of the pasta market

H1 From the aspect of the factor supply of the pasta enterprises, the negative effects of natural conditions can be compensated for while improving competitiveness.
H2 The bargaining position of buyers in the pasta business sector is expected to increase.

H3 When examining entrepreneurial strategies, general success and failure factors are expected to be screened.
H4 The bargaining position of businesses towards suppliers is not expected to change or deteriorate, i.e. the threat of this factor stagnates
H5 By the end of the decade (2010s), economic governance is expected to promote the whitening of the grey-black economy and the commitment to environmentally conscious behaviour will increase.
H6 Businesses are expected to find a variety of solutions to offset the negative impact of accidental events on competitiveness of which success and failure factors can be identified.
For evaluating the competitiveness of micro enterprises, a dimension that can be implemented and efficient in practice needs to be searched into. Four models of regional competition are presented, one of them being the pyramid model, the other being the tree model, the third being the ring model and the fourth being the diamond model. The pyramid model ignores the factors that influence well-being and it is too static (Nagyné, 2013). The wood model overemphasises the importance of industrial structure and its application would have difficulties in measuring sustainability. (Lukovics, 2008). The diamond model is the most dynamic and commonly used in foreign literature, and it has proved its merit in practice. This reality suggests that it is appropriate forexamining the competitiveness of the pasta companies. (Porter, 1998)

MATERIAL AND METHOD

Supporting points have been found in several studies while analysing case studies on the supply side. One such case in Italy was the case of a production cooperative (Hassanein, N - Gilchrist, K. 2013) and in Hungary a research entitled in competition with the world (Chikán, Czakó, 2009) about the culture of inheriting family businesses. (Noszkay. 2017.) Building a company's reputation is effective when it comes to building long-term mutual benefits with customers. (Dalgic, 2006)
I had to cope with the fact that micro and small businesses were on the border of the white and grey economy, recommended to each other, therefore the sample could not be considered representative.
The research was done in several parts.
In Hungary, I conducted a case study with five companies. I visited two Fresca pasta shops in northern Italy and then did a case study at the dry pasta factory of Alce Nero cooperative. I was welcome in a bakery and mini mill in Moldavia, Romania, and I made interviews in two bakeries of Transylvania.

RESULTS

The purpose of my primary research is to make recommendations to micro-entrepreneurs, small scale producers, and rural tourism decision makers to enhance viable sustainable competitiveness.

Evaluation of the case studies in Hungary and abroad

Such micro enterprises of pasta production in Hungary were visited where the number of employees is below 10 like Pásztortűz Kft, Józsa Kft, Fehérné Tésztája, Kalász Tészta. An interview was also made at a big company, namely, Gyermely Zrt. In addition to the Hungarian companies, enterprises in two different economic environments were also visited abroad.
One of the countries visited was a typical Eastern European country, Romania, with a developing economy. A micro company was introduced here in Moldova and one in Transylvania. During the research in the micro-region of Oroszhegy, the village of Tibód proved to be good practice, so I recorded the experiences of the development.
The other country is a typical Western European one, Italy, where two "fresh pasta shops" in the province of Emilia Romagna were visited and interviews were made at the pasta factory of Alce Nero Cooperative. In the field I learned about the great local development of the pasta factory in the Isola del Piano micro-region, so I used it as a good practice in my research.
The semi-structured interviews were based on the factors of the diamond model and the responses were analysed in four logical steps. According to this, I recorded the problem and then the response and the impact of the

Table 1. Presentation of case studies

Hungarian comparison	International comparison		
	Italy	Romania	
	Emilia Romagna	Transylvania	Moldavia
1. Pásztortűz Kft.	6. Pasta Fresca Shop	8. Jánosi Bakery	10. Feer Mill
2. Fehérné Tésztája	7. Alce Nero Association	9. Vidéki (Rural) Bakery	11. Maestro Pizzeria
3. Kalász Tészta			
4. Józsa Tészta	Isola Del Piano micro region	Oroszhegy micro region	
5. Gyermely Zrt.			

Source: author's own editing

measures on the company. Finally, in the note, I described the factors of competitiveness.
Through the research I intend to use their experience for the domestic enterprises, but not only for the micro entrepreneurs, the primary producers and the small scale producers, but also for the decision makers who develop the micro-region, for the economic utilization of the micro-region.

Case study analysis of the diamond model factors regarding

Factor and asset supply

From the case study stories, elements that show the physical, human and R&D resources of businesses were searched.

Examining Hypothesis H1 in terms of factor and asset supply

H1 From the aspect of the factor supply of the pasta enterprises, the negative effects of natural conditions can be compensated for while improving competitiveness.
In terms of equipment supply, the success factors behind the product are the creation of a philosophical background and cultural value added, machine development in-house, adaptive trend tracking, and the distribution of domestic knowledge transfer abroad. The failure factors are the narrow product range and lack of the expected return on investment.
Based on the above, it can be stated that Hypothesis H1 can be justified by the details of the above interviews, i.e. the disadvantaged natural conditions of the enterprise in terms of asset and factor supply can be reversed in order to increase competitiveness. The hypothesis is confirmed.

Threatening buyers' bargaining power

From the stories of the case studies, elements that reveal the technology of making pasta, the demand, and the sensitivity of entrepreneurs to consumption trends were looked for.

