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FOOD LOSS ANALYSIS

Theses

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CONTENTS

1. INTRODUCTION 1

2. CONCLUSIONS FROM LITERATURE DATA.....3

3. OBJECTIVES 5

4. DATA, CALCULATIONS AND RESULT 6

5. ARTICLES CONTAINING ANSWERS TO THE RESEARCH QUESTIONS ..9

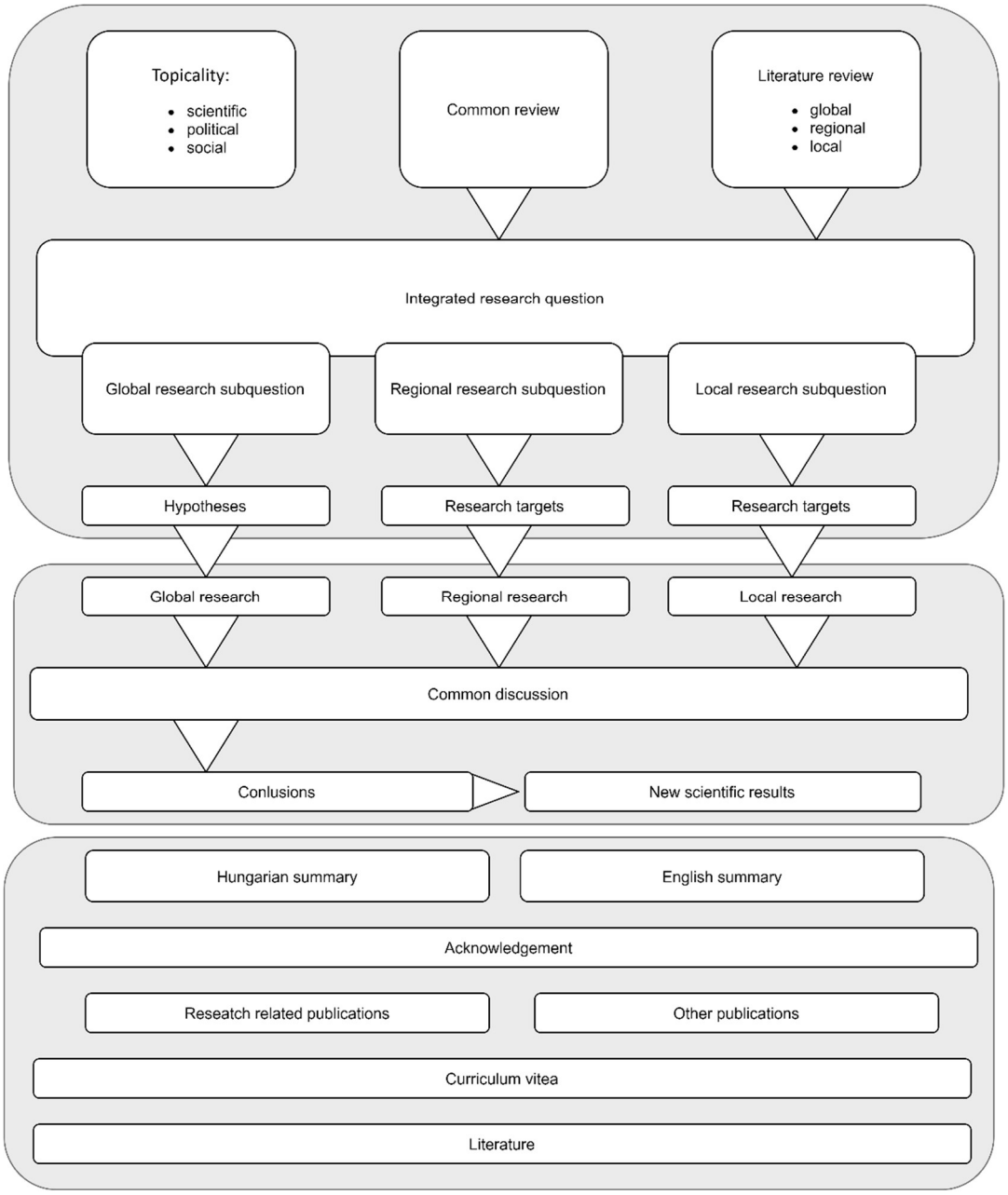
6. CONCLUSIONS.....10

7. NEW SCIENTIFIC RESULTS.....12

8. SUMMARY 13

9. PUBLICATIONS RELATED TO THE TOPIC OF MY THESIS.....15

10. BIBLIOGRAPHY 18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Common discussion
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New scientific results
Hungarian summary
English summary
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Reseatch related publications
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Motto:

'... the greatest public evil of the 21st century is unsustainability'.

[Prof. Dr. Gergely Tóth]

1. INTRODUCTION

I was still in secondary school when I already noticed the unsustainability of the industrialising agriculture of the 1970s and the nature-consuming development of agriculture. At university, it was systematically brought to my attention as part of my environmental studies. Specifically, in Budapest, in the mid-2010s, I was so much struck by a dairy product being transported from the dairy to a sewage treatment plant that I chose food loss analysis as the subject of my research.

In my thesis, I consider food-loss the food that becomes waste, i.e. food that is at most used for energy production, but typically is rather composted, landfilled or destroyed.

When drawing up the Research Plan,

