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May 2017

Environmental management, land use, biodiversity

FROM CONTENTS

HERMAN OTTÓ INTÉZET NONPROFIT KFT.

LIFE Clim'Foot Project

Implementing Public Policies to Calculate and Reduce Organisations' Carbon Footprint

BENEFICIARIES:

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Dear Reader!

When starting the Hungarian Agricultural Research journal the main aim of the founders was to give space to the high standard display and dissemination of national agricultural research results on a national and international level too. The journal became well-known and recognised thanks to the self-sacrificing work of the drafting committee the chief editor, furthermore because of the professional value of the published scientific works.

As a result of the changing professional and scientific expectations – like in the life of any other scientific paper – at the beginning of 2014, the moment arrived when the Hungarian Agricultural Research came under renewal, both in the content and in the form. This was reflected in the transformation of the drafting committee and in the personal change of the editor, and demonstrated by the fact that it provided opportunity of appearance for the research communities of the whole Carpathian Basin. The pictorial representation of the paper has been changed, it became more colourfully illustrated and attractive in visualization. On the other hand, naturally, it has retained its previous high professional level and its thematic orientation.

In parallel to the present issue of the newspaper - following the change in the focus of research in the field of agriculture - we can inform the Reader about a repeated renewal. Bearing in mind that sustainable agricultural production can only be achieved with the utmost respect of environmental and conservation expectations - while maintaining the basic agricultural orientation - we are expanding the journal's thematic towards new disciplines. In connection with this, in the case of presented articles we would like to provide greater space for the fields of environmental management, land use and biodiversity, and as already seen, this was declared in the new subtitle of the paper. In line with the expansion of disciplines discussed, the editorial committee has been partly changed, providing space for the well-known and recognized national representatives of the disciplines concerned. One of the most important features of the paper, that was already laid down by the founders and the publisher is naturally not affected by the renewal: the publications should fully satisfy the basic expectations of scientific writings by presenting the new scientific results of the discussed areas in a readable, colourfully illustrated manner.

We trust that the partial renewal of the paper - in line with the expectations of the age – will further improve its publicity and reputation, on the other hand encourage researchers and research teams in a broader range to the presentation of their new scientific results in this paper.

HUNGARIAN AGRICULTURAL RESEARCH

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WILL THE PERFORMANCE OF SMES IN THE FOOD INDUSTRY BE IMPROVED THROUGH TIGHTER SUPPLY CHAIN INTEGRATION? - RESULTS OF A SURVEY

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SUMMARY

This paper aims to briefly present the results of studying the correlation between the cooperation and performance of small- and medium-sized enterprises. One of the novelties of the study is that by using a part of the variables measured by our questionnaire, we established a supply chain integration index (SCII) with which it can be measured how closely each company is cooperating with its supply chain partners. Since the variables in the index are not sector-specific but are aiming to measure the level of integration in general, it can be used in other sectors as well. By creating the index, we distinguished four categories at the examined SMEs in the food industry. Using the SCII, we verified that the higher the level of supply chain integration, the more profit SMEs operating in the food industry gain (we confirmed this correlation with two different statistical methods).

Keywords: strategy, supply chain, cooperation, partnerships, power relationships, FMCG/Food sector

1. BRIEF OUTLINE OF THE LITERATURE

In a broader sense, supply chain integration can be understood as the synonym of coordination and cooperative relations between chain members. According to Flynn et al. (2010), supply chain integration is the level of cooperation where a company co-operates with its supply chain partners and they manage processes inside and between/among the organisations with their supply chain partners in order to attain effective and successful products, services, information and cash flow as well as to put a decision-making mechanism into practice in order to achieve maximum customer satisfaction. Parallel with the development of partnerships in the supply chain and the increase of the complexity of chains, supply chain integration is defined by more and more factors simultaneously, such as inventory management, information sharing, the power relations between chain members, the "soft" side of partnerships (trust, commitment, communication etc.) (Choudhury et al., 2008; Harris et al., 2011). In the success of supply chain integration, different factors become emphasised in each sector, country and culture (see e.g. Herczeg - Vastag, 2012). According to this, there is no generally definable level of integration, businesses should plan and implement the closeness, areas and aims of cooperation with their partners by taking the specifics of the sector and the supply chain into consideration (Csíkné Mácsai et al., 2013, Garcia et al., 2006).

Three types of supply chain integration can be distinguished based on the role of the company in the supply chain strategy: integrating suppliers, integrating internal, business processes and integrating customers (Jayaram - Tan, 2010). The opinion of researchers is divided on the significance of integration types (especially customer and supplier integration). Devaraj et al. (2007) verified by empirical studies that it is more beneficial for businesses to first establish closer relations with their suppliers and after that, their customers (and not the other way around). In contrast with that, according to the studies of Zhao et al. (2008) the competitiveness and performance of a business is defined primarily by the closeness and quality of the contact with its customers (Customer Integration – CI), the most important elements of which are information-sharing and harmonising business processes with the customers.

2. RESEARCH FOCUS AND METHODOLOGY

The population of our study comprises Hungarian small- and medium-sized enterprises manufacturing food products (10), beverages (11) and tobacco products (12) or are wholesalers (463) or retailers (472) in the food industry[1]. We have taken the general business size categories of the EU-conform statistical delimitation (10-49 employees for small businesses, 50-249 employees for medium businesses). According to the Hungarian Statistical Office, in the Hungarian food industry in the year of querying with the questionnaire (2011), there were 1855 small and 422 medium businesses. We used random sampling to create the sample. The questionnaires were received by 550 businesses of the population. The questionnaires were filled in with the assistance of interviewers in the form of personal questioning. The questionnaire was filled in by one of the strategic leaders (in the overwhelming majority of cases, logistical leaders and executive directors). We filtered the approximately 450 questionnaires received and as a result, we deemed 196 questionnaires to be evaluable. Accordingly, the results to be presented are based on the data of 196 businesses (N=196).

The question in the focus of this study is how the scale of integration between supply chain members influences the performance of the examined food industrial businesses. To measure the level of integration, we have established a Supply Chain Integration Index (hereinafter SCII). Due to length limits, hereby we do not present the steps of its creation.

The hypothesis of our current study is the following:

H1. SMEs operating in the food industry, which have established tighter integration with their partners in the supply chain, have higher indexes of profitableness.

Besides this consolidated hypothesis above, we have done specific calculations of the integration with their immediate suppliers and their immediate customers. Accordingly, we can formulate the sub-hypotheses as follows:

H1.1. Those SMEs operating in the food industry that have established a higher level of integration with their **suppliers***, have higher indexes of profitableness.*

H1.2. Those SMEs operating in the food industry that have established a higher level of integration with their ***customers****, have higher indexes of profitableness.*

According to these the hypotheses we have also formulated a "consolidated integration index" (H1.) but also separately is based on "TEÁOR" (Hungarian NACE) numbers of 2008, the names cover the TEÁOR numbers of each sectors.

[1] The categorisation of economic activities

the supplier-side (H1.1.) and customer-side (H1.2.) indexes. We also gathered secondary data to compile the study database, we calculated indexes of profitableness (Return On Equity - ROE, Return On Assets - ROA, Return On Sales - ROS) for the 196 businesses. We gained the information necessary via the electronic reporting portal of the Ministry of Public Administration and Justice.

The type and amount of information gathered as well as the verification of the formulated hypothesis required the use of various statistical methods. We used factor analysis for creating the before-mentioned SCII. During the testing of each model, we used many performance indicators (total variance explained – TVE, Bartlett test, KMO index) in order for the supply chain indicator to have as many integration indexes as possible while sustaining the adequate explaining power of the model (Horváth et al., 2001). We studied the relation of the level of integration and profitability in the case of both linear (linear regression) and categorical (analysis of variance) index interpretation. To confirm the causation between the factors examined, we have calculated also the so-called "eta" indexes beside using linear regression. We carried out statistical analyses with a 5% significance level of the models as validity criterion.

3. RESULTS OF THE SURVAY

Integration with partners in the supply chain includes partnerships on both the supplier and customer side. Since these two types of integration cannot be interpreted as two end points of a single scale (although a scale of [-1;1] would seem practical where -1: absolute supplier-focused integration, 0: no integration, 1: absolute customer-focused integration), this would not allow to express the status when the business had established a high-level of integration on both the supplier and customer side with the chain members. Therefore it is practical to create two indexes, a customer-side SCI and a supplier-side SCI, and the final (integrated) SCI index will be able to be created by combining the two simple ones. Table 1 shows which partner relation criteria are contained by our supplier and customer supply chain integration index.

To characterize the level of integration with one single index (integrated SCI) – independent of whether it is rather from the supplier or customer side –, we need to measure the distance of each entity from the origin in the dimension of supplier and customer SCIs because this expresses the scale of integration. Figure 1 shows the four categories in which the businesses examined by us can be grouped, depending on the scale and direction of supply chain integration.
To correctly conduct some statistical examinations, it is

Table 1: The variables of the supplier and customer SCI index created for the sample			
Supplier SCI		**Customer SCI**	
Applying modern supply chain methods, principles, technologies	Vendor-managed inventory (VMI)	Applying modern supply chain methods, principles, technologies	Vendor-managed inventory (VMI)
	Postponement		Postponement
	Risk-sharing		Risk-sharing
	Transparency of costs (open book)		Transparency of costs (open book)
	Electronic data interchange		Electronic data interchange
	Sharing market information		Sharing market information
Type of inter-organizational relations on the supplier side		Type of inter-organizational relations on the customer side	
Aspects beyond general terms and conditions of contract	Length of cooperation	Aspects beyond general terms and conditions of contract	Length of cooperation
	Informal communication with partner		Informal communication with partner
	The evaluation of the contact time to time together with the partner		The evaluation of the contact time to time together with the partner
	The use of performance indicators for the cooperation		The use of performance indicators for the cooperation
Factors of trust	Formal control over suppliers	Factors of trust	Formal control over customers
	Informal control over suppliers		Informal control over customers
	Sharing knowledge and experience with suppliers		Sharing knowledge and experience with customers
	Trust in suppliers		Trust in customers
	Asking suggestions for process development		

Source: own edition

practical to assign a nominal scale to the metric values of the obtained indexes. For this, we trisected the variables among their terciles, and determined whether they are low, medium or high (SCI categories). Our hypothesis can be verified by analysis of variance (ANOVA). Out of the indexes of profitability examined, ROE (F sig.: 0,023) and ROA (F sig.: 0,032) shows significant correlation with the integrated SCI index of SMEs in the food industry. The correlation is linear and positive in the case of both return indexes (Figure 2a), therefore the higher the index is, the higher the return on equity or assets.

If we examine the correlation of supplier-side integration scale and return (Figure 2b), we can see again that return on assets (F sig.: 0,007) and return on equity (F sig.: 0,034) of the SMEs examined is significantly different in each supplier SCI categories.