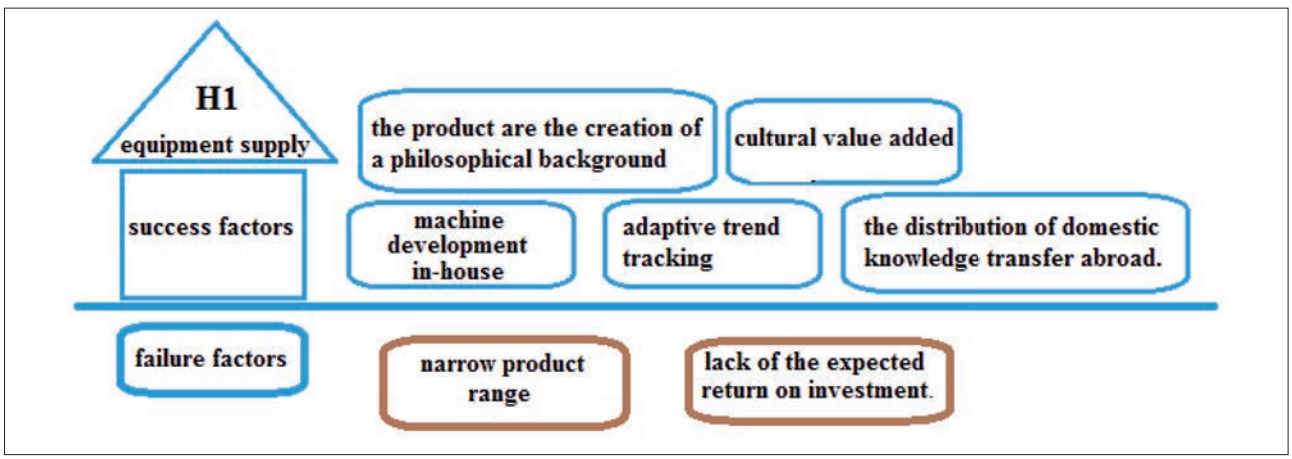


Figure 1. Factor and asset supply ***(Source: author's own editing)***

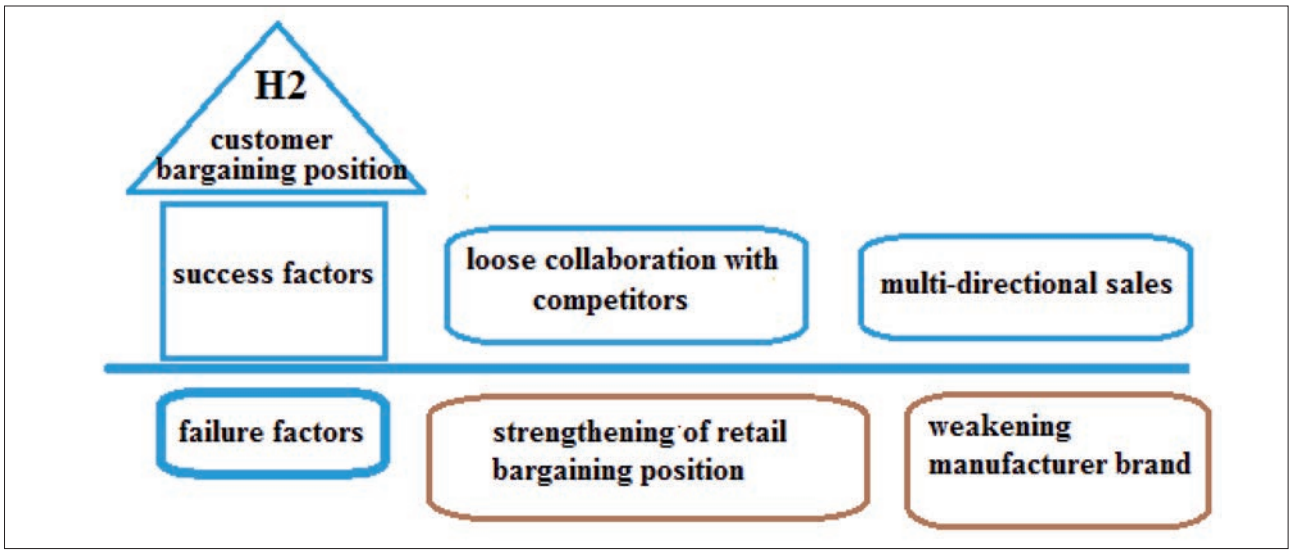


Figure 2. Threatening buyers' bargaining power ***(Source: author's own editing)***

Examining Hypothesis H2 in terms of threat to demand and bargaining power of buyers

In terms of customer bargaining position, success factors include loose collaboration with competitors and multi-directional sales. Failure factors include a strengthening of retail bargaining position and a weakening manufacturer brand.

H2 The bargaining position of buyers in the pasta business sector is expected to increase.

Based on the above, it can be stated that the exposure of businesses to customers has increased. Several success and failure factors were identified ranging from avoiding strategy to resignation to vulnerability. The hypothesis is confirmed.

Strategies of enterprises

From the case studies parts which shed light on the relationship of the enterprises with competitors, the strategy of the enterprise and how quick they reacted to consumer needs were looked for.

Examining Hypothesis H3 in terms of selecting strategy by the enterprises.

Regarding business strategies, success factors include a wider range of services, organising cyclical production, including family members, umbrella branding, public engagement in complex micro regional strategy. The failure factors consist of disregarding consumer value system and misjudging, miscalculating bank loans.

H3 When examining entrepreneurial strategies, general success and failure factors are expected to be screened.

Based on the above, it can be stated that of the entrepreneurial strategies, overall success and failure factors at international level can be excluded, despite various environmental influences. The hypothesis was confirmed.

