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STATISTICAL ANALYSIS OF SUITABILITY OF THE ACTIVITY BASED COSTING METHOD IN AGRICULTURAL ENTERPRISES

Purpose. *The paper focuses on comparing two cost calculation method describing the principle, utilisation, advantages and disadvantages of the traditional mark-up on cost pricing (overhead method) against Activity Based Costing (ABC), a new, unconventional method of cost calculation. The aim is to prove that the ABC method allocates costs differently to individual products, in a different proportion thereto, unlike the mark-up method. The ABC method is considered by us more accurate because it views differently how costs originate.*

Methodology / approach. *Statistical data testing was carried out, using the Kolmogorov-Smirnov and Shapiro-Wilk W tests, followed by a paired t-test, and completed with the Wilcoxon signed-ranks test. The data was evaluated for eight selected products, whose overhead value was calculated from both marking-up and ABC, out of a selected set of primary agricultural enterprises in Slovakia. Finally, the results were assessed with an unproven statistically significant difference between the calculation methods found.*

Results. *This paper emphasises a different view of costing with the ABC method which, unlike conventional methods, offers multidimensionality and variation of cost tracking based on real and relevant data. A statistically significant difference between the methods was demonstrated for three pairs of variables (out of a total eight pairs). Statistically significant differences were found for cattle, wheat and sugar beets. Although statistical testing has not shown any significant difference between the methods, ABC is still considered a more accurate costing method for allocating overhead. The argument here follows from the very principle and method of ABC allocation of overheads. Unlike traditional methods, ABC offers multidimensional and diverse cost tracking based on real and relevant data. The direct allocation of costs (using an equal budget base) to products and services does not necessarily capture actual cost flows. Because overheads are higher on farms, misleading data can be provided. Practical experience in agriculture seems to imply that the ABC method is the most cost-effective tool for cost control and encourages its further use in budgeting, planning, modelling and decision-making.*

Originality / scientific novelty. *The paper focuses on cost calculations made in agricultural holdings, often a neglected topic in agricultural management. In particular, high overhead costs in agriculture deserve more attention. Their exact allocation to products is important. The paper also focuses on assessing the suitability of calculation methods in agricultural holdings and on pointing out the need for accurate cost allocation.*

Practical value / implications. *The main results and ideas here can be beneficial for managing agricultural holdings. Where the proportion of overheads is higher, management may be provided with misleading data. Practical experience shows the ABC method to be currently the most cost-effective tool for controlling costs and provides opportunities for its use in budgeting, planning, modelling and decision-making on product range structure, alongside other options.*

Key words: *Activity Based Costing, mark-up calculation method, resulting calculation, agriculture, overhead cost, statistical testing.*

Introduction and review of literature. Perfect knowledge of the total cost of production is one of the basic conditions for business success. Without a knowledge of costs, it is not possible to set the correct price of a product or service, nor to take the correct decision to include the product in the company's production programme. Results from calculations of the cost of activities can become a powerful weapon in the hands of an enterprise competing in the market. Cost advantage is an important source of competitive advantage in a strong competitive environment (Grznár et al., 2009; Bojnec and Fertő, 2010) and calculation of product costs plays an important role in a company's information system. It is a source of information on the costs of selected products that exhibits great explanatory power.

Traditional costing methods frequently mark-up overhead costs. Although these methods are currently considered obsolete, most agricultural enterprises in Slovakia still use them. Contrary to previous convention, more modern calculation methods are converting non-specific, anonymous overheads at direct cost. This is critical because the agricultural sector is characterised by high overheads. Traditional calculation methods use a schedule base – a mark-up – to indirectly include overhead in the cost of a product. It most often consists of the direct costs of different cultivated crops, farm animals, customer orders, labour and services for others.

Companies should always seek to allocate as many product or activity costs as possible among direct costs. While managing overhead costs is complicated, it is nevertheless very important because the calculation formula requires changing the content structure for individual cost items. A good solution for agricultural overheads is non-traditional calculation methods, especially Activity Based Costing (ABC), which converts them into direct costs, bringing a new perspective. The importance of the ABC calculation method is summarised in the review of literature about it below.

The process of substantiating, adopting and implementing managerial decisions requires much analytical work derived from various economic calculations. Objective and accurate results of such an analysis are always sought when developing and justifying managerial decisions (Bakulina et al., 2020). Costs always remain the focus of financial managers, being an important indicator with a degrading impact on the benefit of the entity (Stratan and Manole, 2018). Agricultural enterprises currently need tools in practice to measure production costs for particular steps in currently processes. One of these tools is activity based costing, which lays the groundwork for decision-making processes (Więcek et al., 2020). Yet there has been little penetration of the ABC in small and medium-sized enterprises (SMEs) still using traditional systems due to lack of knowledge, while others are using no costing system at all (Ríos-Manríquez et al., 2017).

Apart from product quality, manufacturing costs are an important element in competitive sectors. Detailed economic assessments are important for estimating product costs accurately and to avoid overestimations or underestimations that reflect poorly on the enterprise (Jiran, 2019). Because companies are now facing stronger competition at the global level, the pressure to increase productivity and cut production costs has sparked the search for a method that estimates the costs of various products from the same company in a rigorous and precise way and this has turned into a strategic objective (Almeida and Cunha, 2017).

ABC is an accounting system that collects and analyses all costs related to activities that occur in an organisation based on their nature. ABC can overcome many of the limitations of traditional cost accounting (TCA) methods as it helps to discover hidden or distorted cost information and remove the generalisation in TCAs (Al-Eidan et al., 2019). ABC systems emerged as a management accounting innovation in the mid-1980s, in response to dissatisfaction with traditional management accounting techniques and heightened international competition (Park et al., 2019). Because the business environment has been changing rapidly, especially in the last 20 years, companies are facing stiff global competition and those using traditional costing systems have been forced to adopt newer costing approaches like ABC, which is able to provide better decision-making information (Altawati et al., 2018).