- the scientific topicality of the subject could be defined by the fact that the number of articles on the topic published on ScienceDirect by the end of September 2017 (1,171) was almost four times the number of articles published in 2012 (473). Four years have passed since then, and by September 2021, the number of articles on the topic will have increased by another order of magnitude (to 15,666),

- the political relevance of the subject became manifested in that the new, revised Common Agricultural Policy (CAP) set the objective of eliminating food waste[1] and in the EU Action Plan on the Circular Economy a chapter on reducing food waste and raising awareness[2] of it was included,

- the social relevance of the subject was reflected in the growing public interest in the stand of NÉBIH (National Food Chain Safety Office) at OMÉK (National Agricultural and Food Exhibition and Fair) in 2017 and the popularity of the

[1] Official Journal of the European Union, HL C 288., 2017.8.31., p. 75–80.
[2] Official Journal of the European Union, HL C 88., 2017.3.21., p. 83–90.

NÉBIH's "No Leftovers" campaign, which has since grown thanks to the continuous development of the campaign's website[3].

The drive to reduce food waste probably goes back to prehistoric times, with the earliest scientific paper on the subject dating back well over a century was published in the US. In his book published in 1895 [1], Atwater describes how a visual inspection of residential garbage bins in New York City revealed large amounts of food purchased and discarded in the living quarters of the better-off, and less in the living quarters of those on modest incomes. As early as 1910, it was also he who quantified that 10-14% of food in school clubs was wasted, and as much as 25% in institutions [2].

It was during the food shortages of the Second World War that science turned to the study of loss reduction options [3], the factors of which are summarised in Figure 1:

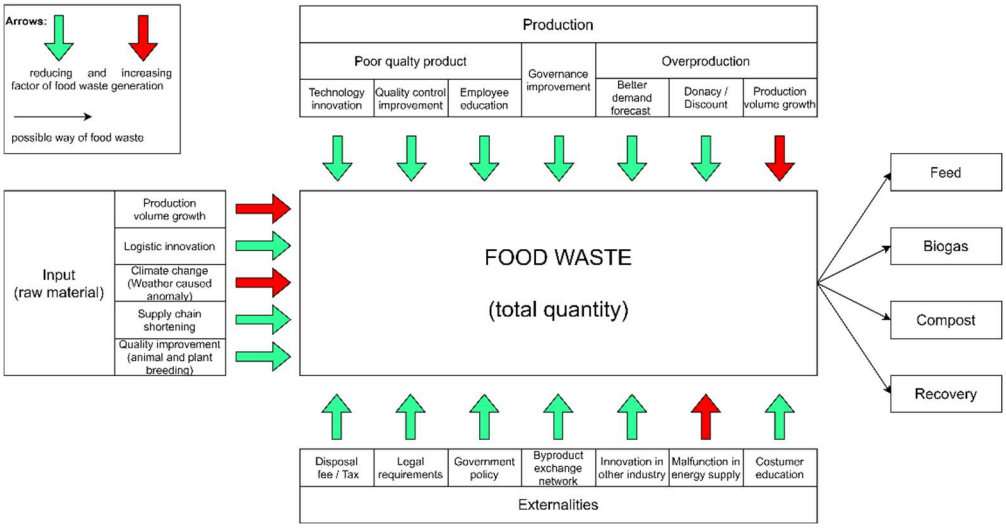

Figure 1 Factors affecting food waste (Source: own ed.)

[3] https://maradeknelkul.hu/

2. CONCLUSIONS FROM LITERATURE DATA

In this thesis I have only presented in a nutshell the literature on global - regional - local research. In general, the rationale for the research on this topic is that the literature suggests that SDG 2 and SDG 12.3 will not be met by 2030.

The preparation of the global survey revealed methodological gaps in food loss estimation, leading to inconsistent data, mainly due to differences in definitions. According to sociological studies, the main cause of famine is poverty, not the unavailability of food. In my review of scientific publications, I did not find data on how much food overweight and obese people consume above their physiological needs or how much food is needed to end famine.

Statistical data collected from different perspectives in EU countries show inconsistencies of an order of magnitude. The reason for this is that the definitions used are adapted to the purpose of the survey. All the indices used to express the reduction in food loss have been severely criticised.

In my review of waste generation in Hungary, I found differences of magnitude between the data in the available sources, likewise due to the use of different definitions.

On this basis, I formulated the following research question:

How much food waste is actually generated in the whole food chain, do consumers really waste most of the food, and what are the main causes of food waste and what are the ways to reduce it?

This research question can be broken down into three sub-questions:

i) How much food is missing to end famine (global research?)

ii) What are the correlates of food loss within the European Union (regional research)?

iii) Can inconsistencies in food loss data be eliminated by reviewing the definitions used in the data collection? (Local research)

In answering these questions, I expect to be able to

- give an accurate picture of the quantitative proportions of food loss and food shortage,

- provide a method for evaluating the effectiveness of policy measures,

- clarify the reasons for the differences and the real quantities by comparing the definitions used in food loss assessments.

The theoretical background of my work is to contribute to the clarification and implementation of the actions needed to meet SDG 2 and SDG 12.3.

3. OBJECTIVES

A consistent use of terminology is a basic requirement for theses. In this chapter, however, I will partly formulate hypotheses and partly define research objectives, in line with the vocabulary used in scientific publications presenting the results of the research.

3.1 Global research hypotheses

i) The current trend of famine reduction is not enough to end famine by 2030.

ii) Less than half of the food loss would be sufficient to end famine.

3.2 Objectives of the regional research

i) To analyse food loss definitions in order to interpret the data.

ii) A comparative analysis of the 2010-2018 data (correlation, trends, significance).

iii) Search for correlation with other indices (GDP and HDI).

iv) Finding a new index that can be used as a better SDG 12.3 indicator than the current one.

v) Characterisation of food losses in the 28 EU Member States with the new index.

3.3 Objectives of local research

i) To analyse and compare definitions of food waste.

ii) To identify the reasons for the differences and eliminate inconsistencies in the data by reviewing the types of waste taken into account in the summary of the data.

4. DATA, CALCULATIONS AND RESULT

4.1 Global research[4]

By visualising data from the WHO Global Health Observatory database, it can be seen that the current trends will not meet SDG 2 in order to end famine by 2030. In 2016, the proportion of people who were thin was the 10.7% of the population, and the proportion of people who were undernourished was 9%. My calculation is that to end famine and meet SDG 2, the number of people who are hungry or undernourished will need to fall 2.5-3 times faster by 2030.