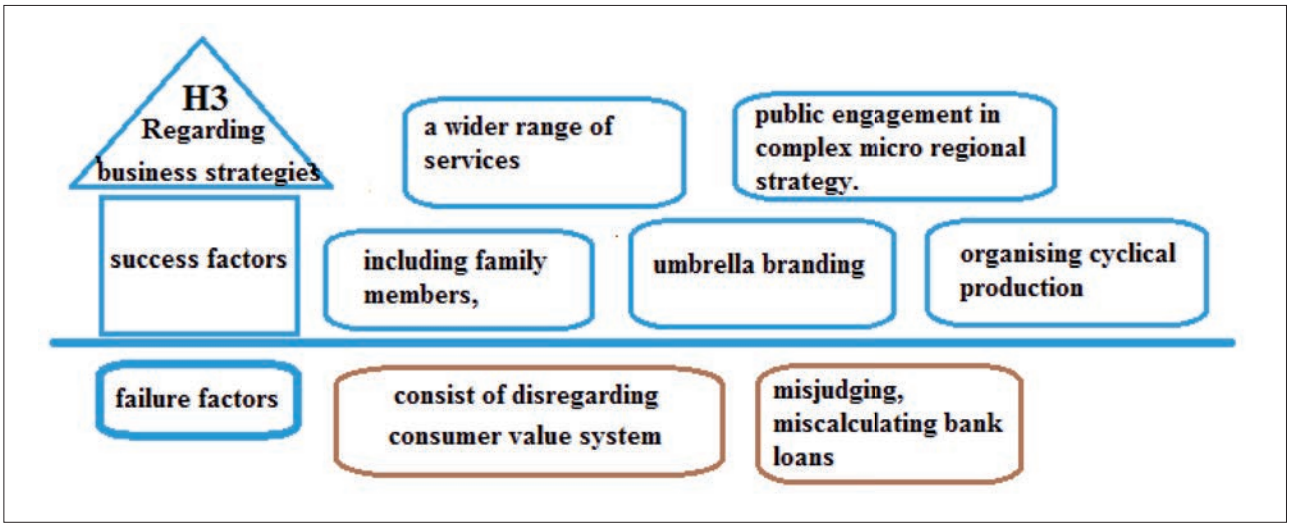


Figure 3. Strategies of enterprises ***(Source: author's own editing)***

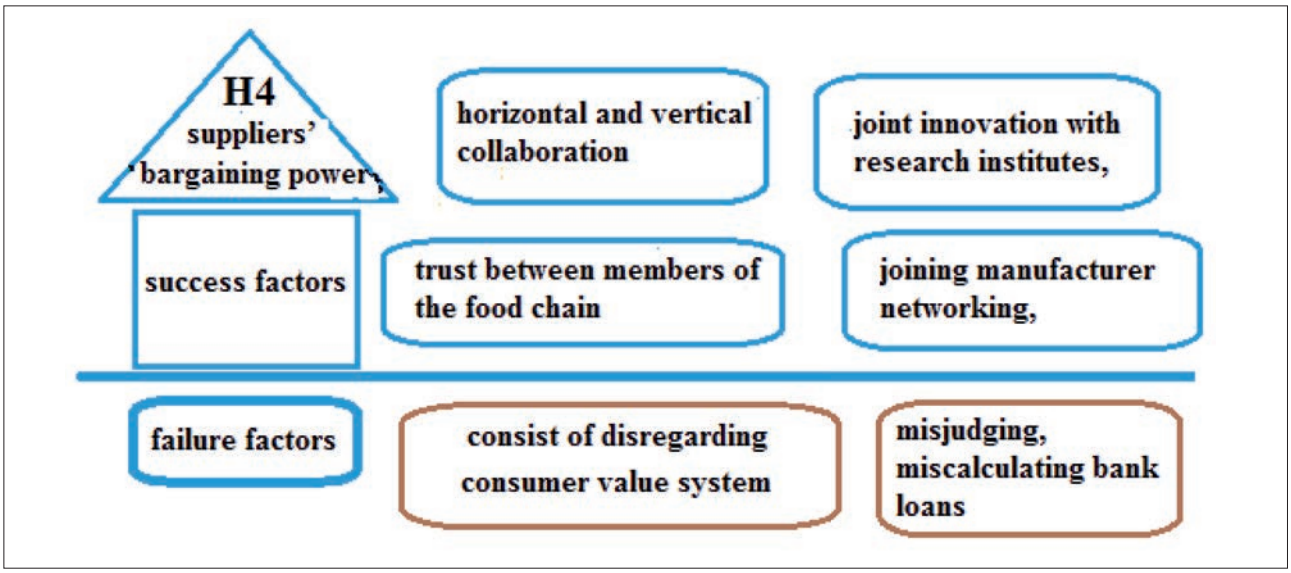


Figure 4. Threatening the bargaining power of suppliers ***(Source: author's own editing)***

Threatening the bargaining power of suppliers

From the case studies parts which shed light on what suppliers the enterprises had relationship with were looked for.

Examining Hypothesis H4 in terms of threatening the bargaining power of suppliers

Success factors in suppliers' bargaining power include trust between members of the food chain, joining manufacturer networking, horizontal and vertical collaboration, joint innovation with research institutes, while failure factors are mistrust, and lack of fair competition behaviour.

H4 The bargaining position of businesses towards suppliers is not expected to change or deteriorate, i.e. the threat of this factor stagnates.

Based on the above it can be stated that hypothesis H4 is confirmed. The threat of supplier bargaining power stagnates.

Economic-political environment and its impact on competitiveness

From the case studies elements that reveal the type of relationship between economic and political issues were looked for.

Examining Hypothesis H5 in terms of the economic-political environmental impact

Success factors regarding the bargaining power of suppliers are as follows: level-playing ground, ethical behaviour in competition, EU regulations and sanctions. The failure factors include forging and debatable product quality.

H5 By the end of the decade, economic governance is expected to promote the whitening of the grey-black economy.

Hypothesis H5 seems to be confirmed because non-industry specific economic governance will help to whiten the grey-black economy in 2019 and strengthen commitment to responsible entrepreneurial behaviour. The hypothesis is confirmed.

The impact of accidental events on entrepreneurial competitiveness

From the case studies parts which shed light on what role accidental events played in the life of the enterprise may they be either nature or technology related or incidents in the management.

Examining Hypothesis H6 in terms of accidental events

Regarding accidental events the main success factors include preparedness for generation change and networking to set off the disadvantages of accidental events. The failure factors perceive accidental events as unavoidable economic tsunami and they just drift away without being prepared.

H6 Businesses are expected to find a variety of solutions to offset the negative impact of accidental events on competitiveness of which success and failure factors can be identified.

It can be stated that Hypothesis H6 has been justified. Several solutions can be found to offset the competitiveness-reducing effect of accidental events, among which success and failure factors can be identified. The hypothesis was confirmed.

Summary of hypothesis testing (H1-H12)

Summarising the research was started with reviewing the hypotheses test followed by the new and novel scientific achievements (Table 2).

DISCUSSION

Comparison of case studies

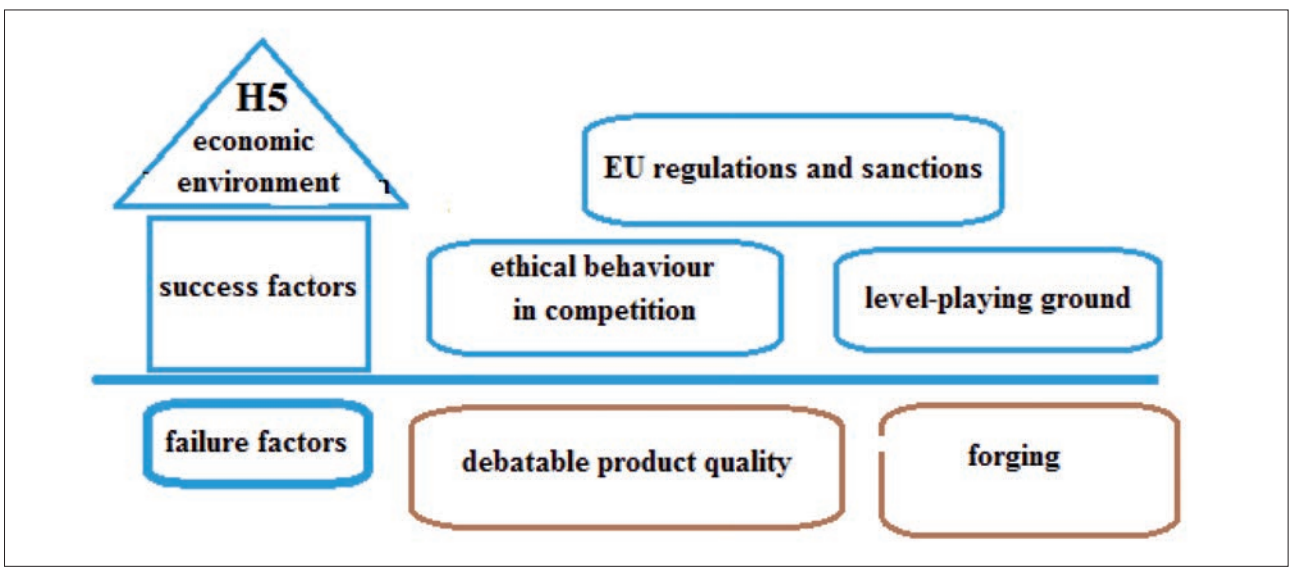


Figure 5. Economic-political environment and its impact on competitiveness *(Source: author's own editing)*

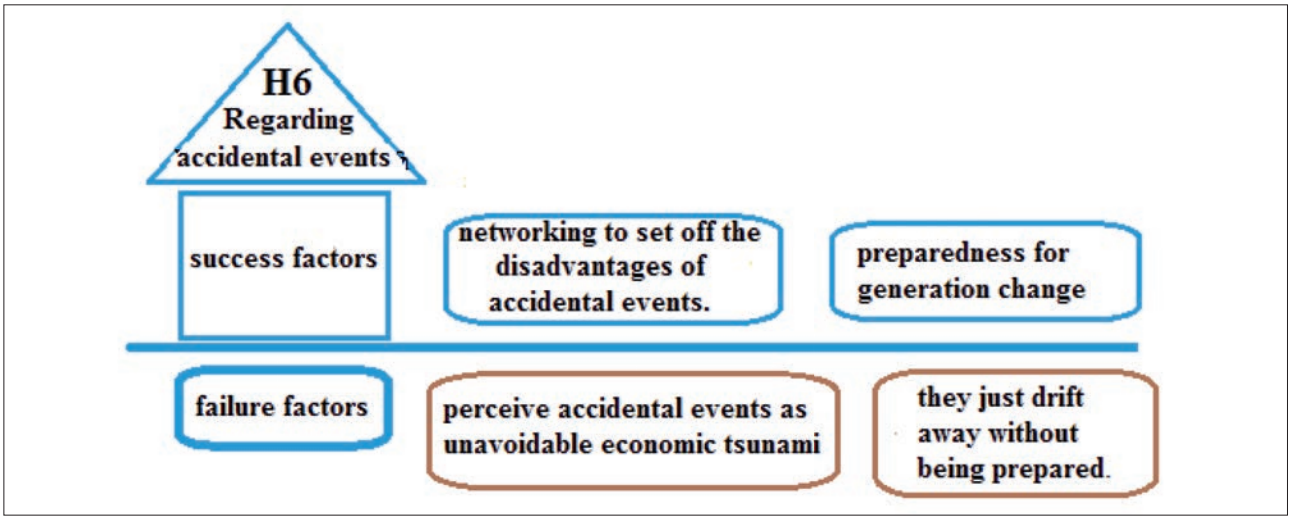


Figure 6. The impact of accidental events on entrepreneurial competitiveness ***(Source: author's own editing)***