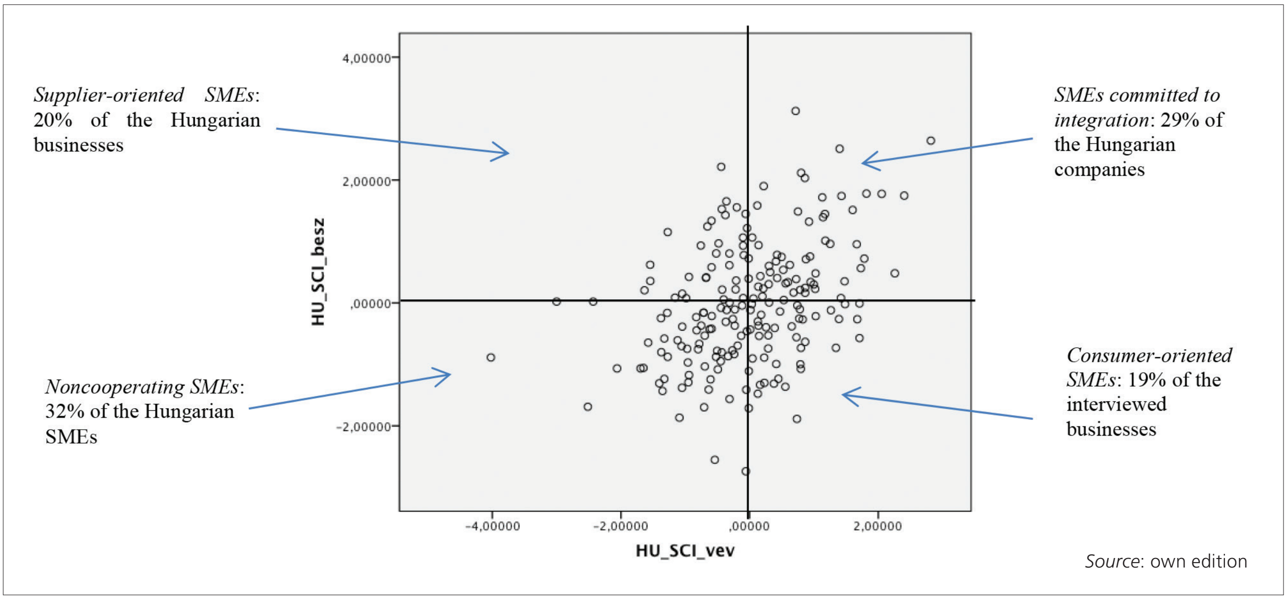

Figure 1: The scale of supplier and customer side integration among Hungarian SMEs operating in the food industry

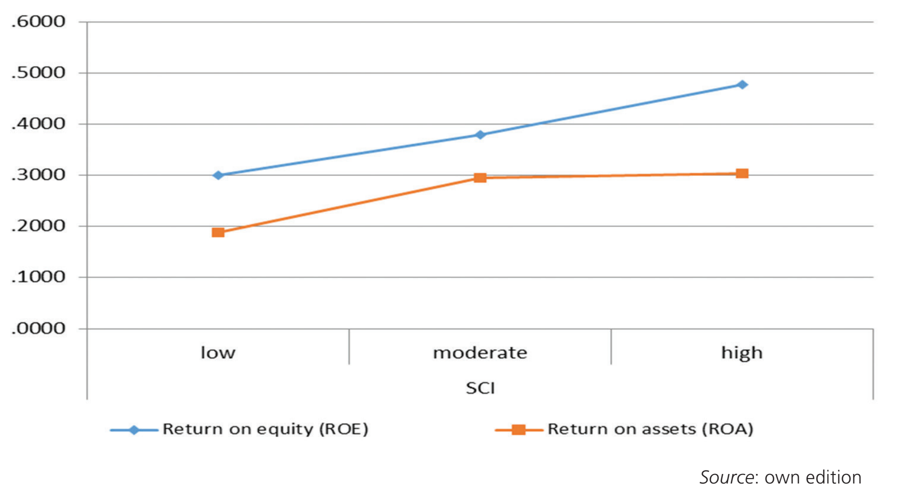

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Figure 2a: Average values of indicators of profitability in the integrated SCI categories

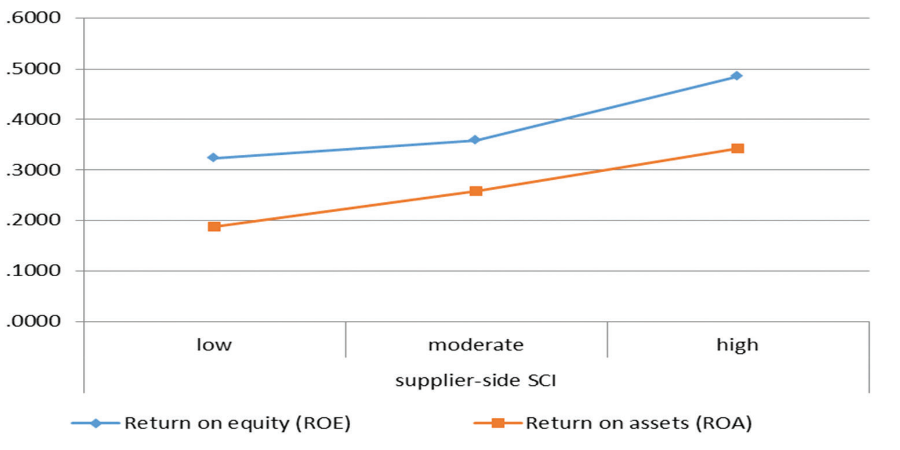

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Figure 2b: Average values of indicators of profitability in the supplier-side SCI categories

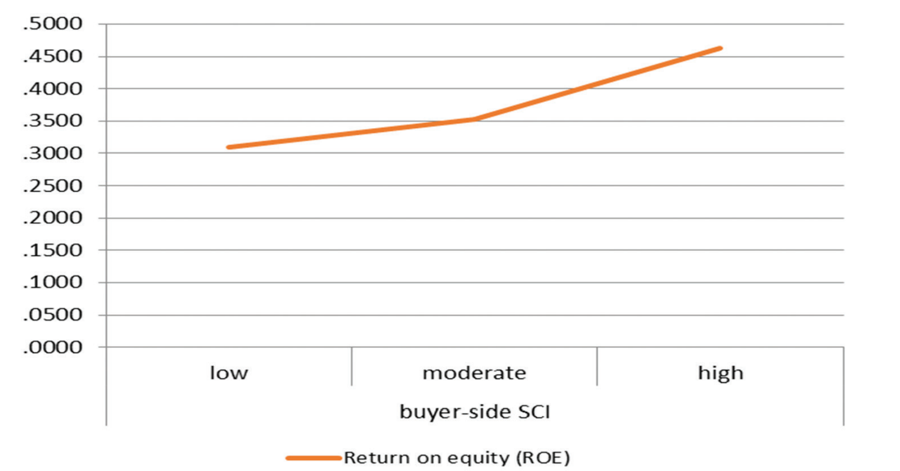

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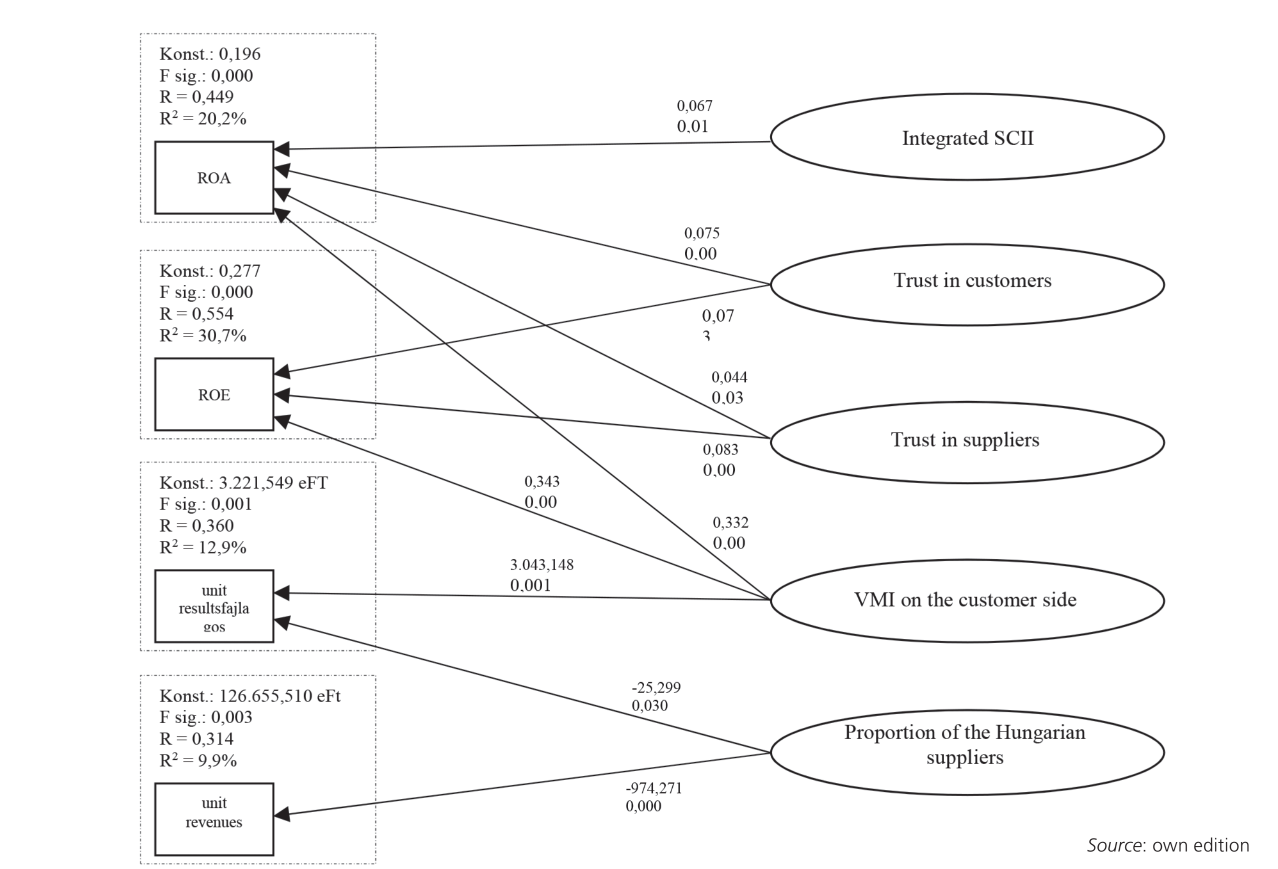
Figure 2c: Average values of ROE in the buyer-side SCI categories

In the case of supplier-side supply chain integration index (Figure 2c), only ROE values are significantly different in each categories of the index (F sig.: 0,042). The correlation is linear and positive here, too.

But the question arises whether a higher scale of integration increases the return or, are otherwise competitive, more profitable businesses more inclined to establish close supply chain cooperative relationships? As a first step, we created a linear regression model with the variables we used to measure the efficiency of businesses (dependent variables) and those that according to our assumption determine the efficiency of businesses (independent variables). Here, we did not exclusively include the dependent and independent variables necessary to verify the hypothesis but with keeping the aims of this study in mind, we only mention results that are related.

Figure 3 shows the obtained model, keeping only significant relations. The arrows on the figure show the existence of the correlation, the upper one of the numbers on them shows the regression betas, the lower one shows the significance level of the explanatory variable. In total, four indicators can be explained with five variables observed. Each indicator in the model is significant (that is hinted at by the F sig. value in the rectangle with the dashed line). The R^2 values show that to what percentage the explanatory variables connected with the indicator explain the variance of the indicator. For example out of the variables measured (and calculated further) by the questionnaire, the ROA indicator can be significantly expressed by the integrated SCI (the increase of SCI by one unit increases the



Source: own edition

Figure 3: Regression model of partner relations criteria and indicators of profitability of the SMEs examined

value of ROA by 0.067), customer trust, supplier trust and the customer-side application of VMI. These four variables determine the change of the ROA indicator by 20.2%, the other 79.8% are beyond the (model-included) factors of the questionnaire. This means that the change of the four variables considerably influence the change of return on assets. Based on the regression model results, we drew two important conclusions. On one hand, the direction of the examined connections was drawn, the higher level of integration (integrated SCI) causes higher return. The other important conclusion is that the "higher-scale integration results in higher return" correlation can not only be demonstrated when the SCII is examined as a categorical (nominal) variable but also as a continuous (metric) variable.