Traditional costing systems distort the costs of services and products because overhead costs are allocated through cost centres or departments, while activity-based costing assigns costs to products and services on the basis of resources consumed in their production, providing an effective tool for activity based costing/management (ABC/M). Costs are assigned to specific activities like planning, design, engineering, production and despatch, associating the value chain to different products or services. ABC/M facilitates proper decision-making, improving effectiveness and efficiency. ABC's methodology for determining the real cost of products and services makes it easy to identify products and services that are or are not economically viable, or are just breaking even. Eventually, the economic break-even point can be determined for a comparison of the different options available and to explore opportunities for strategic, cost-controlling decision-making. An ABC/M system lets businesses analyse their information bases for activity-based costing and identify what can be eliminated because it adds no useful value to a product, as well as to focus on what contributes to useful value and to support product improvements that will satisfy consumer demands (Sinha, 2020). ABC also provides enterprises with relevant cost information (Sánchez, 2020).

In recent years, manufacturers have expanded their product portfolios and derived numerous variants for their products. To make strategic decisions for product portfolios, it is essential to know what each product costs and all the alternatives available for every product. But often no such exact allocation of a company's indirect costs for their products is possible. Existing methods such as activity-based costing and process costing aim for cause-related allocation to products of the costs to manufacture them, particularly indirect and overhead costs. Increasing digitisation and the use in companies of business information systems are providing them with new capabilities to obtain cost-relevant data faster and to increase calculate costs in a more timely fashion (Riesener et al., 2019).

Applying the recommended activity-based costing methodology allows for the most accurate possible allocation of indirect costs according to the processes they provide, as well as to determine expenses and recognise them more quickly in the correct period (Polikarpova and Mizikovskiy, 2019). The result should be refined information top management would then use to make decisions and overcome problems they have faced (Kucera, 2019).

The relationship between product diversity and the need to adopt ABC is quite significant and has been positive (Alcouffe et al., 2019). Development of an ABC cost management system takes into account at all stages the directions information flows between elements of a cost management system organisational structure, making it possible for resources to be used effectively (Perevozova et al., 2019). Extensive use of ABC for cost analysis, strategy and evaluation directly improves operational performance and also indirectly improves financial performance. The results are similar for manufacturing and non-manufacturing firms, and for large firms and SMEs (Vetchagool, 2020).

The results reflect a costing-based system that performs better compared to traditional costing systems. ABC enhances decision-making with better adaptable costing features to support the new business environment and global business competition, thus creating a more sustainable source of competitive advantage. In addition, it identifies a company's under-costed and over-costed products (Altawati et al., 2018).

Companies operating in the agricultural sector need to deepen effective use of the appropriate techniques for strategically managing their process and business costs to meet the different demands of the agribusiness economic system, caught in an environment of new perspectives and challenges due to the reshaping of markets and continuous improvement of competitiveness (da Silva et al., 2019).

Research on agricultural calculations is beneficial for farmers, where it is essential for them to have knowledge about how to determine and calculate product costs in order to set selling prices either from traditional, conventional methods or activity-based methods for calculating costs. Traditional methods recognise costs from the product itself, including production costs not incurred by the product. On the other hand, activity-based cost calculation explains how the cost is classified, driven, and controlled for the products. Research generally suggests that farmers should adopt an activity-based calculation method, as it more accurately classifies costs (Barus et al., 2019). The studies recommended implementation of ABC to obtain the various benefits associated with it (Arora and Raju, 2018).

ABC provides more accurate cost information for a competitive product price strategy that greatly contributes toward increasing an enterprise's profitability and competitive power (Lu, 2017). Adopting and implementing ABC in companies play a major role in reducing costs and maximising profitability (Al Hanini, 2018) and utilising the ABC concept can lead to better decision-making when selecting re-manufacturing system configurations (Calvi et al., 2019). Expert managers from all over the globe have actively introduced ABC into enterprise logistics cost accounting and achieved results (Zhang and Li, 2018). Yet they should be equally aware that designing and implementing a cost system that can also control costs is a very difficult, if not insurmountable challenge (Allain and Laurin, 2018). An enterprise willing to implement ABC should be capable of comprehending the associated operational adjustments (Sorros, 2017). The ABC system was found to be efficient for management and administration of agro and agroforestry enterprises (Araujo, 2020). Because of ongoing income pressure in agriculture, analysis of farm activity services and costs is gaining in importance. ABC's advantage would be to achieve a wider impact, encouraging cost awareness at farms and possibly improve the income picture ultimately (Gazzarin and Lips, 2018).

The purpose of the article. The paper focuses on comparing two cost calculation method describing the principle, utilisation, advantages and disadvantages of the traditional mark-up on cost pricing (overhead method) against Activity Based Costing, a new, unconventional method of cost calculation. The aim is to prove that the ABC method allocates costs differently to individual products, in a different proportion thereto, unlike the mark-up method. The ABC method is considered by us more accurate because it views differently how costs originate.

Research methodology. Agricultural enterprises are presently paying insufficient attention to internal management, their own valuation methodologies and their internal accounting practices. Costs are reported and calculated with hitherto used practices and algorithms, currently built on existing software products. Agricultural enterprises seem unconcerned about the practical aspect of those calculations. Recognising costs according to the type of cost cannot fully meet the needs of their internal management, while linking the allocation of costs to activities performed fails to provide an objective view of the enterprise's own costs. Practically, this is reflected in production cost management and appears as an issue when ascertaining the fair value of assets acquired through the enterprise's own business activities.

This paper seeks to use statistical methods in order to compare the resulting cost calculations. Two calculation methods – conventional marking-up and Activity Based Costing – are then applied and the resulting overheads established. Another objective of this paper is to describe the approaches both methods employ to calculate costs, pointing out how either method causes deviations in the results and assessing how accurate product costs are allocated.