Table 2. Testing the research hypotheses

Hypothesis	Test
H1 From the aspect of the factor supply of the pasta enterprises, the negative effects of natural conditions can be compensated for while improving competitiveness.	Confirmed
H2 The bargaining position of buyers in the pasta business sector is expected to increase.	Confirmed
H3 When examining entrepreneurial strategies, general success and failure factors are expected to be screened.	Confirmed
H4 The bargaining position of businesses towards suppliers is not expected to change or deteriorate, i.e. the threat of this factor stagnates.	Confirmed
H5 By the end of the decade (2010s), economic governance is expected to promote the whitening of the grey-black economy and the commitment to environmentally conscious behaviour will increase.	Confirmed
H6 Businesses are expected to find a variety of solutions to offset the negative impact of accidental events on competitiveness of which success and failure factors can be identified.	Confirmed

Similar analyses have already been made in the literature in the wine, milk and meat sectors (Komáromi - Lehota, 2004). A benchmarking tool (comparative matrix) was prepared to analyse the competitiveness of the companies in the case studies. (Evans, 1997) In preparing the table, I have taken into account that "the benchmark is the concentration on a benchmark that achieves best practice in the process." (Camp, 1995, p. 37)
The following categories were established to characterise the single factors in the matrix.
Asset supply (low, medium, high); geographical limits of market; (local, national, abroad), market bargaining power (no, mutual, subordinate, highly subordinated), degree of product differentiation (low, medium, high).
Need for innovation (no, low, medium, high); branding, (own label brand orientation, the brand is oriented on custom production); sign of origin (yes, no),
form on market orientation (technological, customer, competitor, planning orientation).
Pasta industry competition structure in the environment of the enterprise (atomistic, oligopolistic or bipolar), entrance and exit barriers (no, low, medium, high); dependence on supplier, (no, weak, mutual, subordinate, highly subordinated).
The rows of the table present the competitiveness factors while the columns stand for the numbers that represent the entrepreneurs.

With respect to the overall classification of the competition of domestic and foreign micro and small enterprises, it can be mentioned that domestic enterprises ' asset supply can be rated as low and medium, whereas foreign enterprises ' asset supply is high and near to Hungarian.On the supply chain's demand side, market scope typically lies near the place of residence and locally. The firmly subordinate and delegate groups are common for the domestic pasta market bargaining position, while the collective bargaining position is more usual in the international pasta industry. In the case of domestic companies, the degree of product differentiation is in the medium level, whereas the degree of product differentiation of foreign companies is between the small and medium values. Examining the characteristics of entrepreneurial strategy, domestic companies have a higher need for innovation compared to foreign firms.

Table 3. Comparison of the results of case studies

			Hungarian enterprises					Italian		Transylvanian		Moldavian	
Factors of competitiveness			1	2	3	4	5	6	7	8	9	10	11
1	Assets	Natural resources	low	low	low	medium	high	medium	high	medium	medium	low	medium
		Physical resources	low	low	low	medium	high	medium	high	low	medium	low	low
		Machines	medium	medium	medium	high	high	high	high	medium	medium	low	medium
		Investment	low	medium	medium	high	high	high	high	medium	high	low	medium
		Use of current assets	low	low	low	medium	high	low	high	low	high	low	medium
2	Supply chain, demand	Geographical limits of market	local	local	residence	national	abroad	residence	abroad	residence	local	residence	residence
		Market bargaining power	highly subordi-nated	subordi-nated.	subordi-nated.	mutual	mutual	mutual	mutual	subordi-nated	mutual	subordi-nated	mutual
		Product differentiation	low	low	medium	high	high	medium	high	medium	high	medium	low
3	Characteristics of entrepre-neurial strategy	Innovation	medium	medium	high	high	high	medium	high	medium	high	medium	low
		Branding	own label	own label	own label	own label	own label	own label	own label and trade		own label, and trade	own label	own label
		Sign of origin	yes	no	yes	yes	no	no	yes	no	yes	no	no
		Marker orientation	technol.	compet.	planning	compet.	customer	compet.	customer	technol.	customer	technol.	competi-tor.
		Competition structure	atomist.	atomist.	atomist.	atomist.	oligopoly.	atomist.	oligopoly	atomist.	atomist	atomist.	atomist.
4	Entrance barriers		high	high	high	high	high	high	high	medium	medium	medium	low
	Exit barriers		high	high	high	high	high	high	high	medium	medium	medium	low
5	Supply chain	dependence on supplier	mutual	mutual	mutual	mutual	no	mutual	no	weak	mutual	weak	mutual

Source: author's own editing based on own research

Own brand strategy is the most characteristic of the commercial brands both in Hungary and abroad. Examining the business focus of the organization strategy, we see the implications of the high concentration of the pasta industry in Hungary, together withtechnological orientation, competitor orientation, producer orientation as well as consumer orientation.

CONCLUSION

I have examined the competitiveness of the Hungarian and foreign entrepreneurs. I have identified the success and failure factors of the competitiveness of micro-entrepreneurs. I have proved that the networking activity of pasta manufacturers is intensifying. The emerging horizontal networking ranging from the research institute via the farmland to the table, the vertical networking, rural tourism, hospitality, and networking on local values have already begun.

Recommendations for utilising the research

The significance of the research is that it will bring economic benefits not only to domestic, small, rural and micro entrepreneurs, but also to local micro-region developers and decision-makers.

Recommendation 1: It is recommended to extend the horizontal and vertical business relations to pasta manufacturers, in the direction of tourism, rural tourism and other hospitality, as well as a variety of complementary activities.

Recommendation 2: To increase the competitiveness of micro and small businesses, I recommend product innovations that not only offer gluten-free and carbohydrate-poor dry pasta but also keep traditional homemade pasta products.

Recommendation 3: Rethinking and transforming old economic knowledge not only boosts its micro-region but also spreads to other continents as good practice. The key to this is human resources, which means a consistent economic commitment that is philosophically based and enjoys the trust of the local community.

At the end of the study I emphasize that if a local micro-region becomes depopulated, the local economic process can be reversed. The prerequisite for this is human resources, a leader who feels a call to the community of own label. The knowledge of the re-populated, micro-region is transformed and utilized by micro-enterprises on other continents. In the future, further research about the impact of human resources on local economic development is recommended.