The statistical toolbox allows the use of asymmetry test to establish the causality between the variables: calculations of η (eta) indicators can determine which variable fills the role of cause and which one the effect. (Morgan et al., 2011) For this, both variables have to be converted to a nominal scale because the indicator can be calculated in association relationships. Since the variables measuring the scale of integration (SCI indicators) have been variables measured on the nominal scale so far, only return indicators were needed to be converted. The values of the ηindicators are in Table 2. The value of the indicators hints at the strength of the relationship, and regarding every relationship, two values can be seen in the table assuming that one of the variables plays the role of cause. The value of the indicators is typically not too high, but in this case for us, our aim is not validating the existence of the relation but rather getting information on its direction. Based on the results of the calculations, typically performance indicators play the role of effect (light grey background), while SCI indicators play the role of cause.

The association tests bore results similar to regression presented earlier, in other words, the higher scale of SCI indexes that we deem to be independent variables result in higher profitability indicators.

4. CONCLUSIONS, SUGGESTIONS

By using a part of the variables measured in our survey questionnaire, we have created a supply chain integration index with which it can be measured how closely each business cooperates with its partners in the chain. The index can be created by supplier- and customer-side integration indexes. Since the variables in the indexes are not sector-specific but generally aim to measure the scale of integration, they can be used in other sectors. By creating the index, we divided the examined SMEs into four groups according to the scale of supplier and customer-side integration, thereby specifying that to what scale are the four supply chain integration strategies (SMEs committed to integration, supplier- and customer-oriented SMEs, non-cooperating SMEs) determined by the indexes are typical to small and medium-sized enterprises operating in the food industry.

We also proved by using two statistical methods that higher-level supply chain integration results in higher return for SMEs in the food industry. Therefore making partnerships in the supply chain closer with the appropriate chain members can be a kind of help for members of the SME sector in the hard situation that is generally typical of them.

According to our view, business culture should be changed at small and medium-sized businesses of the Hungarian food industry sector from the current introverted strategy to a more open strategy where the conscious, goal-oriented establishment, sustainment and development of partnerships gets the needed emphasis. Businesses of the food industry are decisively thinking about their own business performance. This mindset should be changed in a direction that if the efficiency of the whole chain or a certain part of the chain improves (more harmonised logistical processes, shorter lead-times, lower time costs, better product identification, lower stock volumes, in other words, making integration closer) then each business can operate more efficiently. For this, they have to find those areas, processes of integration where relations have to be deepened for successful cooperation. But it has to be noted that priorities of integration can be different on each level of the supply chain (production, wholesale, retail, etc.) therefore the establishment of different integration strategies is advised for each level.

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WATER FOOTPRINT ASSESSMENT OF A WINERY AND ITS VINEYARD

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ABSTRACT

The primary aim of the study was to set up a model for the water footprint assessment of a vine grape growing and processing enterprise, improve optimization of the water consumption and the rainfall use efficiency, calculate the water footprint of the vineyard and of 1 liter of wine. In term of water use aspects, viticulture is a very significant user in the agricultural sector, as to prepare 1 liter of wine 5-6 hundred liters of water required. Climatic and soil parameters, as well as popular grape varieties have all been considered in the development of the water footprint model, including power and water usage of processing. The climate data was obtained from the local METOS monitoring stations and national databases. The vineyard-related information, such as vine grape varieties, the plantation areas, and the yields were supplied by a local grower. First, we determined the water footprint of grape growing and production processes, which together gave the wine's water footprint. There is a correspondence between the results and the international observations. Different grape varieties show different values for the water footprint of one liter of wine. The model we have established in this study may be relevant for the purposes of any environmentally conscious efforts in viticulture and grape processing. This model can be applied in smaller parts to make the process more economical, or to reduce water consumption in the winery by identifying high water consumption "hot-spots" in sub-processes.

INTRODUCTION

With an increasing interest in the relationship between a country's economic development and a country's water use, and ways of its expression, water footprint can be applied as an index-number. The water footprint consists of three components: blue, green and grey water footprint. The blue water footprint shows the consumption of surface and underground waters, which expresses the amount of evaporation and the water incorporated into a product. The green water footprint is the quantity of the utilized rainwater, which is essential for crop production. The rate of freshwater pollution during the production processes settle the gray water footprint. Studies about water footprints show that how the variety of products and raw materials contribute to the water pollution and consumption at the most diverse places (Hoekstra et al. 2011).

Various human activities pollute or waste a lot of water, but the global standard shows that the most water consumption occurs in agricultural production (Hoekstra et al., 2009). Most of the products we use contain ingredients that have agricultural or forestry origins. Since the agriculture and forestry sectors both use a significant amount of water, these products have large water footprints (Hoekstra et al. 2011). Establishing the value of cotton production's worldwide water consumption showed that in the period 1997 to 2001 cotton products require 2,56 x 10^{29} m^3 of water per year, which has a significant impact for India and Uzbekistan (Chapagain et al. 2005). A study on the water footprint of rice found that its global water footprint is 7,84 x 10^{11} m^3/year, which means an average of 1325 m^3/Mg, and the EU27 countries with their rice consumption are responsible for 2,279 x 10^9 m^3 of evaporation and 1,78 x 10^8 m^3 of water pollution in every year, all around the world (Chapagain et al.2012).

The impacts of water resources utilization were studied in viticulture in Marlborough and Gisborne regions of New Zealand. The green water footprint was negligible; while in term of the blue water footprint significant differences occurred between the two regions, which pointed out that estimates of water depletion should be made in a local scale (Herath et al. 2013). The Italian VIVA project developed a new model for the determination of a winery's water footprint. During the experiment, a Sicilian winery followed through the wine making of six different varieties with both VIVA and Water Footprint Network model. In any case, the green water footprint had the highest value, but the new model showed differences between the varieties of wine (Lamastre et al. 2014).

The main goal of the present study was to develop a model for the calculation of the water footprint for a Hungarian vineyard, as well as the vines produced there.

MATERIAL AND METHODS

The subject of our study was a vineyard located in the Wine Region of Balatonboglár, close to Lake Balaton, with sites located in Balatonboglár, Balatonlelle, Visz and Szőlőskislak. The northern boundary of the region is the Lake Balaton, which provides a unique microclimate. The meteorological data of the study area where provided to us by Viticoop Ltd. This company has a METOS® meteorological station, which records the temperature, the amount of humidity, leaf surface humidity and rainfall every hour. Data on sunshine duration was obtained from Germany's National Meteorological Service's database, while wind speed data was based on a study about the wind session of the lake areas. (PwC Hungary, 2012) The weather data was processed using the CROPWAT software developed by the Food and Agriculture Organization to support farmers' decisions. (FAO 1992) The software calculates water demand and irrigation requirements of crops, based on soil, climate and yield data.

At first, to set up a water footprint model we had to determine the goals. The primary objectives of the study were to optimize water consumption of vineyard and winery, and to improve the efficiency of rainfall utilization. The water footprint of the viticulture, and one liter of wine preparation have also been established in the study. The scope of the examination of water consumption in vine growing and processing extended from January 2015 to December 2015. During harvest, the grapes go straight to the winery, at first into the receiving hopper, then to the grape stalk remover, next into the wine press, afterwards into the fermentation tanks and oak barrels. Wine bottling uses packaging materials manufactured by different suppliers so we did not have information of their water footprint, therefore the water footprint calculation was performed until the wine bottling.

The total water footprint of grape production was based on the blue, green and grey water footprint of vine-stocks expressed in m^3/Mg. The green component of the water footprint consisted of the water consumption of crops (m^3/ha) and the average yield (Mg/ha). Due to local climatic conditions irrigation is not required, so we excluded the blue water footprint from the calculation. The water footprint of wine had two components, the water footprint of viticulture, and the water footprint of wine preparation.

The green water footprint's primary constituent is the water applied during the growing season (m^3/ha) that can be obtained as the summary of the evapotranspiration index during the vegetation period. The Cropwat program was used to determine the evapotranspiration index (mm/day), for which the necessary data were: the exact latitude and elevation of the area, minimum and maximum temperature (°C), humidity (%) wind speed (km/day), sunshine hours (h/day), monthly distribution of annual precipitation (mm), and soil moisture. The second step of the green water footprint calculation is to divide the amount we received (Wcons: m^3/ha) with the average yield (Y: Mg/ha) to compute the green water footprint (WF green: m^3/Mg) of the viticulture:

$$WF\ green = \frac{Wcons}{Y}$$

The grey water footprint (WF grey) is obtained from three components: spraying, weed control and nitrogen fertilization. (Hoekstra 2011) Since only the fertilizer is likely to the groundwater, we have used it to determine the grey water footprint. We used an average 260 kg/ha of nitrogen fertilizer application. In the calculation, the amount of active ingredient per hectare (AI: kg/ha) was multiplied by the so-called washout coefficient (α) – that can be found in water footprint estimation literature - and then we divided with the maximum allowable pollutant concentration (Cmax: kg/m^3). (Franke et al. 2013) The quotient of the received value and the yield (Y: Mg/ha) were the gray water footprint (m^3/Mg):

$$\text{WF grey} = \frac{(AI\ \times \propto) \div Cmax}{Y}$$

RESULTS

The results show that the green water footprint component were significant, because the vine stocks have relatively high rainwater utilization within the whole water consumption. As you can see at Figure 1, the most grape varieties have similar water footprint values, expect the Grüner Veltliner's raised water footprint and the very low water footprint vale of Merlot. The grey water footprint values are nearly equaled, only the Grüner Veltliner and the Merlot are different, because Grüner Veltliner has the lowest yield, and the Merlot has the largest yield, correlated with the same fertilizer application.

After the grape harvest, during processing the grape went into a hopper, destemmer machine and then to a wine press. Overall we calculated with a 75% wine press capacity, extracting 75 liters of must from 100 kg of grapes. After pressing and fermentation the wine was ready, without any additives.

The green water footprint of product processing was estimated by the quantity of the annual incoming precipitation for the entire territory and the quantity of the wine prepared for. The blue water footprint of processing were the quotient of the summed up utilized water (all machines and container cleaning, water for spraying) and the quantity of ready wine (Figure 2). For the gray water footprint we did not have data of the cleaning chemicals that were used, so this component was excluded from the calculation.