As mentioned earlier, the first part of the paper describes the views of experts on the ABC calculation method; the second part focuses on characterising the two calculation methods, comparing them and also describing the statistical methods that were used in testing, and the third part concentrates on the actual statistical testing and submission of conclusions and suggestions. The statistical investigation included cost data that had been calculated for selected products at 35 agricultural enterprises engaged in primary production. These included cooperatives, limited liability companies and joint-stock companies established and based in Slovakia. These enterprises' costs were calculated from eight pre-selected products, four from crop production – wheat, barley, sugar beet and grain maize – and four livestock products – dairy cows and cattle, pigs and chickens raised for meat.

Input data for statistical testing were obtained from costs calculated by both conventional marking-up and ABC. Data was obtained from controlled interviews with staff at the specific businesses and with the consulting companies implementing the Activity Based Costing model into business practice.

The traditional mark-up method for calculation allocates plant overheads to products based on the volume of production resources consumed. It is a less demanding calculation still used in many manufacturing and non-manufacturing companies. Under this method, overheads are usually allocated based on either the amount of direct working time consumed or the machine time used. The main disadvantage of this method is that it combines all indirect costs and allocates them using the products themselves. In most cases, this allocation method makes no sense because it incorporates indirect costs for all products at different phases. For calculation purposes, costs should be split into two groups, one consisting of the direct costs able to be estimated according to the technical and economic standards and calculated either by units or the amount of output, and the other of indirect costs shared by all of the calculating units or multiples of them. Indirect costs need to be allocated to the calculating units according to certain budgetary bases or keys. When there is more than one type of output, indirect costs are incorporated into the calculation through a mark-up or an overhead rate, depending on which budgetary base is used.

All overheads are allocated to one calculation using a single common budgetary base. It should be determined so link the overheads are linked very closely (i.e. an increase in the base will also increase the overheads for the calculated output and vice versa). Budgetary bases can be monetary or based on natural units based on quantity. While monetary values are used for direct material, direct wages and direct costs, quantity can be the weight of consumed material, standard hours, machine hours and other values not monetarily based. In practice, direct wages are used most often in budgeting. In percentage points, overhead mark-up expresses how much overhead is allocated to each type of output according to the selected base. When allocating indirect costs from a value-based base, the mark-up is calculated with these formulas below:

% overhead mark-up = (overhead costs / budgetary base in monetary units) x 100,

where the equation is the percentage of budgeted costs per calculated output, thus (mark-up % x total budgeted costs per calculated output) / 100.

The overhead rate is calculated when budgeting indirect costs from the natural base. The overhead rate is calculated as the ratio of overhead costs and the budgetary base in natural units.

overhead rate = overhead costs / budgetary base in natural units

percentage of budgeted costs in calculated output = rate x number of natural units,

where rate is calculated in cash for a natural unit, for example € 20 per tonne.

Financial accounting easier identifies and checks values than quantities, which have to be monitored through less reliable operational records. Therefore, values are used more frequently to budget indirect costs.

The disadvantage of this method is its failure to take the company’s own activities into account, thereby limiting the accuracy of costing. In this case, it is a one-step allocation of costs to cost objects and is especially suitable for smaller, simpler and less dynamic companies with low indirect costs. Traditional costing still works well for financial statement reporting, where it is simply intended to apply overhead to the number of produced units for the purpose of valuing finished product inventories. There is no consequence here from a management decision-making perspective. But especially in the modern world, the traditional method is loses favour. Cost experts have therefore come up with the newer ABC calculation, which simply reinforces the existing traditional method of calculation.

ABC was developed to circumvent the problem of traditional calculations. It uses a more detailed analysis of the relationship between overhead costs and cost factors. Many cost factors can be used to create a more sound allocation of overhead costs. ABC can be defined as a costing approach that identifies individual activities as basic cost objects. This method first allocates the costs of individual activities and then uses them as the basis for assigning costs to the final cost objects. This is in an activity-based calculation, first assigning to each activity and then redistributing the costs to individual products or services. Some of the factors used to distribute overhead costs are the number of orders, inspections and proposed production. The comparison of both approaches is shown in Fig. 1.

The ABC system assigns costs through the use of so-called "cost drivers". These are any data that can be monitored monthly, such as staff headcount, wage costs, trade receivables and operation time per product. If the activities are internal in nature (e.g. maintenance, human resources), their calculated costs are then transferred to other business activities according to how they are actually performed. The next step involves transferring the costs of these activities to products and services according to real data about the product subjected to the activity, thereby obtaining final monthly results for all products with a high level of accuracy.

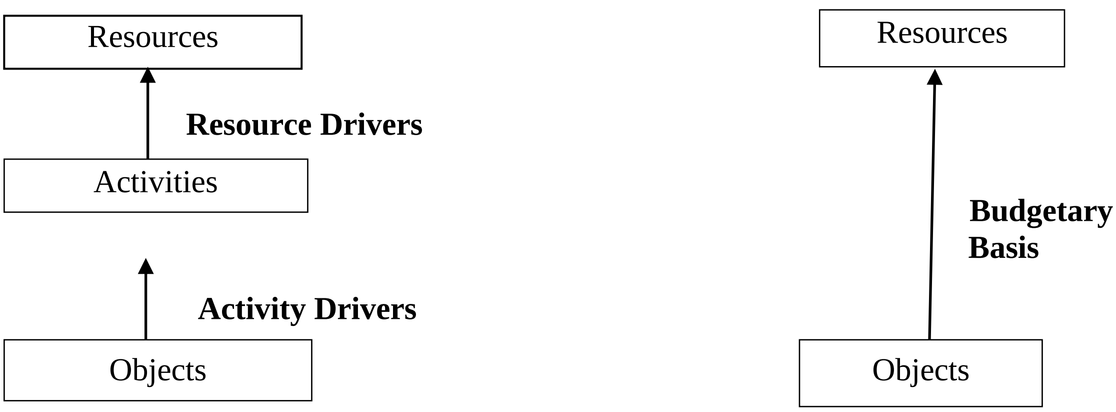

Fig. 1. ABC principle in comparison with traditional calculation

Source: own figure.