REFERENCES

1. Camp, R. C. (1995) Business Process Benchmarking: Finding and Implementing Best Practices. ASQC Quality Press, 1995. pp. 464.
2. Chikán, A. – Czakó, E. (2009) Versenyben a világgal - Vállalataink versenyképessége az új évezred küszöbén. Akadémiai Kiadó, 2009.
3. Dalgic, T. (2006) Handbook of Nice Marketing, Principles and Practice. Best Business Book. Psychology Press
4. Doney, A. (2018) Worldwide pasta consumption on the rise. In: Food Business News 2018. 05. 25. Accesses 02 September 2019https://www.foodbusinessnews.net/articles/11886-worldwide-pasta-consumption-on-the-rise
5. Evans, A. (1994) Benchmarking: Taking Your Organization Towards Best Practice! Paperback – 1994. The Business Library (1994)
6. Jelentés (2016) 85/2016. (XII. 19.) FM rendelet A Magyar Élelmiszerkönyv kötelező előírásairól szóló 152/2009. (XI. 12.) FVM rendelet módosításáról
7. Komáromi, N. - Lehota J. - Szabó, Z. (2004)Marketing stratégiai típusok és csoportok szerepe, valamint a magyarországi borászatok. In: Gazdálkodás: Scientific Journal on Agricultural Economics, Károly Robert University College, vol. 48(3), pages 13-24.
8. Lakner Z. (2017) Az élelmiszer-ellátó hálózatok modernizációja. Budapest, 2017. MTA Doktori Értekezés.
9. Lukovics, M. (2008) Térségek versenyképességének mérése JATEPress Szeged. Accessed 01 March 2019 https://slideplayer.hu/slide/1976630/
10. Maharashtra, P. (2017) Pasta Industry Analysis. Foresight to 2023. Market Research Future published a Cooked Research Report (CRR) on Global Pasta Market- by Source (whole wheat, rice), Type (spaghetti pasta), form (dried and fresh), Functionality (gluten-free) and Region- Forecast to 2023. Accesses 05 November 2019 https://www.einpresswire.com/article/395408615/pasta-industry-analysis-growth-key-players-and-cagr-of-5-85-foresight-to-2023
11. Nagyné Molnár M. (2013) Területi versenyképesség. Debreceni Egyetem, Gazdálkodástudományok Centruma. Accessed 14 June 2018https://www.tankonyvtar.hu/hu/tartalom/tamop412A/2011-0029_de_terulet_es_tersegmarketing_elmelet/ch02s03.html
12. Noszkay E. (2017) Tapasztalatok a családi vállalkozások átörökítésének dilemmái kapcsán. In: Vezetéstudomány. Vol. XLVIII. 2017, 6-7. 64-72. pp.
13. Pasta Market Growth Report (2019) Market Research Future. Press Release by Size, Share, Global Industry Trends, Regional Analysis, Key Growth Drivers, Forecast Overview by 2023. Published: Oct 11, 2019 2:24 a.m. ET. Accessed 20 November 2019https://www.marketresearchfuture.com/reports/pasta-market-2428
14. Porter, M.E. (1998) On Competition. Harvard Business Review Book, Boston
15. Székelyhidi K. (2016) Pékáru, tésztafélék gyártása. In: A magyarországi élelmiszeripar helyzete és jövőképe. Agrárgazdasági Kutató Intézet. Budapest. 147-172. p.

BEHAVIOR OF CONSUMERS IN THE PASTA MARKET

ILONA **FEHÉR**

Szent Istvan University, Faculty of Economics and SocialSciences, SZIU Doctoral School of Management and Business Administration Hungary
e-mail: fehetili0223@gmail.com

ABSTRACT

I have been studying dry pasta consumer behaviour with the aim of making recommendations for micro and small businesses to boost their competitiveness. In 2019, a questionnaire was used to gather data on trends of pasta use. I wanted to know what kind of pasta customers reflected in their purchasing habits, and what kind of pattern in food preferences could be detected.
First and foremost, I studied the frequency of purchase of pasta customers and their willingness to pay premium prices, and then looked at the characteristics of pasta products. Among the abstract product features, I discovered the perception of the term "handmade". The research suggested that the market share of the commercial brands is projected to go up.
When researching the patterns of pasta products, I found a correlation between the properties of pasta products, according to which three factors of pasta products were drawn: the "free" pasta component, the mildly "fortified" pasta, and finally the "traditional" (many egg) pasta. Consumers who have completed the questionnaire may be divided into four clusters. Brand-Confidence-oriented - Manufacturer-Confidence-oriented, Fragrance-oriented preference group, and those who love slightly fortified products.
It is important for micro and small businesses to launch innovative products in the pasta market.

INTRODUCTION

The study is centred around in the pasta industry, with special regard to the impact of consumer behaviour.
Pasta has always played an essential role as staple food in the consumption of households around the world. The dynamic development of the pasta industry is evidenced by the fact that the global consumption of pasta has almost tripled since 1974. (Doney, 2018)
Regarding the trends in the global pasta market, growth is expected to be 5.85% between 2019 and 2023. The market is driven by the growth of the working population, the need for convenience foods and the changing consumer lifestyle. (Pasta Market Growth Report, 2019). As for the segmentation of pasta products, market growth is expected in functional food, organic pasta may dominate the market due to rising demand, and the market of chemical-free foods for health-conscious consumers is also increasing. (Maharashtra, 2017)

Trend research

An important part of consumer behaviour analysis is studying trends, which look at social phenomena that are rising dramatically today to support the economic actors' ' decisions. Thus, trend is the course of changes detected and reported. (Horváth-Füredíné 2008, p.123)
We discern between megatrends, trends and current trends in the literature. Megatrends or base trends, are emerging gradually, staying on for twenty, thirty years and impacting everyone in the long run. Trends have a medium-term influence, they do appear to be countertrends or trends again. Current trends are fashionable, they work for a short period and they will transform within a year. (Brávácz, 2015).
Megatrends have also emerged in food consumption, which are reflected in the concept of sustainable consumption. Ecological principles, healthcare standards, social and economic values form the foundation for consumer behaviour in the long term. (Popovics, Polenszki, Nótári, 2010. 87. old.)
Trends predicted in pasta sales. Of supermarket pastas, the sales of gluten-free increased the most. It almost tripled the conventional bread, winning a 41.3 percent market share. Ancient alternative cereals and rice as a pasta dough are more common than in the earlier period, but a major challenge is the lack of market awareness for producing alternative products.Producers can help with an effective marketing strategy, recipes, discount deals. Sales are rising in all gluten-free food categories. Quinoa (beetroot artificial cereal and close to couscous) is both free of gluten and high in protein. Mintel forecasts that in the future demand for traditional wheat pasta will increase in pursuit of high-quality, distinctive pasta and those with new and distinctive properties. (Shoukas, 2013)