The estimation of the wine production's water footprint needed a so-called processing quotient, which was the amount of products (wine) divided with the amount of

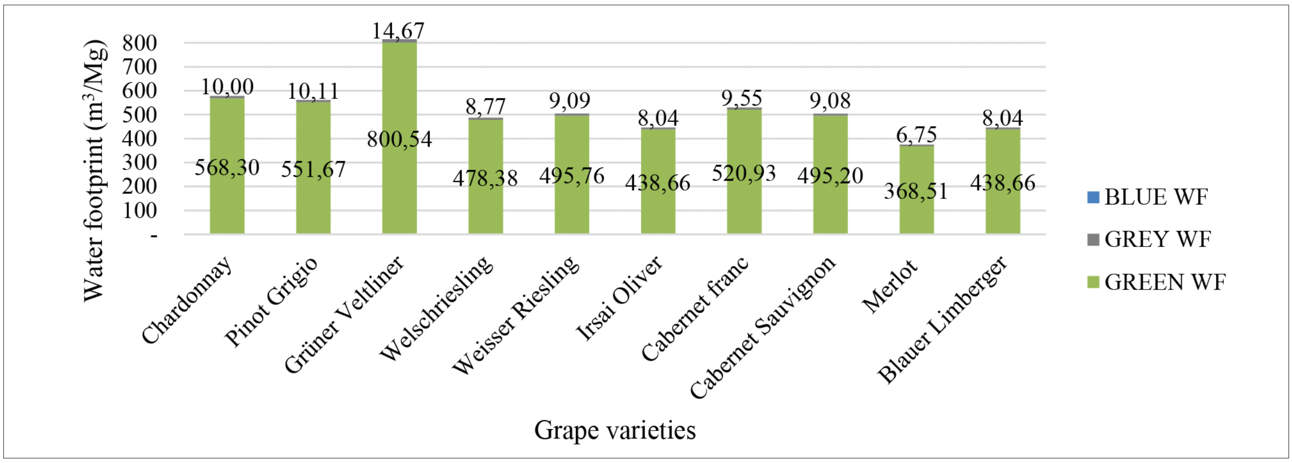

Figure 1: Water footprint of viticulture.

inputs (grapes). We divided the water footprint of inputs by the processing quotient (Proc Q), and then we summed up the received value and water footprint of the process (WF proc) to establish the water footprint of the final product (WF wine).

The water footprint of wine were given in m^3/Mg units through the formulas used in the literature of estimation, which needed a conversion to 1 liter of wine.

At figure 3, most grape varieties showed about 400-500 liter per 1 liter of wine water footprint values, what consist of 97-98% green water footprint plus 2-3% the of blue and grey water footprint. The Grüner Veltliner had a more significant value, than other varieties. (Figure 3) It has been established, that for 1 liter of wine's preparation 400 to 600 liters of water was needed. In terms of water consumption, Merlot was the most economical grape variety, as the average yield is much higher than the others, and in addition it has the smallest amount of water footprint. Using this variety could reduce risks associated with the effects of climate change, especially unpredictable rainfall patterns, due to it's relativly low water footprint.

DISCUSSION

Our goals were to establish and then apply a water footprint model, with which the water footprint of a vineyard and a winery - irrespectively of their dimensions - could be calculated. Two components were excluded from the estimates, due to a lack of information, but their calculation can be executed at any time, based on the model. The model can be applied to make processes more economical, for example viticulture spraying, irrigation or water consumption in wine processing. The scope of water footprint calculation was extended until bottling - though in practice water is also used for the bottling process – thus it is suggested to also include it in future water footprint calculations.

The green water footprint of vineyards was calculated for the relevant year, however, one may want to perform a longer period of several years to address variation, because the yield capacity depends on the age of vines. In addition, the values are highly affected by the weather, health status and nutrient supply as well. The gray water footprint was a calculation using the average amount of nitrogen fertilizer estimation, but for an exact determination nutrient management plan values would be required based on soil analysis.

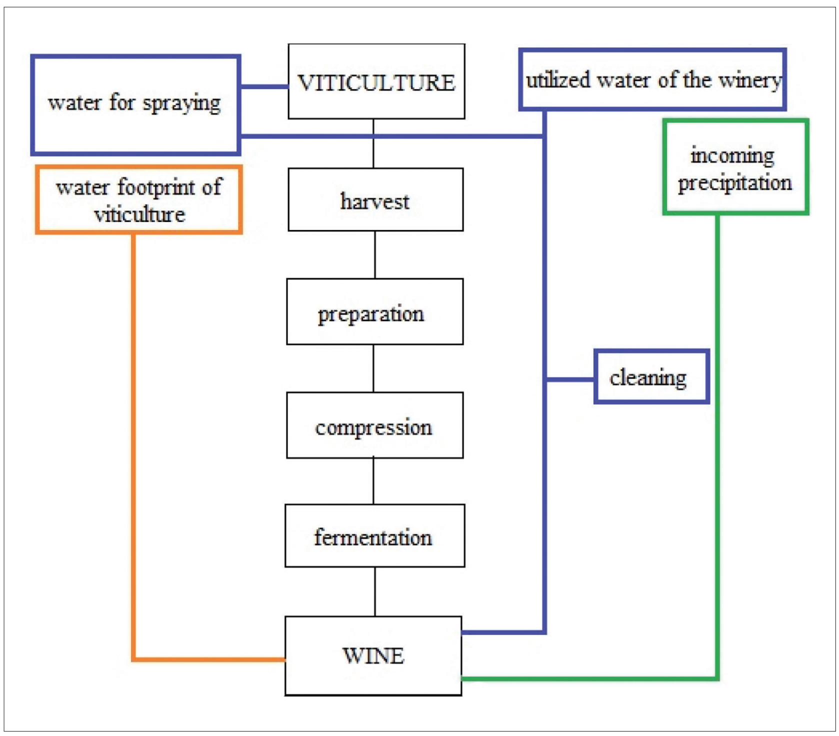

Figure 2: Water footprint components of product processing

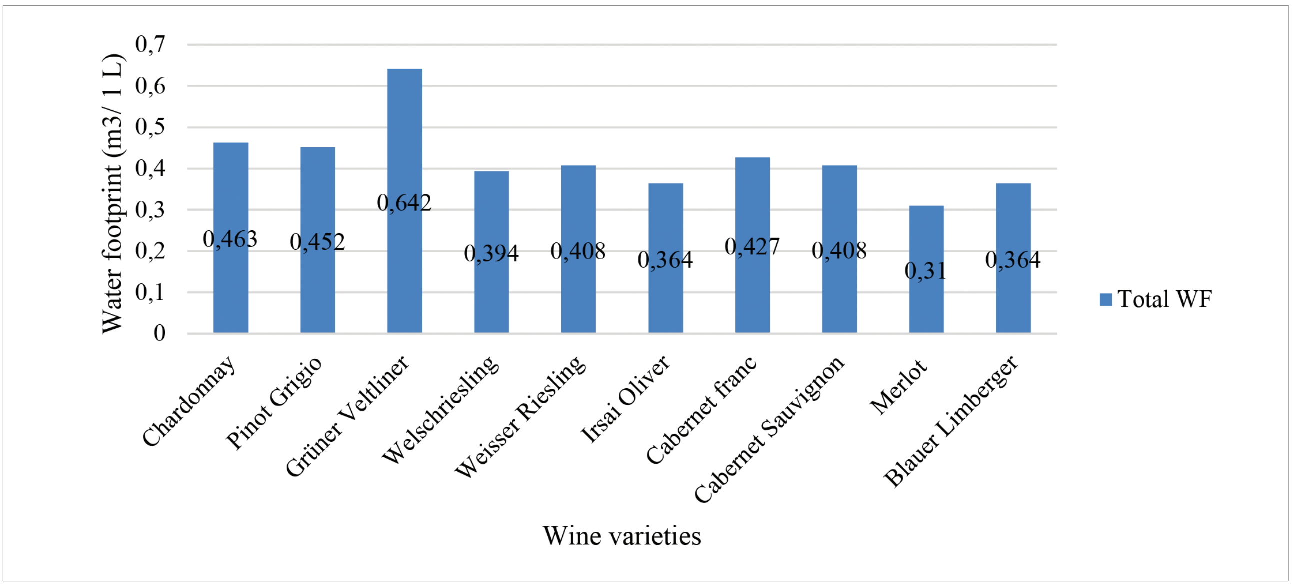

Figure 3: Water footprint of 1 liter of wine.

CONCLUSIONS

Due to the effects of climate change, with the expected increase in aridity, grape varieties with small water footprint and ability for a better water utilization could play an important role in the future of wine production. The water footprint can be examined by the quality of the crop to see which variety uses less water to produce the fruit in both sufficient quality and quantity. Practical application of water footprint models can give huge benefits to the company's sustainable and economical operation in agriculture.

The viticulture's water use makes up most of the water footprint of wine, however the water footprint reduction of a winery does not only depend on that. If one compares the amount of water required for the production process and the annual precipitation on the winery's total area, it is worth to recycle rainfall (for spraying and cleaning machines). The exact water footprint calculation of sub-processes can be used for making the sub-processes - which have extremely high water consumption - more economical.

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THE IMPORTANCE OF SITE-SPECIFIC CROP MANAGEMENT - AS AGRICULTURAL INNOVATION - IN SUSTAINABLE FARMING

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ABSTRACT

Continuous agricultural innovation will become increasingly important for sustainable agriculture, in reducing the environmental impact. Site-specific crop management is an opportunity for the necessary but not excessive chemical use, which could be part of CAP "greening" component. The technology has been known known for almost three decades, distributors marketed the machines equipped with the devices and yet, adaptation of certain elements into practice – compared to the initial expectations - is at relatively low level. The question is whether all this can be traced back. Besides the economies of scale, studies point out that the influencing factor for the permeation of the innovation is the application of the technology being highly dependent on the managers' (owners, farmers) attitude, the lack of competence and willingness to cooperate. As long as the advantages of site-specific chemical application to reduce the environmental impact cannot be realized at the producer, (and it will not be strengthening by the support system) a mass conversion is not expected.
The aim of this study is the exploration of the factors influencing the spread of precision crop management, furthermore to determine where we need to intervene to help the wide range application in short term. Among the explored factors, supplying the actors of the value chain with adequate information, their confidence towards the technology and one another, and their willingness to cooperate are determinant. Based on the examination of innovation spread along with economic theory, convincing the "late sceptical" along with need to create a strategy is very important. Integrating the support of precision farming into the CAP "greening" component could encourage the wider range of application of more elements.

Keywords: precision crop management, spreading, CAP "greening"

Fotó: Takács, 2006

INTRODUCTION

The technical progress of agriculture is a defining part of competitive farming, innovation is the development's driver. In the new millennium, innovation means the way knowledge is applied. Innovation is meant renewing and growing of products and services and their markets; application of new processes in farming, distribution, market works, management, organizations and working conditions; the expansion and renewal of professional experience of the workers. (European Commission, 2004)
Under the concept of innovation, professional experts, users, economic politicians and an average person meant different things. In the following, I use the interpretation from the new Oslo manual. According to this, innovation activity means: all those scientific, technological, organizational, financial and commercial steps that de facto serve or control the implementation of innovation.
In agriculture and food industry, the innovation as technical development is based on four pillars: biological, chemical, technical and human factors (Dimeny, 1975), but it cannot be autotelic at the same time: it must comply with the criteria of economy. The requirement of the success of innovation process is that the human factor (the person who is applying it, mostly a worker) is capable and also

Fotó: Takács, 2006

has the will to use the novelty. The management also must have the proper skills, leading capability and knowledge. The role of co-operation significantly increasing in the process of "implementation" of the innovation results in practice, which puts the human factor and organizational innovation to the fore. Several authors draw attention to the need of cooperation between farmers in connection with precision farming (Takacs, 2000; Lawson et al., 2010; Baranyai et al., 2011; Jacobsen et al., 2011; Takacs et al., 2012; PRRP, 2014).

MATERIAL AND METHODS

The aim of this study is the economic analysis of the practical implementation process of site-specific crop management, not giving details about the impact of technology on cost and income related to the spreading of the technology. With the content analysis of the used international and - narrowly found - Hungarian literature we defined the rate of spreading, while along the economic theories related to innovation, we explored the factors that affect the spreading.