One of the greatest benefits of ABC is its linking of recognised costs, the costs of the processes, product costs and costs per customer in one system. Other benefits of ABC include effectively producing monthly final product-related calculations monthly, evaluating monthly earnings and economic added value per customer and per product, streamlining the economic efficiency of processes, direct allocation of overhead costs to specific business activities, process cost analysis, objective information for outsourcing and benchmarking, process and activity planning and budgeting, optimising product and customer portfolios and generating data for management accounting and controlling. The ABC method is a progressive tool for cost controlling and a special form of Function Cost Analysis offering a modern understanding and a more accurate description of costs, allowing a company to assess its financial situation continuously.

This paper compares the resulting calculations per products yielded by both calculation methods. Input data in the calculations are data on the amount of costs by type for the enterprise as a whole. These total costs are allocated among eight agricultural products by the traditional method (overhead, mark-up calculation) and, for the sake of the comparison, the same total costs are calculated by unconventional Activity Based Costing (which uses a two-step allocation to calculate overheads).

Comparing the resulting cost calculations both methods yield, the focus is on the calculated overheads, as both methods allocate direct costs equally by adding them directly to the product. The difference lies in the different approaches to allocating the overheads. Based on the above, the following *scientific hypotheses* have been determined*:*

H0: The two methods show equal mean values.

H1: The two methods show unequal mean values.

Testing can lead to either rejecting or accepting the zero hypothesis H0 and the alternative hypothesis H1. The decision whether to reject or accept the zero hypothesis is made by the p-value (the Sig. column in the outputs). All testing was performed at 5% of the test level. When the p-value is less than 0.05, H0 (equal mean values) will be dismissed and H1 (unequal mean values) will be accepted.

The first step involves a pair t-test to assume whether the methodology is normal. If this assumption were not met, a non-parametric alternative would no longer support this assumption.

The postulated hypotheses were tested statistically, running in the R program. For statistical purposes, normality was tested first; in other words to verify whether the monitored variable had a normal distribution. The Kolmogorov-Smirnov and the Shapiro-Wilk test were used here.

In probability and mathematical statistics, Kolmogorov-Smirnov (abbreviated "K-S") is a nonparametric test whose test statistics follow the greatest deviation between the theoretical distribution function (referred to as F (x)) and the empirical distribution function (referred to as Fn (x)), or between two empirical distribution functions. The empirical distribution function is obtained from random selection. Kolmogorov-Smirnov test statistics are then expressed as follows:

$$D_n = \sup_x |F_n(x) - F(x)|$$

where sup_x indicates supremacy.

The Kolmogorov-Smirnov test is designed to test the zero hypothesis H_0: F(x) = G (x) for all x ϵ R against the alternative hypothesis H_1: F(x) ≠ G(x) for at least for one x, where F a G are the distribution functions of two independent selections.

The zero hypothesis would be rejected at the α level of significance, if $D \geq D_{m,n}$, where $D_{m,n}$ is a critical value according to the respective table.

In most situations, the Shapiro-Wilk W test has the greatest strength of all normality tests. If the *W* statistics are significant, the zero hypothesis that claims the data come from a normal distribution would be rejected.

$$W = \frac{\left(\sum_{i=1}^{n} a_i x_{(i)}\right)^2}{\sum_{i=1}^{n} (x_i - \bar{x})^2} \quad (1)$$

where $x_{(i)}$ (with parentheses enclosing the subscript index *i*) is the *i*th order statistic, i.e., the *i*th-smallest number in the sample; and

$$\bar{x} = \frac{(x_1 + \dots + x_n)}{n}$$ is the sample mean;

The constants a_i are given by

$$(a_1, \dots, \quad a_n) = \frac{m^T V^{-1}}{(m^T V^{-1} V^{-1} m)^2} \quad (2)$$

where $M = (m_1, \dots., m_n)$ T;

$m_1, \dots., m_n$ are the expected values of the order statistics of independent and identically distributed random variables sampled from the standard normal distribution; and V is the covariance matrix of those order statistics.

The significance is calculated from the computed W statistic by linearly interpolating it within the range of simulated critical values. When non-integer weights are specified, the Shapiro-Wilk's statistic is calculated with the weighted sample size lying between 3 and 50. For no weights or integer weights, the statistic is calculated when the weighted sample size lies between 3 and 5000. For Ww > 0.99, the critical value of the 99th percentile, the significance is reported as greater than 0.99. Similarly, for Ww < 0.01, the critical value of the first percentile, the significance is reported as less than 0.01.

A pair t-test was subsequently performed. The paired sample t-test, sometimes called the dependent sample t-test, is a statistical procedure used to determine whether the mean difference between two sets of observations is zero. In a paired sample t-test, each subject or entity is measured twice, resulting in pairs of observations. Common applications of the paired sample t-test include case-control studies and repeated-measures designs. The dependent t-test (called the paired-samples t-test) compares the means between the two related groups on the same continuous, dependent variable.

Basic statistics:

Means

$$\bar{X} = \sum_{i=1}^{\infty N} w_i X_i / W \quad (3)$$

$$\bar{Y} = \sum_{i=1}^{\infty N} w_i X_i / W \tag{4}$$

Difference of the Means D= $\bar{X}$ - $\bar{Y}$

Standard Error of the Difference

$$S_D = \sqrt{\left(S^2 x + s^2 y - 2s_{xy}\right)/W} \tag{5}$$

t statistic for Equality of Means $t=D/S_D$
with W −1 bg degrees of freedom. A two-tailed significance level is printed.
95 % Confidence Interval for Mean Difference
$D \pm t_{w-1} S_D$
Correlation Coefficient between X and Y

$$r = \frac{S_{XY}}{S_X S_Y} \tag{6}$$

The two-tailed significance level is based on

$$t = r\sqrt{\frac{W-2}{1-r^2}} \tag{7}$$

with W −2 bg degrees of freedom.