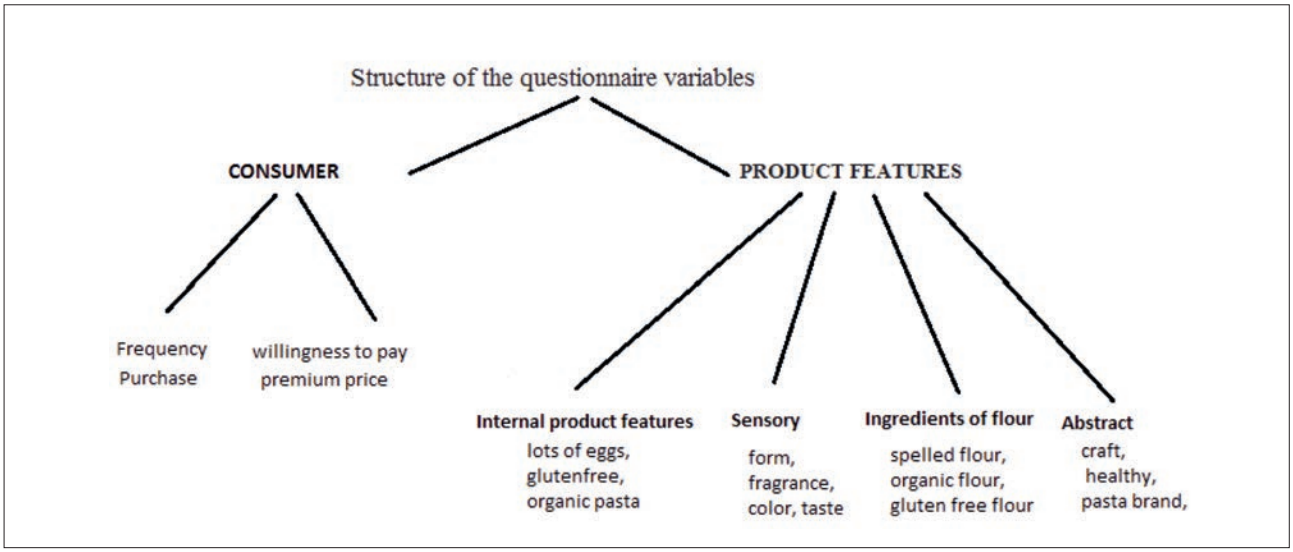


Figure 1. Source: author's own research

The aim was to analyse the behaviour of dry pasta consumers on the demand side of the pasta market by means of questionnaires.

The research revealed trends influencing consumer behaviour, and the primary research questionnaire contributed to the analysis of consumer behaviour. In line with the research objectives, I formulated the following hypotheses, hypotheses H1-H6 on the supply side of the pasta market:

H1The most frequent response to purchase frequency is expected to be "once a week" and "several times a week".

H2 The willingness to pay a premium for handmade dry pasta is low, one and a half times higher than for mass products.

H3 Pastas from plain flour and many eggs are most often expected to be very important, and few people are expected to consider "gluten-free" or "organic" dry pasta.

H4 Of the organoleptic characteristics, the shape of the dry pasta will be the most important and the smell will be the least important to dry pasta buyers.

H5 "Wholemeal flour" is expected to be preferred over "spelled flour", "gluten free" or "rice flour".

H6 It is expected that hand-made pasta will have a higher nutritional value meaning that they will also have healthier and more favourable organoleptic properties than mass-produced retail products.

MATERIAL AND METHOD

On the demand side, I received guidance from several similar studies on consumer behaviour (Lehota, Csíkné, Rácz, 2017) on risk-reducing consumer behaviour (Komáromi, Lehota 2016), consumer value systems in methods of researching consumer behaviour. (Lehota Zs, 2018. p. 90). and research on expected consumer trends (Shoukas, 2013) as well as emotionally based product differentiation (Shepherd, Raats, 2006). The consumer questionnaire (n = 118) was analysed with SPSS 16.

It can be stated from the sample that it is not representative, but it can still be used in the research because it is suitable of exploring new results. Finally, an online consumer questionnaire was completed in 2019. (n = 118) This is how the research material was compiled. (Figure 1)

RESULTS

Analysis of consumer behaviour, the statistical processing of the questionnaire

This chapter analyses the buying habits of pasta consumers and the product characteristics. The questionnaire was compiled to reveal the pasta buying habits as well as identifiable product characteristics and pasta consumption segments. The variables inform us about frequency of buying habits (H1). The willingness to pay the premium price is relative to the retail prices (H2). First, the variables describing the direct properties of the pasta products were examined (H3). Then, the group of flour ingredients was considered. (H4) I asked about the organoleptic characteristics of the product (H5), the taste, smell, shape and colour of the pasta were also analysed.

The description of the term "handmade pasta" (H6), the "healthy pasta" and the spontaneous mentioning of the brand followed.

Descriptive statistical analysis

In my first analysis, I inquired about buying habits, volume of purchase, frequency, and location of purchase.

Customer responses revealed that dry pasta was staple food as almost everyone consumes it. (95%) In contrast, only one-quarter of the respondents (22%) require stuffed pasta.

It is clear from the volume of the purchase that 43% of the respondents consume 1 kg dry pasta per month and 65% do not consume any stuffed pasta at all.

Frequency of purchase is highlighted: examining H1

Regarding the frequency of purchase, it can be stated that typically 50% buys it on a monthly basis; 52% of the respondents do not buy stuffed pasta at all. (Table 1.)

Table 1. Consumer information variable (H1)

Questions	Highest frequency	Percent	Valid percent	Cumulative percent
How often do you take the dry pasta?	50% monthly	2.1	1.2	1.2
How often do you take stuffed pasta?	52% never	0.6	0.9	0.8
You would love to buy artisanal pasta?	40% very fond of	3.7	1.3	1.7
How much would you pay for it?	51% the same number	3.3	0.8	0.6

Source: Own construction based on own research results. Table. 2. ***Location of procurement***

H1 The most frequent response to purchase frequency is expected to be "once a week" and "several times a week". The hypothesis can be partially justified because in the case of dry pasta the frequency of purchase is 45% per week and 50% per month. This part of the hypothesis is confirmed. In the case of stuffed pasta, 51.7% do not require it at all. This part of the hypothesis has not been justified.

Willingness to pay premium price is highlighted: examining H2

The premium nature of pasta categories was measured by the willingness to pay the premium price. The willingness to pay a premium for handmade pasta is almost 40%, the same as for mass produced pasta products. (51%) (Table 2.)

H2 The willingness to pay a premium for handmade dry pasta is low, one and a half times higher than for mass products.

The willingness of the respondents to pay a premium price is low, they would not pay one and a half times more, but the value of a handmade product for a consumer is just as much as a mass-produced pasta product. So, the hypothesis was not confirmed.

Traditional and free variables of the direct product characteristics are highlighted: examining H3

34% would like to buy traditional 8 egg pastas in the order of preference for dry pasta product categories. The other categories of pasta are rejected to various degrees. They do not require pasta from quail eggs (81%), gluten free (67%), vegetable (56%), organic pasta (46%), low carbohydrate (42%), and durum pasta products (33%). (Table 3.)

H3 Pastas from plain flour and many eggs are most often expected to be very important, and few people are expected to consider "gluten-free" or "organic" dry pasta. Of the dry pasta categories, quail egg pasta (81%) is not required, gluten-free pasta was chosen by 67% and 46% opted for organic pasta. So, the hypothesis is confirmed.

Analysing organoleptic product characteristics are highlighted: examining H4

The characteristics of the products by eyesight, touching, smelling and tasting were investigated. The results showed that taste (67%) and shape (42%) are very important. The smell is a bit important, (28%), but the coloured nature is not at all important. (56%) (Table 4.)