RESULTS: *the innovative model of precision crop management, or why there aren't more people applying it ?*

The development of technical and technological background of precision agriculture as innovation, can be described with the demand creating model as the technological pressure is strong from the manufacturer-distributor organizations' side. However, it should be highlighted that the demand following character in the spreading has already been released - and is expected to grow stronger with the growing need of environmentally conscious management (Takácsné, 2011). The technical background of site-specific crop management has been around for more than twenty

Fotó: Pecze, 2007

Fotó: Takács, 2015

years. During this period it demonstrated its role in environmental impact mitigation and its technological usability in economic terms (economically profitable) under specified farming conditions. All this confirms its place in the repository of sustainable management. However, practical prevalence (proportion of farmers, number of elements, the size of the area) is significantly lower than previously expected (predicted), both at domestic and international field (Pedersen et. al., 2004). At the same time, the continuous two-way communication becomes increasingly important between actors in the innovation chain, and there is an increasing role in how to reach out to the widest possible range that are not familiar with the technology, the farmers who do not apply it (Kirketerp-Scavenius - Pedersen, 2010; Kutter et. al., 2011). The results of a non-representative exploratory survey among farmers in Hungary conducted in 2012, found that (Lencsés, 2013), from the possible elements of precision agriculture, those related to nutrient supply (site-specific nutrient application and yield mapping based on soil sampling) were included in the common farming. Furthermore, the use of progressive cultivation and harvesting equipment are typical. The application is significantly dependent on the size of cultivated land and the farmer's age, while there was no evidence of a link between the use of technological elements of precision agriculture and the farmer's education.

The practical spreading of precision crop management can not be described fully with the 1960s Rogers model (Rogers, 1995), because the individual phases become long-drawn if we consider the whole of the technology as the object of technical development (Lencsés – Takácsné, 2010; Takácsné, 2012). In terms of innovation, Normann (1998) takes over the classical grouping: „innovators, technology enthusiasts", „early adopters, visionaries", "majority of early pragmatic adopters", „majority of late conservative adopters", „late sceptical". He specifies that point – chasm – from where not only innovators, early followers require the novelty itself but also the majority of the market, as markets driving force. In later phases of innovation spreading, practicality and conservatism dominates, users expects solutions of the given problem, with as low personal cost as possible. Moore (1995) draws attention to the fact that in the two different section of innovation spreading, different kind of marketing strategy is needed (Nielsen Norman Group, é.n.). Looking at the spreading of the whole system of precision farming, it can be concluded that the multi-player ("early pragmatic adopters" consist of the wider majority of adopters, the "late conservative adopters" and the "late sceptical"), and typically diversified user side has a variety of needs that the manufacturers can not take into account.

Taken into account the above, on precision farming as technical and technological innovation, Rogers' typology has to be interpreted particularly (figure 1). If we count the factors influencing the spreading as a base, we should not ignore the country-specific agriculture features, mainly the biostructure, the assets and capital supply, the service/consultancy background, last but not least, the agricultural workers' qualification, technical knowledge and commitment to novelties.

Although the technology has already quit the innovator's stage, the development is constantly going on even today, so there are currently R & D activities related to technology.

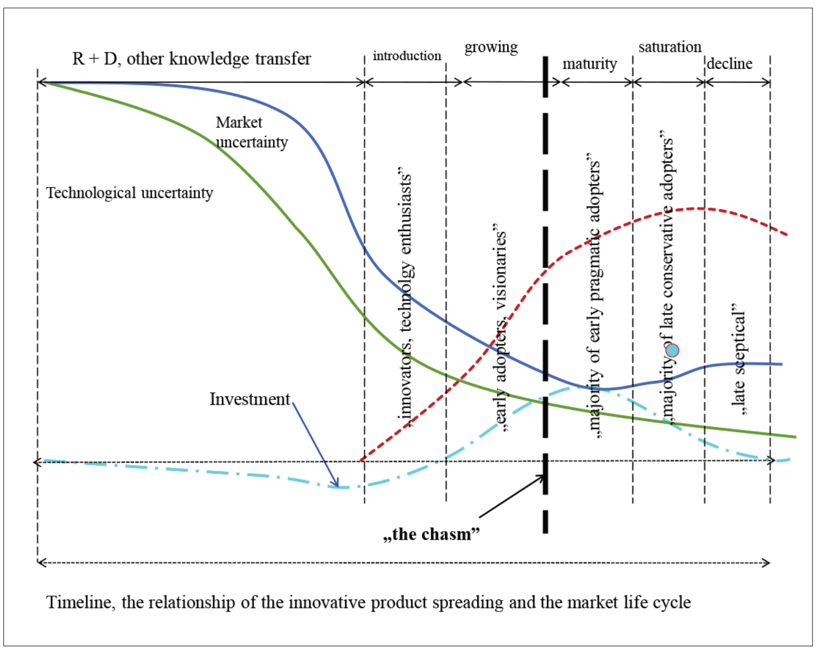

Figure 1: Relationship of the innovative technology spreading and market processes
Source: based on Norman, 1998, completing with risks of market cycle

The main reason of the differences is that the components of the precision crop management are applicable individually and are also interconnected (Paxton et. al., 2011).
In terms of practical spread, the slow practical spread can be partly explained by the followings and can be described with the following characteristics according to Rogers' (1995) typology:

1. When introduced it had a relative advantage against the technological elements that were general in common farming, and it would have allowed a relatively quick spreading.
2. In terms of compatibility, as farmers can be characterized by different knowledge, skills, and differing affinity to new things, and not to forget their different farming area and financial opportunities – the precision crop management is considered to be less compatible. If consultancy support during the introduction of technology is missing, the spread process slows down. In this area, the Hungarian practice can be characterized with many positive elements, such as the successors of the production systems built decades ago, or the consultancy network built in the 1990s.
3. The comprehensebility of the use of precision crop production can not be judged clearly, as adapting the components of technology is not too difficult, but requires much more attention, precise work and is based on wider information base.
4. In terms of trialability and knowability, the industrial actors and providers involved in application and marketing of the technology are dominant. (In favor of spreading, annualy multiple professional presentations are organized.)
5. Part of the advantages achievable with the introduction of precision technology is directly noticable (material saving, improved cost efficiency, yield growth) together with additional expenditures and costs. At the same time, the indirect effects – environmental impact mitigation, improved food safety - are less obvious. In the meantime, as long as the measurable positive dividend is not clear in practice for the farmers, or its risk is high, the technology spread is slow even besides good financial background. (This can be observable, both in the Unites States and Europe.) (Takács-György et. al., 2013)

Precision crop management brings a new management philosophy. Instead of the former, table optimized farming concept, the planning of quantity of inputs, the application and the efficiency tracking based on micro production site capability. It is an important criteria that in every case where the production site, the cultivated plants population, the type of the harmful organisms, its abundance and developing dynamic are heterogenic, a point can be determined where site-specific faming is justified even in economic sense. Several authors have dealt with this problem, highlighting its role in environmental impact mitigation, food safety and food security (**Ørum** et al., 2002; Gutjahr et al., 2008; Schellberg et al., 2008; Biermacher , et al. 2009; Kutter et al.; 2011; Takácsné, 2011; Takács-György et al., 2013; Gil et al., 2014). In November 2014, with the backup of the European Committee, the EIP-AGRI Focus Group on Precision Farming (PF) formulated the following summary statement and tasks – including but not limited to:

– there is a need for the emphasized mediation of the added value of PF and its role in value chain toward the producers and stakeholders of the sector;
– answering the question "how we can reach the farmers, and how to support the advisers?", four key areas have been highlighted:
  – "messengers of farmers", who belongs to the group of early adopters, visionaries, who can convince others;
  – advisers, who gather and answer the farmers questions, as well they are ensure interconnections towards manufacturers, developers, producers;
  – the manufacturers of products, the researchers/developers and providers who are committed to provide appropriate solutions for the farmers' needs;
  – the farmers – the "majority of early pragmatic adopters", the „majority of late conservative adopters" and the „late sceptical" - so the multitude of late followers. The target is their convincing along the needs creating strategy.
– in connection with the small and medium, mainly family owned farms, regional education and consciousness, the necessity to strenghten the commitment towards PF, shared using of the precision farming tool system (sharing PF machinery), common thinking and activity to achieve the economies of scale are highlighted. Larger trustworthy advisor support is necessary, accessible (in terms of investment) and easy to use tools are needed which can be learnt, taught during operation.
– open, shared data: farmers are basically reluctant to share their data, to resolve this obstacle there is a need for a new bussiness model. Farmers have to be convinced that if they manage their data better, they can achieve
– more with their tools, increasing the effectiveness and income (partly, they can take all the opportunities of economies of scale, by reducing their expenditures) moreover they can mitigate their invironmental impact (EIP – Agri Focus Goup, 2014).

Its operational application requires new, systematic management knowledge, the table work coming to fore requires change of attitude from the worker and the manager too. Several authors highlighted the importance of the competence and management required to carry out an appropriate precision farming (Székely, 1992; Wang, 2001; Pecze, 2007; Lencsés – Toyserkani, 2012; Tey – Brindal, 2012; Husti, 2013). If we take the changes in work organization as organizational innovation, the precision agriculture meets the definition of organizational innovation, because with the making of the required maps and records needed to the technology, the scope of tasks that must be taken into account in work organization changes.

CONCLUSION

Sustainable development requires the adaptation from all the actors of the agricultural sector, as this is one of the pledge of efficiency and competitiveness. This means that it is required to apply a strategy which in addition farmers are able to meet the requirements of ecological, economic and social sustainability. The ability of continuous renewing, namely innovativeness is a necessary precursor of the above.

The diffusion of precision crop management slowed down, elements of the technology – despite the perceived or real benefits – were slowly drawn into the practice, meanwhile their application requires commitment both from the management and the staff side. The deficient knowledge, the lack of commitment often leads to economic benefits not being realized at plant level. As long as the advantages of site-specific chemical application for reducing environmental impact cannot be realized at the producer, and it will not be strengthened by the support system, a mass changeover is not expected.

Direct accessible benefits, facts manifest

in cost-effectivity, and their interrelationships on income must be emphasized from the factors affecting the deployment. The detection of less obvious indirect effects, the quantifying and the communication towards the farmers must be the responsibility of the players of the sector. Small and medium-sized farms can successfully apply the technology, partly based on proprietary device system, partly along the forms of common machine use, or as the use of services.

In my view, integrating the support of precision farming into the CAP "greening" component could encourage the spread. Innovative organizational behaviour is progressive, which also indicates that proper information of famers (education, counselling, experiences spread by "word of mouth"), susceptibility towards new, strengthening the confidence in cooperation, bolder use of services, the consolidation of different mechanization associations, machinery rings can speed up the widely spread of the many application of precision technology.

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APPLICABILITY OF DRONES IN AGRICULTURE AND FARMSTEAD MANAGEMENT

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ABSTRACT

The appearance of drone technology and the rapid development of remote sensing open new possibilities in civilian applications including agriculture and rural development. The process is accelerating with the more common application of the efficient and low-cost commercial drones within the last decade. The author gives an overview of the main characteristics of drones and the autonomy levels of remote sensing systems on board. The classification of unmanned aerial vehicles in terms of the safety requirements is also discussed. The main agricultural application such as the use of Normalized Difference Vegetation Index and the novel hyperspectral imaging are briefly summarized with special regards to precision agriculture. However, the drones can extremely valuable in the daily routine of smallholders or farmstead owner also. For the latter, the crops and land plots monitoring could be the best solution to improve the production level. The application possibilities are demonstrated through a pilot study in which a commercial drone and free photogrammetry software were used to develop 3D models of a farmyard and a nearby land. Finally, a few options of a further application in drone technology are mentioned.

keywords: remote sensing, drones, GIS, agriculture, farmstead

HISTORY

The unmanned aerial vehicle (UAV) or drones have a long history dating back to the Three Kingdoms area in Chine where hot air balloons were used for military signaling. In the late 16th century the balloon of the Montgolfier brother's made its first unmanned flight and shortly thereafter the first military use took place. At the beginning of 19th century, the aircraft based technology was further developed mainly for military purposes and in the early 1930s, the prototype of the first "returnable and reusable" drone was completed. During the World War II then the Vietnam War the drones became more and more powerful reconnaissance vehicles. After the appearance of civil drones, the agriculture became one of the main fields of this technology. From that point of view, at first, Japanese farmers used unmanned helicopters to spraying their crops in 1987. Thereafter, in the 1990s different types of drones were developed for civil and hobby purposes, then in the twenty-first century, a more common application of these types of vehicles can be seen (Colomina and Molina, 2014).