We tested the values for one of the analyzed products (sugar beet) by the non-parametric *Wilcoxon Signed Ranks Test*. The test statistic is

$$Z = \frac{\min\left(S_p, S_n\right) - \left(n(n+1)/4\right)}{\sqrt{n(n+1)(2n+1)/24 - \sum_{j=1}^{l}\left(t_j^3 - t_j\right)/48}} \tag{8}$$

where n – number of cases with non-zero differences;
l – number of ties;
t_j – number of elements in the j-th tie, j =1, ..., *l*.

For large sample sizes the distribution of Z is approximately standard normal. A two-tailed probability level is printed.

Results and discussion. Table 1 lists the data for statistical testing. These are data on overhead costs that were calculated for selected products using ABC as the alternative calculation and by conventionally marking up.

The distribution of the frequencies of the input analysed variables is graphically represented by a boxplot (Fig. 2). The blue window indicates the quartile range in which the median is marked.

Table 1

Data for statistical analysis

Agricul-tural holdings	Overhead unit costs in EUR calculated using the mark-up method (traditional)									
	Livestock production					Crop production				
	Milk cows-milk	Fatte-ning beef cattle	Fatte-ning pigs	Fatte-ning chickens	Total	Wheat	Barley	Sugar beet	Corn for grain	Total
1	0,25	0,91	0,73	0,61	2,5	35,23	37,89	8,65	36,96	118,73
2	0,19	0,65	0,53	0,31	1,68	23,61	28,14	6,52	25,87	84,14
3	0,28	0,78	0,68	1,12	2,86	32,12	39,85	6,19	31,23	109,39
4	0,24	0,75	0,42	0,82	2,23	28,45	32,45	4,89	31,56	97,35
5	0,14	0,99	0,54	0,32	1,99	25,68	21,62	5,67	12,62	65,59
6	0,17	0,81	0,51	0,31	1,8	27,56	35,56	5,23	25,86	94,21
7	0,19	0,68	0,68	0,38	1,93	33,26	34,22	7,32	23,37	98,17
8	0,15	0,85	0,72	0,12	1,84	32,52	52,89	4,23	18,25	107,89
9	0,11	0,75	0,65	-	1,51	55,87	71,24	12,36	46,68	186,15
10	0,15	0,82	0,45	-	1,42	23,64	29,42	5,29	12,83	71,18
11	0,28	0,71	0,69	0,19	1,87	29,33	32,88	3,72	-	65,93
12	0,11	0,76	0,56	0,26	1,69	51,23	55,25	10,25	22,56	139,29
13	0,09	1,13	0,62	0,19	2,03	26,96	31,59	4,97	22,47	85,99
14	0,19	1,21	0,69	0,39	2,48	35,65	40,65	9,67	22,95	108,92
15	0,26	0,52	0,48	0,52	1,78	38,57	44,57	-	39,32	122,46
16	0,16	1,19	0,79	0,47	2,61	19,55	22,33	4,23	9,52	55,63
17	0,14	0,83	0,32	-	1,29	37,26	31,25	9,59	32,65	110,75
18	0,18	0,72	0,83	0,56	2,29	22,15	25,89	7,52	25,89	81,45
19	0,13	0,72	0,46	0,03	1,34	28,83	30,52	4,59	19,26	83,2
20	0,34	0,98	0,89	0,84	3,05	58,24	69,45	6,55	55,53	189,77
21	0,12	0,56	0,47	0,29	1,44	30,26	39,24	5,12	30,76	105,38
22	0,19	0,51	0,56	0,18	1,44	31,56	21,56	7,56	21,58	82,26
23	0,17	0,56	0,54	0,76	2,03	19,57	27,23	3,78	-	50,58
24	0,17	0,87	0,55	0,71	2,3	28,23	31,54	7,56	18,26	85,59
25	0,19	1,26	0,48	0,07	2	35,37	37,26	8,37	27,88	108,88
26	0,12	0,75	0,21	0,04	1,12	27,66	26,68	4,25	-	58,59
27	0,13	0,82	0,32	0,33	1,6	46,41	66,55	-	17,89	130,85
28	0,14	1,19	0,55	0,12	2	17,72	20,48	5,92	16,73	60,85
29	0,17	0,86	0,59	0,31	1,93	25,65	32,56	12,56	32,15	102,92
30	0,15	0,86	0,59	0,37	1,97	72,24	78,55	15,25	62,79	228,83
31	0,17	0,66	0,55	0,53	1,91	22,15	28,31	-	18,78	69,24
32	0,14	1,12	0,41	-	1,67	22,37	23,89	5,56	18,37	70,19
33	0,35	0,87	0,98	0,16	2,36	24,12	25,88	10,13	12,64	72,77
34	0,18	0,81	0,72	0,61	2,32	33,25	31,25	8,56	16,32	89,38
35	0,21	0,81	0,45	0,52	1,99	28,95	31,52	7,58	16,96	85,01