In my analyses, I calculated an average physiological nutrient requirement of 11460 kJ/day/person and a protein requirement of 56 g/day per person. From FAOSTAT data I calculated that nearly nine times more food is consumed in the world above the physiological needs than would be sufficient in nutritional terms to end famine in Africa.

I calculated how the nutrient content of total cereal losses compares to the amount needed to end famine in Africa. Of the total cereal crop, 143 138 000 tonnes were wasted, which is 11% of the amount consumed and almost eight times the food deficit in Africa.

By reviewing the quantities consumed, I have calculated the ratio of the six main food items consumed and lost. The per capita loss calculated from the consumption/loss ratio is 989 kJ/day/person, while the consumption is 574 kJ less per person per day than the physiological need. Finally, the loss of cereals per continent was calculated. I found that compared to a loss of 1.9% in Europe, Africa has a loss of 9.1%.

4.2 Regional research[5]

Food losses from different sources can be interpreted only if we know the definitions found during the data collection.

[4] This chapter was written on base of article „Towards Food Justice – The Global-Economic Material Balance Analysis of Hunger, Food Security and Waste".
[5] This chapter was written on base of article „FOOD WASTE LOSS TREND INDEX (FWLTI), A NEW TOOL TO ENABLE MANAGEMENT DECISIONS".

I have downloaded the ’Generation of waste-by-waste category, hazardousness and NACE Rev. 2 activity [ENV_WASGEN$DEFAULTVIEW]’ data set from the EUROSTAT database. I used the data for ’Animal and mixed food waste’ (W09.1) and ’Vegetal wastes’ (W09.2) for my calculations. I have combined them and will refer to them hereafter as TCCW: Total Consumption Chain Waste (TCCW).

I have downloaded the ‘Food Balances for Europe’ database from the FAOSTAT database and will refer to them hereafter as FSCL: Food Supply Chain Loss (FSCL).

FAOSTAT and EUROSTAT use such a different methodology that their data, TCCW and FSCL, are not comparable and form two different trends. The increase in TCCW is not significant at 95% and the decrease in FSCL is significant at 95%.

There is a medium, linear correlation between GDP and TCCW (r = 0.46 - 0.51) and a very weak, inverse correlation between GDP and FSCL (r = -0.14 - -0.27).

There is a medium straight line correlation between HDI and TCCW (r = 0.55 - 0.59), and a very weak correlation between HDI and FSCL, close to zero (r = -0.01 - -0.12), the latter being considered to be uncorrelated. It can be concluded that TCCW is more strongly correlated with HDI than with GDP.

To compare the trends, I have created a new index (Food Waste Loss Trend Index), which I will refer to as FWLTI (Food Waste Loss Trend Index)

This index is the coefficient "x" in the linear trend line equation. Thus, each country is characterized by two numbers, the TCCW and the FSCL trendline, showing the direction and slope of change. The analysis of FWLTI is done by scatter plot and cluster analysis.

4.3 Local research[6]

In the analysis of food loss in Hungary, I looked at the years 2006, 2011, 2016 and 2018.

According to the AKI report [4], EUROSTAT estimates that 1.86 million tonnes of food waste was generated in Hungary in 2006, of which 62%, 1.15 million tonnes, was generated by the manufacturing industry, with the remainder being generated by households, wholesale and retail trade and catering. This compares with 2006 data

[6] This chapter was written on base of article „A változatosság gyönyörködtet? – Élelmiszer-veszteség a magyarországi feldolgozóiparban”.

for Hungary from other domestic statistical data sources and from the OECD and FAOSTAT websites. There are therefore no inconsistencies in the data, in 2006 the per capita food loss in the manufacturing sector in Hungary was more than 31.6 kg.

The AKI report also includes data for 2011, but for this year there is not as much data available for comparison from other sources as for 2006. In 2011, 566 000 tonnes of food waste was generated in Hungary in the agricultural, processing and consumption phases, of which 51% (289 000 tonnes) came from the processing industry. According to the FAO, however, 454 000 tonnes were generated. The difference is explained by the fact that FAO data include waste generated in the supply chain.