DRONE TYPES AND REGULATION

The civil UAVs can be inserted into two main categories. The multi-rotor or rotary wing drones powered by electric engines are able to take off and land vertically and can be characterized with good maneuvering ability. The fixed wing drones have more efficient aerodynamic properties which provide faster and longer flights (sometimes using gas engines) but need larger space for take-off and landing. Most of the commercial UAVs belong to the aerodynamically efficient quadcopters with four propellers.

The drones can be classified in terms of safety requirements creating open (low risk), specific (medium) and certified (higher risk) categories. Safety is ensured through the fulfillment of operational and weight limitations. According to the European Aviation Safety Agency (EASA), the concept of operations for the open category (class A0, A1, A2 and A3) states that the drone must be flown within direct visual sight, at an altitude below 150 meters and outside of specified reserved areas. The widely used DJI Phantom (similar was used in the latter discussed pilot study) belongs to the A2 class which has a maximum weight limitation of 25 kg. At the end of 2016, the agency called for a mandatory registration of all drones. The EASA document also deals with privacy, data protection and security issues suggesting the establishment of standardized web portals to inform the users about local regulations and temporary restrictions (https://www.easa.europa.eu). The US Federal Aviation Administration has different rules for hobby or business flying. Clearly defined requirements are available for the pilot, the aircraft and operating. The UN agency for civil aviation (ICAO) launched a so-called Unmanned Aircraft Systems (UAS) Toolkit on December 2016 to help the drone pilots to operate their aircraft safely and responsibly. In Hungary, according to the temporary Hungarian legislation of the National Transport Authority, case by case flight permission is needed. The need of such regulations are obvious, but UAVs, for most agricultural applications, have low weight (below 25 kg) and typically fly at low altitudes over private and uninhabited areas.

REMOTE CONTROL

Historically the first demonstration of the remote control can be linked to Nikola Tesla and his radio controlled boat in 1898 (Vujic et al., 2001). The next remarkable development was the automated stabilization control of aircraft and soon after the first pilotless aircraft test was performed just before the World War I. To assure the sensory-motor autonomy of modern UAVs, three-axis accelerometers, gyroscopes an on-board global positioning system (GPS) are needed. This technology regulates the altitude and the position, however, GPS information is not fully adequate when the drone flies few meters above ground level. Therefore drones need complex levels of control autonomy and additional sensors to keep safe and stable trajectories. Per definition: robot autonomy is the ability to perform intended tasks based on current state and sensing, without human intervention. Basically, three levels of increasing autonomy can be identified in case of UAVs: sensory-motor autonomy, reactive autonomy, and cognitive autonomy (Floreano and Wood, 2015). A DJI Phantom drone is able to fly at a given altitude, move to or maintain GPS position (in the presence of wind), follow pre-programmed trajectories, avoid barriers, keep safe distance from the ground, coordinate with moving objects etc. – based on these, this UAV has the characteristics of reactive autonomy.

REMOTE SENSING

Remote sensing is a way of obtaining information about a given object without direct physical contact. In this sense, one of the first instrumental sensings was performed by Galileo, who described the imperfection of the moon in 1609. The first land survey aerial photograph was captured by Nadar, the famous French balloonist in 1859. With the flight of Wilbur Wright in France, the age of aerial photography began in 1908. Soon after the beginning of the World War I, the military on both sides applied the aerial photography on a daily basis. During the next decades, the improvement of sensing technologies including the near infrared photography became more and more successful. The latter was applied for camouflage detection in WW II. As a consequence of the Cold War, the high-flying U-2 airplane was constructed, the air-borne radar technology and the so-called multispectral imagery were developed. Barely two centuries after Nadar the Apollo 8 mission returned the first images of the Earth from a lunar orbit. In 1972 the NASA launched the Landsat satellite as the first civilian multispectral data remote sensing system to improve the understanding of agriculture, urban growth, and many other main Earth features. Nowadays an exciting development is the public availability of the European Space Agency (ESA) Copernicus program. The Sentinel-1 and 2a satellites were launched in 2014-2015 and provide comprehensive data from our planet. However, the satellite and aircraft remote sensing systems are expensive and weather dependent. The resolution is relatively low and the multi-temporal data evaluation needs special expertise. On the other hand, the drone-based low altitude remote sensing provides high-resolution visible-band, near infrared and multispectral data. UAVs can also be installed with thermal imaging and laser scanning equipment. As a result of the continuous technological development, the large and extremely expensive hyperspectral sensors are smaller and more affordable than ever. Consequently, these sensors became available on the boards of UAVs offering excellent opportunities for scientific researchers and commercial users.

Nowadays the UAVs have become a primary resource of remotely-sensed data. However, it has to be emphasized that the evaluation of the acquired data needs sophisticated tools as Geographic Information System (GIS). By definition, GIS is a computer-based system for capturing, storing, manipulating, analyzing and visualizing geographically referred data.

APPLICATION IN GENERAL

The two primary application categories within the commercial drone sector are aerial imaging and data analysis providing an alternative methodology to traditional field-based measures. The combination of high-resolution cameras with the near-ground flying ability of UAVs enables a very detailed level of mapping. With the onboard cameras, the surface of the Earth can be monitor continuously. Drone remote sensing provides a valuable tool for environmental research, wildlife protection as well as tropical forest monitoring. Construction companies are able to measure their actual work progress in real time. Mining companies can obtain precise volumetric data from the mining area, energy and infrastructure companies can perform exhaustive surveys of pipelines, roads, drainage systems and electric wires. The archeology is another fast-growing application area of drone systems in finding new excavation sites seeing a thing which cannot be perceived from ground level. The real traffic conditions in urban areas can be measured without any influence on driver's behavior. Humanitarian organizations could provide immediate aid efforts for refugees. Transportation drones are capable of safely taking off and landing practically everywhere providing rapid delivery of food and medical supplies in developing countries without road network. Inspection drones that are capable of flying in limited spaces will help fire-fighting and emergency units to assess dangers faster and more safely (Tiwari and Dixit, 2015). As a new technological development, coordinated groups of autonomous drones could enable missions that last longer than the maximum flight time of an individual UAV by allowing some drones to leave the group temporarily for changing their batteries. In conclusion, the drones have several industrial and academic applications that influence our days. However, UAVs operation has some limitation due to its weather (in particular wind and rain) sensitivity and the aforementioned regulations dependency.

APPLICATION IN AGRICULTURE

Modern agriculture is a sophisticated industry, where the farmers often need on-demand high-resolution data. The data from the onboard remote sensing systems can be acquired in 2D/3D format as a function of time. The periodically repeated surveys provide great opportunities for an advanced management of agriculture (Zhang and Kovacs, 2012). The soil temperature and moisture, as well as the ground erosion, can be detected. By means of laser scanning and 3D image analysis, the crop heights are measurable. In plant production, the vegetation dynamics, the phenological stage and the impact of chemical and biological treatments of crops can be described with different vegetation indices, e.g. Normalized Difference Vegetation Index (NDVI). The NDVI estimation is based on the strong absorption of visible light of chlorophyll and the strong reflection of near-infrared light of plant leaves. The spectral reflectance is acquired in the visible (red) and the near-infrared regions of the electromagnetic spectrum. The NDVI is widely applicable in vegetation or land cover classification, in the assessment of biomass production, and the evaluation of attributes related to grazing management. From the NDVI data, so-called yield maps can develop to allow the farmers to compare yield distribution within their field from year to year (Abdullahi and Sheriff, 2015). Based on all these it can be stated that UAV-based remote sensing is an efficient tool for labor and material cost reduction. Furthermore, with continuous analysis of the processes and field status, the risk potential could also minimize.

From the view of precision agriculture, the drones could provide data for treatment and irrigation optimization namely using fertilizers only where and when it is necessary, assisting pollution reduction (Upchurch, 2001). There are reasons to believe that the evaluation of soil characteristics using hyperspectral imaging became much cheaper and faster, and nearly similar in efficiency compared with conventional chemical analysis. The daily routine in precision agriculture comprises a real-time, high-resolution remote sensing data collection about the crop. Thereafter as a result of sophisticated computer aided data analysis, the control data are entered into the board computers of multipurpose agricultural machines for task execution. The process is the part of a fast growing area of the combination of agricultural and information technologies (IT). However, the contributing persons and organizations have to do a lot for the integration, to build joint platforms and to accept and disseminate key standards.

APPLICATION IN FARMSTEAD MANAGEMENT

Due to the wide range of applications, the drones became more and more widely used in intensive large-scale farming. These farms which are operated as a business enterprise can fully utilize the advantages of advanced aerial data collection in their management practices. However for a limited-resource farmer (US terminology), a smallholder (The UK or Developing Countries terminology), a lifestyle block owner (NZ terminology) and/or a Hungarian farmstead owner nowadays the „walking across the field" is the only way for crop monitoring. Unfortunately, this kind of data collection is highly time-consuming or almost impossible. Moreover, the naked eye process of differentiation between the distressed and healthy plants seems to be uncertain. At the same time without a fast, detailed and exact data analysis these farmers are unable to react to a problem such an accidental disease outbreak. The availability of low-cost drones developed for special agricultural purposes could be a solution to remarkably increase the yields and the profitability in the near future.

Historically the waters of the Hungarian Great Plain played an important role in landscape evolution. The regulation of Tisza River results in a flood protection, however, the different kinds of groundwater are still risky and dangerous. Therefore a network of drainage system was developed which continuous maintenance could be supported by regular drone survey.

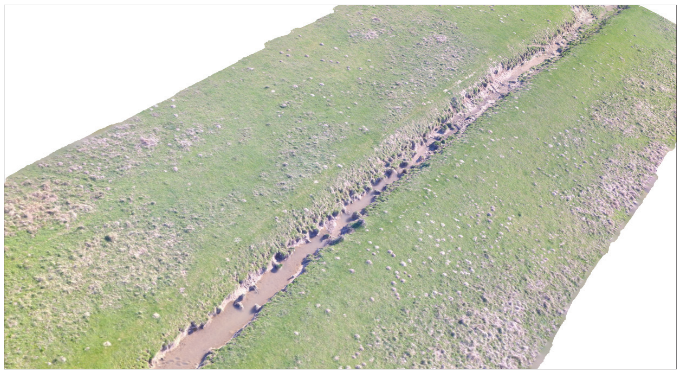
From farmers' perspective, the high-resolution UAV imagery seems to be an effective tool measuring the area of land plots to monitor land policies. Independently from size, shape and land use (vegetation type), the area information can be evaluated using orthophotos without losing accuracy compared to traditional methods based on Global Navigation Satellite System (GNSS) measurements or images obtained from satellites (Mesas-Carrascosa et al., 2014). Therefore a widespread penetration can be expected in surveillance and assessment of estates in the near future, despite the evident social and political implications of the technology.