Continuation of table 1

Agricultural holdings	Overhead unit costs in EUR calculated using the ABC method (non-traditional)									
	Livestock production					Crop production				
	Milk cows-milk	Fattening beef cattle	Fattening pigs	Fattening chickens	Total	Wheat	Barley	Sugar beet	Corn for grain	Total
1	0,22	0,81	0,69	0,55	2,27	29,56	35,62	7,95	31,24	104,37
2	0,12	0,61	0,49	0,29	1,51	21,12	26,71	5,23	23,14	76,2
3	0,31	1,24	0,59	0,64	2,78	34,43	38,72	5,58	29,44	108,17
4	0,27	0,73	0,59	0,65	2,24	25,31	29,53	4,22	30,12	89,18
5	0,12	0,74	0,58	0,59	2,03	20,88	23,45	3,38	17,82	65,53
6	0,16	0,75	0,46	0,22	1,59	25,88	38,55	4,36	21,56	90,35
7	0,17	0,72	0,55	0,48	1,92	31,25	35,12	5,88	26,71	98,96
8	0,16	0,91	0,52	0,41	2	28,45	50,45	3,98	22,54	105,42
9	0,12	0,91	0,51	-	1,54	59,21	66,62	9,62	50,67	186,12
10	0,09	0,79	0,56	-	1,44	22,44	25,88	6,78	19,18	74,28
11	0,26	0,93	0,54	0,12	1,85	28,83	32,42	4,69	-	65,94
12	0,21	0,54	0,57	0,21	1,53	41,56	47,25	8,56	20,85	118,22
13	0,04	0,69	0,55	0,75	2,03	27,25	30,62	4,42	23,29	85,58
14	0,15	0,98	0,56	0,23	1,92	35,23	41,23	8,88	30,47	115,81
15	0,35	0,54	0,61	0,23	1,73	36,82	48,62	-	36,99	122,43
16	0,13	0,91	0,82	0,72	2,58	17,66	19,81	2,86	15,81	56,14
17	0,44	0,59	0,23	-	1,26	35,21	39,65	5,72	30,14	110,72
18	0,16	0,55	0,71	0,45	1,87	19,54	21,58	6,85	21,15	69,12
19	0,07	0,62	0,51	0,13	1,33	27,56	32,34	3,41	19,87	83,18
20	0,4	1,18	1,11	0,45	3,14	61,12	67,51	9,75	51,38	189,76
21	0,24	0,36	0,62	0,21	1,43	33,62	37,21	5,23	29,23	105,29
22	0,15	0,75	0,36	0,16	1,42	29,65	20,85	6,12	20,45	77,07
23	0,15	0,51	0,59	0,77	2,02	17,66	19,86	2,87	-	40,39
24	0,14	0,72	0,55	0,69	2,1	26,23	28,25	7,25	11,23	72,96
25	0,17	0,63	0,51	0,64	1,95	33,64	39,62	5,73	29,87	108,86
26	0,11	0,72	0,18	0,11	1,12	25,61	26,52	4,16	-	56,29
27	0,12	0,76	0,17	0,55	1,6	41,13	71,23		10,12	122,48
28	0,13	0,69	0,58	0,61	2,01	19,31	25,51	2,75	13,65	61,22
29	0,15	0,76	0,45	0,25	1,61	23,12	28,23	10,12	31,12	92,59
30	0,12	0,82	0,57	0,44	1,95	75,45	73,82	12,48	65,76	227,51
31	0,14	0,71	0,58	0,48	1,91	23,22	26,12	-	19,87	69,21
32	0,19	0,69	0,67	-	1,55	21,62	24,38	3,77	19,86	69,63
33	0,26	0,87	0,44	0,77	2,34	25,32	26,53	4,15	14,96	70,96
34	0,17	0,65	0,55	0,51	1,88	32,85	29,87	8,12	14,21	85,05
35	0,19	0,75	0,51	0,49	1,94	26,54	32,65	6,12	15,69	81

Source: own tables.