Table 2. Location of procurement (H2)

(kg/month)	(%) n=118				
	big floor space business	*local small shop*	*local product market*	*other business*	*total*
1 kg	16	2	3	15	36
2 kg	8	0	0	4	12
3kg	6	4	2	6	18
Total	51	8	5	36	100

Source: author's own editing based onresearch results

Table 3. Traditional and free variables (H3)

	Highest frequency	Percent	Valid percent	Cumulative percent
8 egg noodles	34% with pleasure	3.3	1.5	2.2
organic pasta	46% not at all	2.3	1.4	1.9
gluten free pasta	67% not at all	1.8	1.3	1.8

Source: author's own editing based on research results

Table 4. The organoleptic characteristics of the product (H4)

Variables on product valuation	Highest frequency	Percent	Valid percent	Cumulative percent
shape	42% *very important*	4,0	1,2	1,4
taste	67% *very important*	4,4	1,1	1,2
fragrance	28% *less important*	3,5	1,2	1,6
colour	56% *not at all important*	2,0	1,3	1,6

Source: author's own editing based on research results

H4 Of the organoleptic characteristics, the shape of the dry pasta will be the most important and the smell will be the least important to dry pasta buyers.
According to the respondents, the shape of the pasta is very important, but the taste is even more important. The least important is the smell of the product. The hypothesis is confirmed.

Analysing the flour base of dry pasta is highlighted: examining H5

Pasta made from plain wheat flour is a bit important, and whole wheat flour (31%), spelled flour (30%) is not important. Not at all important factors are glass pasta flour (47%), gluten-free flour (46%) and rice flour (41%), as well as whole grain spelled flour. (29%). (Table 5.)

Table 6. Abstract Product Feature: "Craft Product" (H6)

Aspects of analysis	number of respondents/people	Frequency of response (%)
making technology	44	28.38
small scale business	11	7.10
quality characteristics	28	18.06
composition	20	12.90
sensory property	26	16.78
consumer costs	7	4.52
other property	19	12.26
all answers	155	100

Source: author's own editing based on research results

Table 5. The wholemeal-flour base (H5)

Variables on product valuation	Highest frequency	Percent	Valid percent	Cumulative percent
wheat flour	28% a little important	3.3	1.4	1.9
wholegrain flour	31% a little important	3.1	1.4	2.0
spelled flour	30% indifferent,	2.8	1.3	1.8
wholegrain spelled	29% not at all important	2.7	1.4	2.0
gluten free flour	46% not at all important	2.1	1.2	1.5
rice flour	41% not at all important	2.1	1.2	1.4
cellophane noodles	47% not at all important	1.9	1.1	1.2

Source: author's own editing based on research results

H5 "Wholemeal flour" is expected to be preferred over "spelled flour", "gluten free" or "rice flour".
Whole wheat flour is slightly important (31%), spelled flour is indifferent, gluten-free flour is not at all important, rice flour and glass pasta are rejected. The hypothesis is confirmed.

Analysing handmade pasta products of the abstract characteristics is highlighted: examining H12

Most people think that 'handmade pasta' is a product made by hand (28%), has a high nutrient content (18%) and its organoleptic properties are important. (17%).(Table 6.)
H12 It is expected that hand-made pasta will have a higher nutritional value meaning that they will also have healthier and more favourable organoleptic properties than mass-produced retail products.
The definition of "handmade", according to consumer perception, is a product made exclusively by hand, a high nutritional value is attributed to it with a better organoleptic quality than mass products. The hypothesis was confirmed.

Evaluation of the correlation between several variables

During the analysis of product properties, I wanted to know to what extent the preference of different types of pasta was typical of the questionnaire respondents. I revealed this by factor analysis, while I measured the relationship between the variables with seven variables (Table 7).
Based on the calculations, there are three factors that show the correlation with the original variables.
• Chemical-free pasta is the most popular. Low carbohydrate (0.67), gluten-free (0.63) and organic dry pasta (0.50) were grouped.

Table 7. Correlation characteristics of dry pasta products, factor analysis

	Factor 1 „Free pasta"	Factor 2 „Fortified pasta"	Factor3 „Traditional pasta"
reduced carbohydrate	0.669	-0.251	0.071
gluten free	0.635	-0.415	0.347
organic pasta)	0.506	0.046	0.494
eight egg-pasta	-0.495	0.333	0.594
fortified with vegetables	0.504	0.695	-0.033
quail egg noodles	-0.36	0.455	0.575
durum pasta	0.491	0.489	-0.515

Source: author's own editing based onresearch results

• The group of "fortified" pasta consists of coloured pasta (0.69) enriched with vegetables and pasta made from durum flour (0.48).
• 'Traditional 'pasta (0.45) consists of eight-egg dry pasta groups. According to the role of variables in the context model, 'traditional' has the highest value in Factor 3 (61.5%), 'Enriched' in Factor 2 (43.6%), and finally, 'Free' in Factor 1 has a value of 23, 1%, respectively.

Cluster analysis in the light of demographic variables

To characterize consumer segments, demographical data were compared with the three clusters, and then looked for the relationship between clusters and product categories: between clusters and product properties, and finally clusters and additives.
• "Leading intellectual, middle-aged women," the first consumer segment (n = 61) includes women in the capital aged 31-50 who have graduated from university.
• "Rural Working Men" is the second cluster (n = 36) consisting of small-town men aged 31-50 with a certificate from secondary school.
• "Intellectual Women from the capital" (n = 21) are college graduates, 41-50 years old living in the capital.

Cluster analysis in the light of product characteristics (Table 8.)

Based on the preference order of product characteristics, I wanted to know what type of consumer segments can be identified by organoleptic (shape, taste, smell, colour) and external (packaging, brand, manufacturer) rankings. Based on the properties of the pasta products, the test sample can be divided into the following segments:
• The brand-trusted (n = 61) preference group (fourth cluster) chooses pasta based on the external product attributes and is least interested in the vegetable-enriched coloured pasta of the internal product attributes.
• For the manufacturer-trust (n = 29) preference group (first cluster), the external product characteristics are decisive when making a choice, but packaging is less appreciated.
• For the fragrance-centred preference group (n = 14) (second cluster), the intrinsic property of the product is important, but the product brand of the external attributes is less appreciated.

Table 8. Characterization of consumer segments

n=118	Cluster 1 *trust inthe brand*	Cluster 2 *Confidence in the manufacturer*	Cluster 3 Scent lovers	Cluster 4 colourfulpasta lovers
component number	29	14	14	61
shape	3.52	4.36	2.29	4.46
taste	4.45	4.79	2.36	4.69
fragrance	2.97	4.00	1.86	3.95
colourpasta	2.28	3.64	1.93	1.69
packaging	1.79	2.00	1.50	3.87
brand	3.31	1.78	1.43	4.25
manufacturer	3.48	2.29	1.57	4.11

Source: author's own editing based on research results

Table 9. Summary of hypothesis testing	
H1 The most frequent response to purchase frequency is expected to be "once a week" and "several times a week".	Partially confirmed
H2 The willingness to pay a premium for handmade dry pasta is low, one and a half times higher than for mass products.	Rejected
H3 Pastas from plain flour and many eggs are most often expected to be very important, and few people are expected to consider "gluten-free" or "organic" dry pasta.	Confirmed
H4 Of the organoleptic characteristics, the shape of the dry pasta will be the most important and the smell will be the least important to dry pasta buyers.	Confirmed
H5 "Wholemeal flour" is expected to be preferred over "spelled flour", "gluten free" or "rice flour".	Confirmed
H6 It is expected that hand-made pasta will have a higher nutritional value meaning that they will also have healthier and more favourable organoleptic properties than mass-produced retail products.	Confirmed

Source: author's own editing based on research results

• The fortified product consumer preference group (n = 14) (third cluster) prefers coloured pasta enriched with vegetables, but the packaging is not important for them. It is noteworthy that this cluster has a very low rating for all variables compared to other cluster variables. This may be due to the fact that they also consider different aspects when selecting pasta products.