2016 is the last year for which sources are still available that can be compared with the data in the OKIR (National Environmental Information System). According to the national system, the total amount of 02-code[7] waste for this year was 835 681 tonnes. Of this, 405 071 tonnes were generated in the manufacturing sector, out of which 119 365 tonnes (12.0 kg/person/year) was food waste. This quantity is in line with EUROSTAT data.

The lower figures compared to previous years are not exclusively due to less waste being generated in 2016. In 2006, the TEÁOR'03 (Standard Sectoral Classification of Activities) was still in force in Hungary and, according to this, economic operators reported the amount of waste generated to the OKIR, and the KSH (Central Statistical Office) provided data to EUROSTAT (as stated on its website)[8]. The very same CSO brochure also establishes that ’from 2012 the CSO publishes data only according to TEÁOR'08 for all relevant statistics’.

The most recent available data source on this topic is the 2018 OKIR, which shows a per capita consumption of 12.3 kg in 2018, down from 31 kg in 2006. This is in line with the 2016 figure.

[7] 72/2013. (VIII. 27.) VM regulation, annex 2., waste main groups, subgroups, types (valid from 01.01.2016.).
[8] https://www.ksh.hu/docs/osztalyozasok/teaor/teaor_rovid_leiras.pdf

5. ARTICLES CONTAINING ANSWERS TO THE RESEARCH QUESTIONS

5.1 Global (every country):

Tóth, G.; Zachár, J. Towards Food Justice – The Global-Economic Material Balance Analysis of Famine, Food Security and Waste. Agronomy 2021, 11, 1324.

https://doi.org/10.3390/agronomy11071324

Academic Editors: David W. Archer and Rosa Maria Fanelli

1 independent quoter (2022.04.17.): Journal of Water and Land Development, 2021

5.2 Regional (EU28):

Zachár, J. (2021). FOOD WASTE LOSS TREND INDEX (FWLTI), A NEW TOOL TO ENABLE MANAGEMENT DECISIONS. Business Ethics and Leadership, 5(3), 47-60.

https://doi.org/10.21272/bel.5(3).47-60.2021

5.3 Local (Hungary):

Zachár János – Tóth Gergely, A változatosság gyönyörködtet? – Élelmiszer-veszteség a magyarországi feldolgozóiparban STATISZTIKAI SZEMLE 99: 8 pp. 783-808. , 26 p. (2021)

https://doi.org/10.20311/stat2021.8.hu0783

6. CONCLUSIONS

6.1 Conclusions from the global research findings

(i) In 2017, cereal losses in countries around the world represented nearly nine times more nutritional value than the shortfall compared to the physiological need in Africa.

ii) The protein consumed in food met the physiological need in all continents in 2017.

iii) Grain loss in 2017 was 1.9% in Europe compared to 9.1% in Africa.

iv) The nutritional value of food loss in Africa in 2017 was double the deficit. So the food that is lacking for vital needs is there in Africa, it should not be sent there as aid, but poverty reduction and storage infrastructure improvements should be implemented.

(v) In 2017, the nutritional value of food consumed in the European Union in excess of the physiological need is more than enough to end hunger in Africa. I use this figure to demonstrate how little would be enough to meet the physiological need.

vi) Current trends show that, despite ambitious development goals, famine will not be eradicated from the planet by 2030.

To sum up, the two hypotheses of global research, namely that (i) hunger will not be eradicated by 2030, and that (ii) food loss is half of what is needed to meet physiological needs, have been confirmed.

6.2 Conclusions to be drawn from the results of regional research

i) The reason why the definitions used in food loss surveys are so diverse is that they are always adapted to the purpose of the data collection.

ii) There is no correlation between TCCW (Total Consumption Chain Waste) and FSCL (Food Supply Chain Loss) data, due to the fact that the former includes food losses in the population in addition to total industrial waste, while the latter is only the result of material flow calculations.

iii) Between 2010 and 2018, the increase in TCCW was not significant (at 95%), while the decrease in FSCL was significant (at 95%).