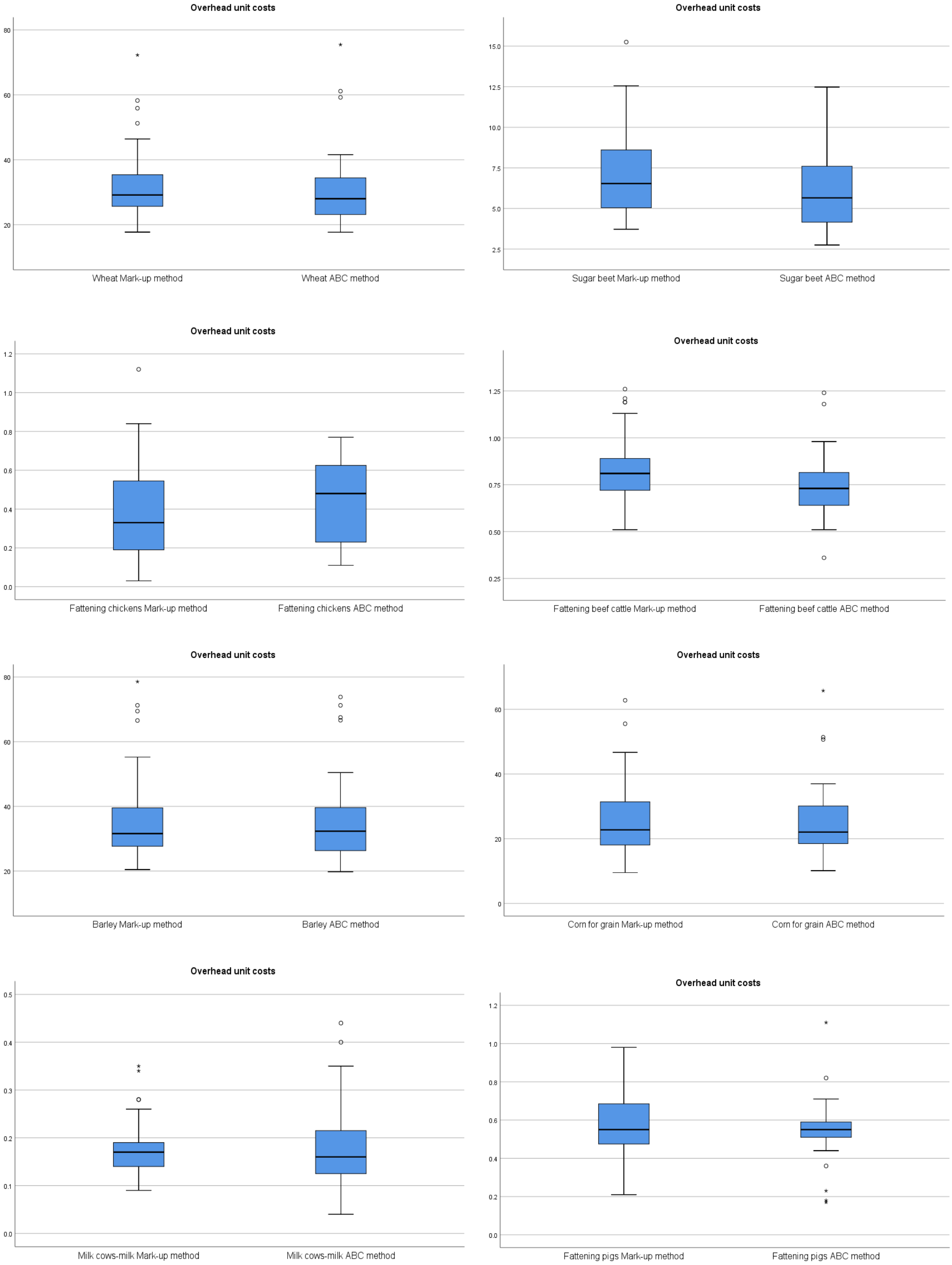

Fig. 2. Frequencies of the input analysed variables is graphically represented by a boxplot

Source: own graphs.

One of the prerequisites for the use of the pair t-test is the normality of the value difference. Table 2 displays normality tested by Kolmogorov – Smirnov and Shapiro – Wilk. It shows the results from the normality tests for the indicators analysed by both costing methods. Because there were a small number of observations, most cases rejected the null hypothesis, which assumes the distribution of a given variable comes to be a normal distribution, at a significance level of alpha 0.05.

Table 2

Test of normality

Tests of Normality						
Indicators	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Milk cows-milk Mark-up method	.216	35	.000	.895	35	.003
Fattening beef cattle Mark-up method	.175	35	.008	.937	35	.046
Fattening pigs Mark-up method	.114	35	.200*	.984	35	.878
Fattening chickens Mark-up method	.130	31	.195	.948	31	.135
Wheat Mark-up method	.193	34	.002	.842	34	.000
Barley Mark-up method	.205	35	.001	.817	35	.000
Sugar beet Mark-up method	.130	32	.182	.913	32	.014
Corn for grain Mark-up method	.154	32	.051	.880	32	.002
Milk cows-milk ABC method	.213	35	.000	.884	35	.001
Fattening beef cattle ABC method	.155	35	.032	.948	35	.096
Fattening pigs ABC method	.193	35	.002	.860	35	.000
Fattening chickens ABC method	.144	31	.103	.931	31	.048
Wheat ABC method	.195	35	.002	.791	35	.000
Barley ABC method	.175	35	.008	.842	35	.000
Sugar beet ABC method	.131	32	.173	.936	32	.058
Corn for grain ABC method	.195	32	.003	.848	32	.000

Notes: * This is a lower bound of the true significance.
a. Lilliefors Significance Correction.
Source: the authors´ own research.

The normality of the data is also evaluated using the quantile – quantile graph, so-called Q-Q graphs. Q-Q graph represents a comparison of measured values against expected normal values. The further the measured values are from the theoretical ones, the more the normality of the data is violated (Fig. 3, Fig. 4).

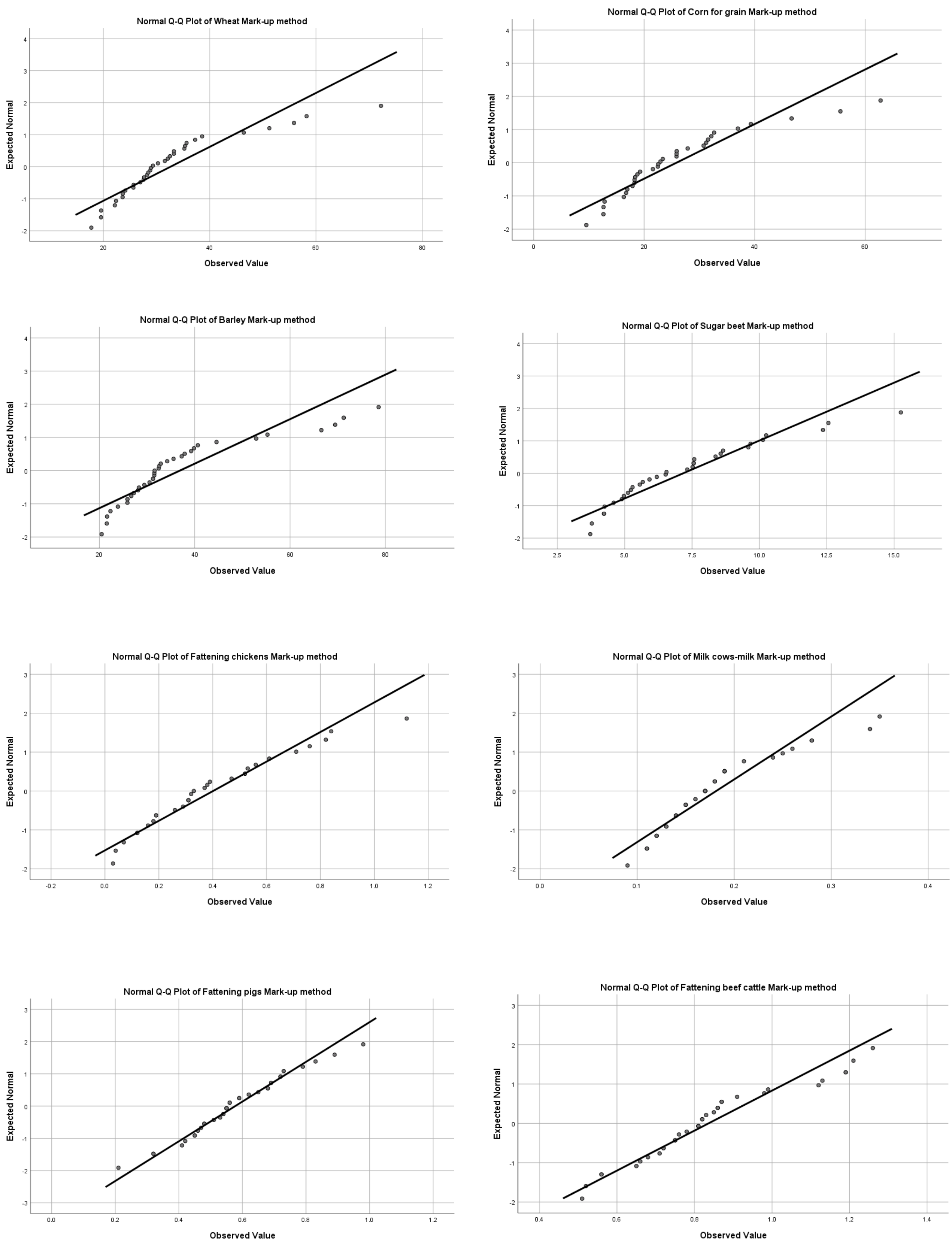

Fig. 3. Q-Q graphs for the Mark-up method

Source: own graphs.