PILOT STUDY

The survey was aimed to demonstrate the applicability of aerial photogrammetry determining the spatial characteristics of a ruined lodge situated within the administrative border of Felsőlajos (Bács-Kiskun County, Hungary) and producing an orthophoto mosaic from a drainage ditch. The village of Felsőlajos can be characterized as a typical example of farmstead settlement of Duna-Tisza Interfluve region.

In the case of both imagery first to so-called point cloud models were generated in conjunction with the free multi-view reconstruction CMPMVS software. Finally the open source Meshlab was used for processing and editing the 3D triangular meshes.
The prepared orthophoto can be georeferenced and used to create maps at local level complement with other mapping methods (Greenwood, 2015).

1. Picture 3D model of a runied lodge



2. Picture Ortophoto mosaic of a drainage ditch

The aerial images were acquired by means of a DJI Phantom 2 Advanced drone equipped with a 3-axis gimbal system keeping the 12-megapixel camera perfectly level (for orthophoto mosaic the straight down perspective is essential). The flight was controlled with DJI GO software running on a Lenovo TAB3 850M tablet. Video records were taken from the farmyard in FHD mode (1920 x 1080p, 50 fps, PNG format) flying at different altitudes and trajectories. An average one-fifth of the frame was loaded into the free VisualSFM photogrammetry software.

For the farmstead imaging, the point of interest function of the DJI GO software was used to guiding the drone. For the drainage study, first, the GPS characteristics coordinates of the rectangle shaped test area were collected with a Garmin 64s portable equipment. Thereafter the flight path was set on the predefined waypoints to ensure the automatic flight of the drone. The flying altitude was adjusted with attention to the outspread of the area. Regarding the 94° field of view of the 20 mm (35 mm format equivalent) lens of the board camera, 25 m flight altitude was chosen which resulted in an approximate 1 cm pixel resolution on the surface using 4:3 image frame format. The horizontal flight speed was 0.5 meter / second and the time between the shots was 10 seconds to ensure the appropriate overlapping of the neighboring images (50%) for the data evaluation process. The images were saved in DNG (RAW) format and then exported to VisualFSM.

NEW POSSIBILITIES

In the last years, enterprises have been founded worldwide to fulfill the farmer's demands on high-resolution data. These companies offer farms specific solutions collecting airborne and space-borne multi- and hyperspectral imaging data together with the corresponding weather records of the given area. Furthermore, they perform crop and variety specific analysis of the acquired data using previously developed models to produce information on crop phenology and physiology. As a result of the complex data evaluation, a detailed map of agronomic data including water or nutrient deficiencies and disease or pest infection is available for clients.

Another way is the use of mobile and cloud technology when the acquired remote sensing data can be evaluated by mobile apps based on regularly updated research information. Moreover, the farmers could share their field data within the network of trusted users developing very promising relationships.

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DEVELOPMENT OF REPRESENTATIVE ODOUR SAMPLING METHOD THROUGH THE EXAMPLE OF A LAMINATE COVERED SIDEWALL DESIGNED COMPOSTING SYSTEM

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ABSTRACT

In the following paper, we present an odour sampling method to determine the odour emitted by 25 meter long and 8 meters wide sidewall designed composting prisms used regularly in Hungary. The significance of our work lies in the fact that the standard in force does not cover the number of sampling, the location of sampling points and their designation either. On the basis of test measurements the number of required samplings has been determined by the Chebyshev formula, which representatively describes the odour concentration conditions prevailing on the surface of the composting prisms. On the basis of controlling examinations, it was concluded that the sampling method presented in this paper is suitable for performing representative odour sampling and odour measurements.

Keywords: composting plant, odour sampling, olfactometry,

INTRODUCTION

Odour is one of the most subjective environmental nuisances, typically not even considered like this, it is difficult to determine the discomfort and health damage as consequences of odour (Ritvay & Kovács 2006). During the evolution of civilization our relationship to odours has significantly changed. Besides, the judgement of odour is subjective, population now reacting extreme sensitively to the slightest odour effects. During the operation of composting plants, what causes the most conflict is stench. For this purpose, procedures should be used where the formation of odour is precluded or moderate, or in cases where the formation of odour is unavoidable, reduction must be ensured with the use of clearances or with the optimal location choice (Green Capital 2008).

The level of air load and the Ministry of Rural Development's 6/2011. (I. 14.) decree on examination, controlling, evaluation of stationary air pollution sources states that in case of odour emitting sources, the odour emission of the emission source, the efficiency of the odour reducing equipment or system must be supervised with olfactometric measurement, frequently depending on the authority's decision (even annually, or every two years). In addition the Ministry of Environmental Protection and Water's 23/2003. (XII. 29.) decree on treatment of bio waste and the technical requirements of composting states in its annex that the efficiency of the treatment with technical equipment against odorous materials must be evaluated with an olfactometric method.

For the determination of odour concentration, the 306/2010. (XII. 23.) Governmental decree on MSZ EN 13725:2003 "Air quality. The determination of odour concentration with dynamic olfactometry" standard should be applied. The standard clearly regulates the odour sampling and odour measurement which forms the basis of the method, but it does not provide sufficient guidelines for the testing of an odour reducing equipment, such as the determination of sampling numbers, the selection of sampling points as well as the evaluation of measurement results (Béres et al. 2014a).

Therefore, the primary objective of our work was the elaboration of a unified measurement method for the determination of odour emission of the 25 meters long and 8 meters wide sidewall designed composting prisms used regularly in Hungary. On the basis of test measurements the number of required samplings has been determined, which representatively characterize the odour concentration conditions prevailing on the surface of the composting prisms. In the course of additional sampling and measurement, we conducted the tests and checked the adequacy and applicability of the developed method determined by preliminary tests. Our measurements were performed on samples at different stages of maturity from Gover Cover membrane covered green waste composting prisms located at the Zöld Híd Régió Ltd. composting plant, Gödöllő.

THE ODOUR AND ITS MEASUREMENT

The effect of odour (environmental disturbing odour) manifest itself primarily in worsening the stakeholders' well-being, quality of life for the exposed individuals with triggering a feeling, causing various symptoms. If we would like to quantify odour, we must choose a method which quantifies this effect, namely the feeling in human population. Each odour-causing ingredient always works jointly as part of a mixture, they mutually strengthen or weaken each-others effect in practice, which cannot be estimated. Therefore a gas mixture's odour intensity and odour concentration cannot be described authentically from the characteristics and individually caused effects of the individual components constituting the mixture. In case of "component-based" odour intensity measurement, it is also problematic that the human nose proved to be more sensitive for certain materials like todays analytic methods, so a sense of odour formed even in lower concentrations than the instrument's measuring limit. Beside of this, costliness and time intensiveness of analytic tests makes new difficulties (Béres 1997, Béres et al. 2014a, Béres et al. 2014b). Because of these difficulties, for determination of the size and concentration of an odour, organoleptic test proved to be the most appropriate, where the "sensor" of the instrument is the human nose itself.

Adequate sense of odour formed only when the strength of the odour exceeds the threshold. Different materials have different odour thresholds. (Odour threshold: the lowest concentration of the odorous material which has sufficient stimulus to incite odour in the olfactory receptors (Ochs 1995). Odours that cause the most disturbing effects are typically derived from sources where the organic matter decomposition takes place. In case of odours from various sources, typically a large number of stinking matters make up a mixture, this is especially true for composting. The diversity of odour sources and the complexity of the emitted odorous gases has the effect that it is almost impossible to complete list of materials causing nuisance odour. In summary, we can say that the chemical properties of a material mean that in the presence of the material a sense of odour can be formed. Not only the intensity but the quality of an odour primarily depends on the creators of the mixture (Zimmer 1987). But the sense of odour is actually a physiological phenomenon. The ability of sensing an odour is practically no other like a kind of individual sensory capability, the manifestation of olfactory ability (Béres et al. 2014a).

Taking into account the activities causing disturbing environmental odour and processes causing odour emission, the main groups of the most common odours can be determined. Among the sometimes strongly odorous gases causing disturbing environmental effect there are aldehydes, mercaptans, ketones, amines, low molecular weight fatty acids, esters, organic acids, simple and aromatic sulphurous compounds. These odours are generally a small amount in terms of emissions, but they are causing significant odour effect even in small concentrations, nearby the odour sources (Béres 1997). The Ministry of Rural Development's 6/2011. (I. 14.) Decree on emission ceilings of air load level limits and stationary air polluting point sources states in its 6th Annex that the requirements for odour emission are not affected by the general emission limits. This requirement also naturally confirms that odour effect typically caused by mixtures of odours so that controlling the individual components emission limits does not cause the controlling or limiting of the odours rate. The Ministry of Rural Developments 6/2011. (I. 14.) Decree on rules on testing, inspection, evaluation related to level of air load and stationary air pollution point sources states that in case of odour emitting sources the odour emissions of the issuing source, the efficiency of the applied odour control equipment and controlling system should be checked annually or in every two years with olfactometric measurement, depending on the decision of the Inspectorate. A Decree states that the organisation that performs the monitoring of the site-specific air pollution source, and measures the level of air pollution load should have accreditation in accordance with its tasks. The Ministry of Environmental Protection and Water's 23/2003. (XII. 29.) Decree on treatment of bio waste and the technical requirements of composting states in its Annex that bio-waste treatment plant located near to residential buildings (less than 500 m) should reduce their odour impact. The effectiveness of treatments with technical equipments agains odorous materials must be evaluated in a dynamic way with olfactometric measurement (Béres et al. 2014a).

In case of dynamic olfactometry, the scent flowing in constant volume mixed to flowing, odourless air, increasingly until that the person performing the measurement (the "nose") feels it. The dilution number (Z') characterized by the odour intensity is determined by the ratio of the odourless air and the scent flow (the ratio of dilution), and that number characterizes the scent concentration that is the strength of the odour (Béres 1997).

$$Z' = \frac{\dot{V}_m + \dot{V}_h}{\dot{V}_m}$$

where:
V_m – the sample gas, the odorous air flow rate [m^3/s],
V_h – the dilution gas (reference gas) flow rate [m^3/s],
Z' – dilution number [1]

The index-number of odour strength is the odour unit (Z, its measurement unit: OU/m^3 – Odour Unit / m^3), which expresses the extent of the odour effect by entering the dilution rate at which odour of air mixed with the sample was not yet/was just about to be sensed.

$$Z = Z' \times c_0$$

where:
Z – odour concentration [OU/m^3]
Z' – dilution number [1]
c_o – odour concentration at the odour threshold [1 OU/m^3].

1 OU/m^3 expresses the amount of odorous material which was not yet/was just about to be sensed in 1 m^3 neutral air within 50% of the people conducting the test. The resulting measure number expresses the extent of the stenching air's odour impact with the diluting ratio at which the odour of polluted air was not yet/was just about to be sensed.

At application of dynamic olfactometry, odour concentration of the gaseous sample is determined by the offer of different dilutions (mixed with neutral gas) for the group of individuals selected for the testing measurement to determine the dilution factor for the 50% detection threshold value (Z50), as described in the standard. Odour concentration of the tested sample is expressed by multiples of 1 European Odour Unit (OUE). One European Odour Unit, [OUE/m^3], is the amount of odourant(s) that, when evaporated into one cubic metre of neutral gas at standard conditions, elicits a physiological response from a panel (detection threshold) equivalent to that elicited by one European Reference Odour Mass (EROM), evaporated in 1 m^3 of neutral gas at standard conditions. 1 EROM evaporated into 1 m^3 neutral gas under standard conditions is similar to the D50 physiological response (detection threshold) which is measured by a measuring group in accordance with this standard and by definition the concentration is 1 OUE/m^3. This is the correlation between the reference material related OUE and any odorous material mix. The correlation is only defined on the level of D50 physiological response (detection threshold), where:
1 OUE (n-butanol) = 1 EROM (n-butanol) = 1 OUE mix of any odorous material. This correlation is the base of the transferability of the odour unit to any odorous material relative to the reference material. Basically the odour concentration is expressed as the "mass equivalent of n-butanol".