(iv) TCCW is more highly correlated with HDI than FSCL with GDP, which is presumably explained by the education component of HDI, but this requires further investigation to confirm.

(v) The Food Waste Loss Trend Index (FWLTI) is more accurate than other indices because it shows the trend from a time series, not just a ratio of two data.

vi) Cluster analysis and scatterplots cannot be used to group the 28 EU Member States - each country is a unique case.

To summarize the conclusions of my thesis: the research objectives have been met, the correlations have been demonstrated and a new index has been developed.

6.3 Conclusions to be drawn from the results of local research:

i) A regulation or standard similar to the Community Directive on WEEE could standardise definitions of food waste.

(ii) The reason for the discrepancies in food waste data from different sources can be identified and their inconsistencies eliminated by reviewing which waste streams are aggregated by each source in the calculations.

To sum up the conclusions, the research objectives have been met, because by analysing the inconsistent data I have identified the causes of the discrepancies and calculated the real food losses in the Hungarian manufacturing industry.

7. NEW SCIENTIFIC RESULTS

1. The cause of hunger in Africa is not the volume of food production, but the high rate of losses and poverty.

2. There is no correlation between TCCW (Total Consumption Chain Waste) and FSCL (Food Supply Chain Loss) data, which is due to the fact that the former includes food losses in the population in addition to total industrial waste, while the latter is only the result of material flow calculations.

3. The Food Waste Loss Trend Index (FWLTI) is more accurate than other indices because it shows the trend from a time series, not just a ratio of two data. It can be used to identify and compare food waste trends in countries and to evaluate the effectiveness of projects, policies and action plans.

8. SUMMARY

Sustainability has become a central issue for the human mankind (1. UN Millennium Development Goals, 2. Sustainable Development Goals). There is neither political nor scientific consensus on the root cause of unsustainability, nor on the solution. Furthermore, the immense inequality between individuals and groups of people, extreme poverty and famine are the most important problems. It is often said that with a better (fairer) distribution the Earth could support considerably more people than it does now.

Others use hunger and poverty data to justify the need to increase food production. I have tested the former claim with real data, but from a theoretical approach: is it theoretically true that the food produced, if a significant proportion of it did not become waste, would be sufficient to feed people in extreme poverty and hunger, i.e. would we avoid deaths from hunger? The causes of food loss vary from one ecosystem to another, so their analysis requires different approaches in different countries. The triadic relationship between obesity, hunger and food loss has not yet been explored in a structured research and only scattered data are available. As a first step, I intend to map the global food supply, the most worrying area of modern bioeconomics. Global thinking is the first step towards a fairer distribution of food, and through this, towards achieving the SDGs.

The issue of food loss has been put on the agenda of many public and international organisations as a means to achieve food security and sustainability, which can lead to the achievement of SDG 12.3, halving food loss by 2030.
The SDGs are not declared in law, they are not necessary for the profitability of the food industry, but we have a moral obligation to achieve them.
I have analysed the definitions of food loss to see clearly the reason for the difference between the data from EUROSTAT and FAOSTAT, and then have compared them with data from other sources. I have found that the reason for the differences in definitions lies in the purpose of the data collection - the definition that best serves the purpose of the data collection is always used within the methodology. I have compared TCCW and FSCL data for the period between 2010 - 2018. I have found such a weak correlation that it can be concluded that there is no correlation between these two indicators and they should be analysed separately. TCCL show an increasing trend which is not significant at 95% and FSCL are decreasing and significant at 95%. TCCL is moderately correlated with HDI and GDP.