Summary of hypothesis testing (H1-H6)

Summarising the research was started with reviewing the hypotheses test followed by the new and novel scientific achievements (Table 9).

DISCUSSION

Result 1: Results of consumer behaviour

I have examined the behaviour, frequency, quantity, location, and willingness to pay the premium price at purchase, and then the characteristics of the pasta products. I have concluded that one kilogram a month is bought from large shops by female shoppers. I have proven that consumers are generally not willing to pay a premium price. I have distinguished three consumer segments: the first is made up by the 31-50-year-old female college graduates in the capital (n = 61), the second comprises the 31-50-year-old college graduate males in small towns (n = 36), and the third a group is of 41-50 year old women college graduates living in the capital. (n = 21)

Result 2: Results of pasta product characteristics

I have examined the properties of pasta products and found that the selection of pasta from smooth flour and many eggs has the most significant effect. I have proved that the shape of pasta products is the most important of the organoleptic properties. I have found that 'hand-made pasta' is a product made by hand with a high nutritional value. I have concluded that domestic pasta brands are more in demand than retail pasta brands, and the popularity of commercial pasta brands are on the rise.

I have also examined the correlations with the consumer demographic data by factor analysis. I have concluded that the most significant product group is the "free" (carbohydrate, gluten) and the "fortified" (with vegetable, durum flour) the third is the "traditional" (eight-egg) pasta products.

I have analysed the supply of products according to their organoleptic and external properties. I have found that four clusters were distinguished: the brand-oriented (n = 61), characterised mostly by external product attributes. The other is the manufacturer-oriented cluster (n = 29), which is mainly influenced by external product characteristics. The third is fragrance-centric (n = 14), the effect of the internal characteristic is strong. The fourth group is those who like fortified products (n = 14) and are influenced by coloured pasta.

CONCLUSION

Recommendations for utilising the research

Recommendation 1: To increase the competitiveness of micro and small businesses, I recommend product innovations that not only offer gluten-free and carbohydrate-poor dry pasta but also keep traditional homemade pasta products.

Recommendation 2: It is recommended to extend the horizontal and vertical business relations to pasta manufacturers, in the direction of tourism, rural tourism and other hospitality, as well as a variety of complementary activities.

Recommendation 3: In the case of pasta consumption, an increase in pluralized trends can be noticed, i.e., following the opposite value orders. The consumer behaviour of dry pasta, according to the respondents to the questionnaire, is based on the following stratification: "Who like free products" go for gluten free and low carbohydrate dry pasta", "Those who like traditional products" prefer

traditional 8-egg homemade pasta. The "Enriched Pasta Consumers" like durum pasta enriched with colourful vegetables.

The significance of the research is that it will bring economic benefits not only to domestic, small, rural and micro entrepreneurs, but also to local micro-region developers and decision-makers.

REFERENCES

1. Brávácz, I. (2015) Az élelmiszerfogyasztói magatartás két dimenziója, egészség-, és környezettudatosság. PhD értekezés. Gödöllő, 2015. Gazdálkodás-, és Szervezéstudományok Doktori Iskola.
2. Doney, A. (2018) Worldwide pasta consumption on the rise. In: Food Business News 2018. 05. 25. Downloaded 02 September 2019 https://www.foodbusinessnews.net/articles/11886-worldwide-pasta-consumption-on-the-rise
3. Horváth, Á - Fodor M. – Füredíné, K. A. – Rácz, G. (2012) Fogyasztói magatartás. Perfekt Gazdasági Tanácsadó, Oktató és Kiadó Zártkörűen Működő Részvénytársaság.
4. Komáromi, N. - Lehota J. - Szabó, Z. (2004) Marketing stratégiai típusok és csoportok szerepe, valamint a magyarországi borászatok. In: Gazdálkodás: Scientific Journal on Agricultural Economics, Károly Róbert University College, vol. 48(3), pages 13-24.
5. Lehota Zs. (2018) A hazai élelmiszerellátási lánc elemzése, különös tekintettel a fogyasztói kockázatokra. PhD Értekezés, SZIE, Gazdálkodás és Szervezéstudományok Doktori Iskola, Gödöllő.
6. Lehota, J. – Csíkné M. É. – Rácz, G. (2017) Az egészségtudatos élelmiszer-fogyasztói magatartás értelmezése a LOHAS koncepció alapján. Táplálkozásmarketing. 2014. 1. (1-2) 39-46.old.
7. Maharashtra, P. (2017) Pasta Industry Analysis. Foresight to 2023. Market Research Future published a Cooked Research Report (CRR) on Global Pasta Market- by Source (whole wheat, rice), Type (spaghetti pasta), form (dried and fresh), Functionality (gluten-free) and Region- Forecast to 2023. Downloaded 05 November 2019https://www.einpresswire.com/article/395408615/pasta-industry-analysis-growth-key-players-and-cagr-of-5-85-foresight-to-2023
8. Pasta Market Growth Report 2019 Market Research Future. Press Release by Size, Share, Global Industry Trends, Regional Analysis, Key Growth Drivers, Forecast Overview by 2023. Published: Oct 11, 2019 2:24 a.m. ET. Downloaded 20 November 2019: https://www.marketresearchfuture.com/reports/pasta-market-2428
9. Popovics A - Polereczki Zs. - Nótári M. (2010) A fogyasztói magatartás sajátosságai a hagyományos és tájjellegű élelmiszerek piacán.82-96. old. In: Marketing a hagyományos és tájjellegű élelmiszerek piacán. Szerk.: Szakály Z. - Pallóné Kisérdi I. - Nábrádi A. Kaposvári Egyetem Gazdaságtudományi Kar.
10. Shepherd, R. Raats, M. (2006) The psychology of food choice. Frontiers in Nutritional Science, No. 3. The Nutrition Society
11. Shoukas, D. (2013) Mintel announces 2013 foodservice trend predictions. In: Food and Drink. January 08th, 2013. Mintel reports store. Specialty Food Magazine. Categories: Trends and Statistics; Industry Stats. 2013/06/24.

GRASSLANDHU

LIFE IP

GRASSLAND-HU

Long term conservation of Pannonian grasslands and related habitats through the implementation of PAF strategic measures

www.grasslandlifeip.hu
grassland@hoi.hu
fb.com/grasslandlifeip
+36 / 1 36 28 100

NATURA 2000

Life

With the contribution of the LIFE Programme of the European Commission (LIFE17 IPE/HU/000018)