MEASURMENT OF ODOUR CONCENTRATION AND THE PROBLEMATICS OF SAMPLING

The standard on the measurement of odour (MSZ EN 13725:2003 „Air quality. Determination of odour concentration with dynamic olfactometry") regulates the odour sampling and measurement clearly which forms the basis of the method, but it does not provide sufficient guidelines for the inspection of odour impact reducing equipment and systems (eg. determination of sample numbers, designation of sampling points, evaluation of test results). In case of odour impact reducing equipment, additional specific problems arise during sampling, which are ambient we do environmental air and point source sampling, so in some case specific sampling techniques are needed. During odour sampling, depending on the sampled emission source, different sampling devices and methods are needed. In case of point source, a so called lung principle operated sampling device is applied, in case of high temperature or humidity gases, the standard requires a pre-dilution sampling device to avoid condensation, and in case of surface sources (so in case of aerated composting prisms too) sampling bells or aerated sampling bells (eg. open fertilizer storage) are applied. With the sampling bells a minor part of the sampled area is covered, and the odour sampling takes place from the air collected by the bell (Béres et al. 2014b).
The high relative humidity of the sampled area is a frequent problem, at this time during sampling, or after that in the sample condensation may occur, which has be to avoided as the aforementioned standard requires. To avoid condensation, a special sampling device has to be used, heated sampling probes and wires widely used in emission sampling are not suitable, because they can alter the concentration and nature of the odour during their operation. The minimum number of samples is also an important issue required to evaluate substantively the equipment and also the determination of sampling points. Especially in case of large equipments (eg. open bed bio-filters) we can find inhomogenity (eg. compacted filter media ranges) in the cleaning medium, thus in some parts of the bio-filter the residence time of the air may vary, resulting in different odour concentration of the treated air leaving at various points of the surface.

As the standard concerning odour measurement does not contain the exact number of samples, nor the location of the sampling points or their designation, our goal during our work was to develop a credible preparatory and resulting sampling method, using the most common 25 meters long and 8 meters wide sidewall composting unit as an example. On the basis of our studies a minimum sampling number has been determined which can provide representative measurement results to determine the odour emission of a composting prism (surface odour emission source).

SAMPLING AND RESULTS

A dimerous sampling plan has been developed before the on-site sampling. The first part consisted of preliminary tests, during which sampling has been carried out from the surface of the composting prisms, from orderly or randomly selected sampling points. A systematic sampling took place according to the required sampling number, based on the results of pre-tests' determined sampling method. The sampling points were determined by pulling an imaginary square grid on top of the composting prism, leaving the sides. During the sampling, RGSB-P/10-type, five layered, 10 l gas sampling balloons were used, which allowed the preservation and transport of the samples to the laboratory olfacometric measurement site, in the same state.
The necessary sampling number were determined by tests measurements, which representatively describe the odour concentration conditions prevailing on the surface of the composting prisms. During further measurements the adequacy and applicability of the developed method was verified through a specified number of measurements.
Our measurements were performed on samples at different stages of maturity from Gover Cover membrane covered green waste composting prisms located at the Zöld Híd Régió Ltd. composting plant, Gödöllő. In our study, the measurement of size and magnitude of odour was done by an olfactometer, as described in the previously presented MSZ EN 13725:2003 standard that is valid in our country.

Determining the required sampling number was done by taking into account the statistical evaluation of the preliminary tests. To determine the required sampling number, we used the Chebyshev formula frequently used in measuring and planning practice, which can help to determine the actual required number of measurements carried out on the basis of the characteristics of preliminary studies and the statistical features of the defined test results (number of measurement, standard deviation, confidence limits, relative failure of the device), the following way:

$$n = \frac{t_{P5\%}^2 \cdot s_{\%}^2}{h_{\%}^2}$$

where:
n – number of measurements
$s_{\%}$ - variation coefficient
$t_{p5\%}$ - safety limit
h% - relative default of the device

We worked with the most commonly used 95 % confidence level, furthermore we selected the relative default of the device (h %) to 20 % based on literature data.
During the preliminary studies, four sampling points was selected, systematically and equally randomly in multiple repetitions on composting prisms of various age. After the measurement, the results were analysed on the basis of the Chebyshev formula. Based on the results of samples from the selected sampling points it is stated that a representative sampling requires at least 8 samples. In order to check this, we worked with eight sampling points and systematic sampling during further measurements. The control measurements were also carried out with composting prisms (with semipermeable membrane cover) of different stages of maturity. It was concluded that in order to reach the representative data which describes the 25x8 m laminate covered composting prism's odour emission, sampling from 8 sample points is necessary and sufficient. The adequacy of sampling numbers were subject to confirmation without exception, based on the Chebyshev formula applied on results. In Figure 1. the odour concentrations are shown on systematically selected measure points during the examination, on a green waste composting prism with membrane cover.(Koplányi 2016)

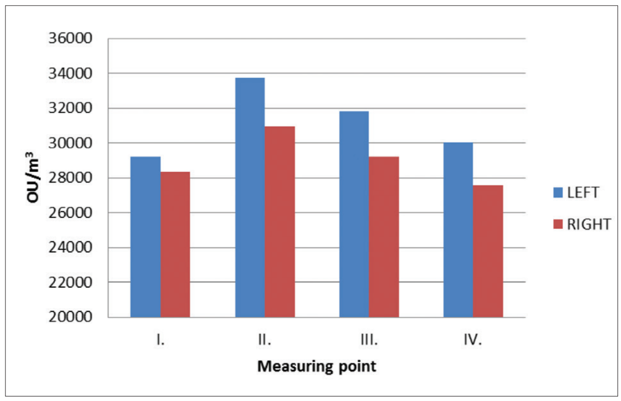

Figure 1 Odour concentrations on systematically selected measure points during the examination, on a green waste composting prism whit membrane cover

It was found during the examination that the obtained odour intensity values are consistent with the odour concentration values reported in literature (4500-77000 OU/m^3) (L.F.Diaz et al. 2007), considering the preliminary tests, the measured values were changed between 15000-38000 OU/m^3.

The resulting odour concentration values obtained in the systematic sampling were corrected in order to achieve representability with the data related to the aeration intensity of the examined technology, and with the data on the on the examined technology's known aeration intensity found in the literature (Fazekas et. al 2011, Kocsis 2011). Odour emission results [OU/s] have been calculated by odour concentration [OU/m^3] and flowrate values obtained from aeration intensity [m^3/s]. In all cases, we got the same results as in the literature, the rate of odour is more intensive in the initial stage of composting, than it gradually decreases. As it is shown in Figure 2, the highest odour emission can be observed in the intensive decomposition stage, where the aeration system operates

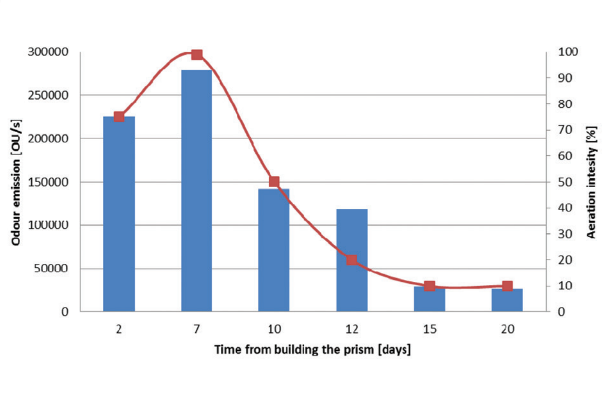

Figure 2 The correlation between odour emission reduction and aeration intensity in the function of time from building the prism, on a green waste composting prism whit membrane cover

with maximum capacity. The figure illustrates that as the biological stabilization advances, the odour emission rate decreases as well.

CONCLUSIONS

On the basis of the conducted studies it is stated that the sampling method presented in this work is suitable for representative odour sampling and odour measurement. By using the method the odour concentration conditions of the 25x8 meters sidewall designed composting prisms used regularly in Hungary can be described. The sample number (8 on the whole surface), determined with the Chebyshev formula in course of test measurement also proved to be adequate during monitoring measurement, to conduct a credible, representative measurement. Although, it was not the aim of the study, we observed during the measurement that answers given by the persons conducting the tests became refined, the sensitivity of their noses was improved. Neither the standard nor the literature contains any references in this respect, so to minimize the resulting subjectivity and the measurement uncertainty a more detailed examination of these issues is recommended during the update of the standard. Our aim during later work is further testing of the reliability of the measurement method and to adapt it to other composting technologies and raw materials. (Koplányi 2016)

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LIFE Clim'Foot Project

"Climate Governance: Implementing Public Policies to Calculate and Reduce Organisations' Carbon Footprint"

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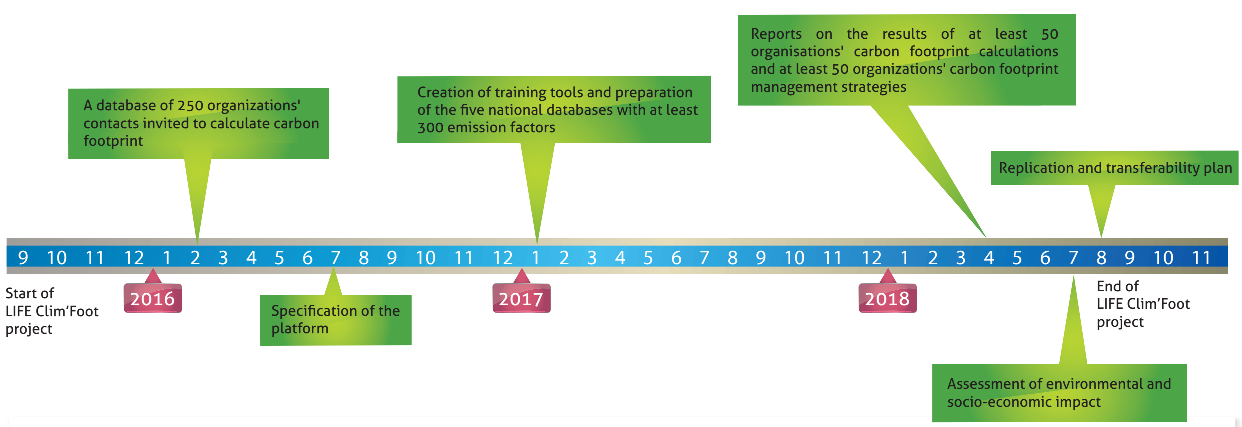
The LIFE Clim'Foot aims are to develop public policies to help organisations calculate and reduce their carbon footprint.

More specifically, the project goals are:

- to launch a dynamic European network for carbon accounting;
- to train end-users and give them the tools for calculating and reducing the carbon footprint of organisations;
- to develop tools (training, database) customised to each country;
- to involve local actors (decision-makers, investors, public bodies) in reducing emissions.

Anticipated results of the project

The LIFE Clim'Foot project is addressing the lack of tools and methodology (other than EU-ETS) for the implementation of national public policies aimed at reducing the carbon footprint of organisations in the EU countries.



Quantitative results of the project are:

- 5 national models for carbon footprint calculation of public and private organisations;
- 5 national databases with at least 300 emission factors;
- at least 50 organisations involved in calculation of carbon footprint;
- at least 50 organisations involved in preparation of carbon footprint management strategy.