I have developed a new tool that I propose to use to test the achievement of SDG 12.3. This is the Food Waste Loss Trend Index - FWLTI, and I have calculated it for the EU28 Member States and then have tested it using cluster analysis and a scatter plot. I have found no clustering factor between the member countries, from which I have concluded that there is no common sorting principle, each country is a unique case.
The figures reported in food loss publications often differ by an order of magnitude. For Hungary, I have looked at the reasons for these differences, from data reporting to definitions. In the context of the report 'Causes of food losses, their management and perception among processing companies', published by the National Agricultural Research and Innovation Centre at the end of September 2019, I have reviewed the definitions of food waste that becomes food losses, looking beyond scientific publications to a wider range of sources (legislation, standards, best available techniques).

I have summarised in a table what different sources consider food waste, and have shown that the seemingly inconsistent waste generation data are actually due to different classifications of waste types. I have interpreted and compared the statistical data and finally have deduced why it is realistic to consider that 12.3 kg/person of food waste was generated in the processing industry in Hungary in 2018.

9. PUBLICATIONS RELATED TO THE TOPIC OF MY THESIS

1. Zachár J.: Úton a körforgásos gazdaság felé: „zéró hulladék” program Európa számára, Lépések, Budapest, 2018. Vol. 71. p. 16.

MTMT: 31992961

2. Zachár J.: Zöld foglalkoztatás, Lépések, Budapest, 2018. Vol. 72. p. 18-19.

MTMT: 31992967

3. Ecker K., Zachár J. Az élelmezési paradoxon. Az élelmezésbiztonság és az élelmiszer-pazarlás globális összefüggései, Lépések, Budapest, 2018. Vol. 73. p. 18-19.

MTMT: 31992974

4. Zachár J.: Investigation of food waste formation, 60th Georgikon Scientific Conference Abstract Volume, Pannon Egyetem, Keszthely, 2018. p. 159. ISBN 978-963-9639-91-1

MTMT: 32059398

5. Zachár J.: Investigation of food waste generation, Georgikon for Agriculture, 2019. Vol 23(3). p. 2-24. HU ISSN 0239 1260

MTMT: 31348451

6. Zachár J.: Investigation of food waste generation by material flow, Abstracts of the International Conference on Sustainable Economy and Agriculture, Kaposvár University – Kaposvár – Hungary – 14th November 2019, p. 123. ISBN 978-615-5599-72-9

MTMT: 32059424

7. Zachár J.: Investigation of food waste generation by material flow, 61th Georgikon Scientific Conference, Abstract Volume, Pannon Egyetem, Keszthely, 2019. p. 123. ISBN 978-963-396-129-2

MTMT: 32059440

8. Tóth, Gergely ; Zachár, János ✉ ÉLELMISZER-VESZTESÉG A FELDOLGOZÓIPARBAN MAGYARORSZÁGON (2021) Poszter, HuPCC konferencián, 2021. április 12-15. – online

MTMT: nem szerepel

9. Zachár, János ✉ A háztartási élelemiszer-pazarlás modellezése In: Besenyei, Mónika CLIMATTERS : Tanulmányok a fenntarthatóságról, Budapest, Magyarország : Ludovika Egyetemi Kiadó (2021) pp. 99-114. , 16 p.

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11. Zachár János ✉, Tóth Gergely Van-e elegendő élelmiszer az éhezés megszüntetéséhez? In: IX. IRI Társadalomtudományi Konferencia TARTALMI ÖSSZEFOGLALÓK p. 70 ISBN 978-80-89691-72-2

MTMT: 32070462

12. Tóth, Gergely ✉ ; Zachár, János Towards Food Justice the Global-Economic Material Balance Analysis of Famine, Food Security and Waste AGRONOMY 11 : 7 pp. 1-15. Paper: 1324 , 15 p. (2021)

MTMT: 32086842

13. Zachár, János ✉ ; Tóth, Gergely

A változatosság gyönyörködtet? – Élelmiszer-veszteség a magyarországi feldolgozóiparban STATISZTIKAI SZEMLE 99 : 8 pp. 783-808. , 26 p. (2021)

MTMT: 32131291

14. Zachár, J. (2021). Food Waste Loss Trend Index (FWLTI), A New Tool to Enable Management Decisions. Business Ethics and Leadership, 5(3), 47-60.

MTMT: 32473130

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