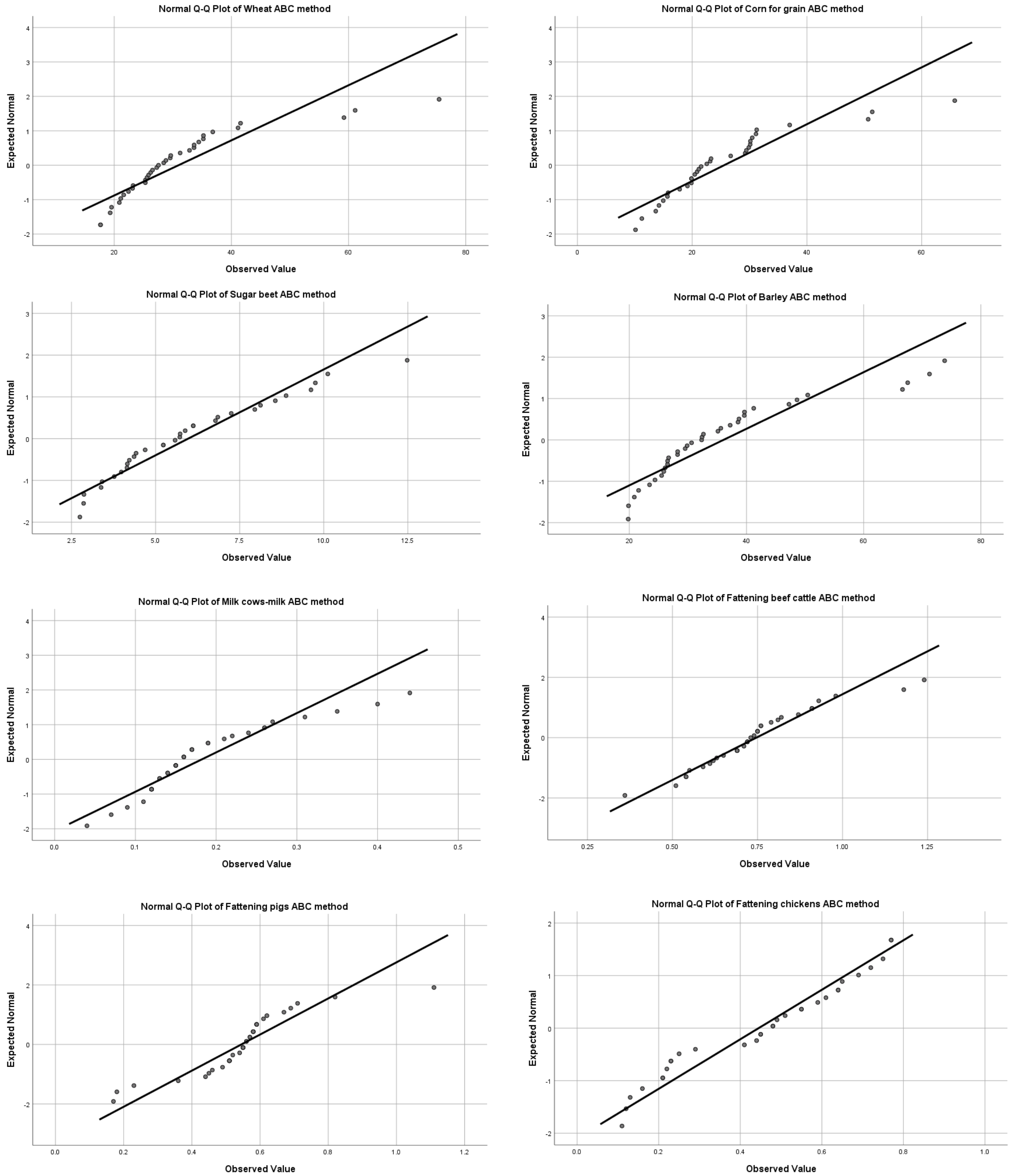

Fig. 4. Q-Q graphs for the ABC method

Source: own graphs.

Table 3 shows paired samples statistics and the descriptive statistics of the analysed variables sorted by cost calculation methods that were used, while Table 4 displays the output from the pair t-test. One of the prerequisites for using parametric tests is data normality. In the case of small samples, this is difficult to observe and, even though it fails to meet the condition of data normality, the parametric test is nevertheless robust.

Table 3

Paired samples statistics

Paired Samples Statistics					
Indicators		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Milk cows-milk Mark-up method	.1814	35	.06203	.01049
	Milk cows-milk ABC method	.1823	35	.08825	.01492
Pair 2	Fattening beef cattle Mark-up method	.8363	35	.19672	.03325
	Fattening beef cattle ABC method	.7466	35	.17585	.02972
Pair 3	Fattening pigs Mark-up method	.5774	35	.16234	.02744
	Fattening pigs ABC method	.5451	35	.16479	.02785
Pair 4	Fattening chickens Mark-up method	.4013	31	.26290	.04722
	Fattening chickens ABC method	.4452	31	.21230	.03813
Pair 5	Wheat Mark-up method	32.6197	34	11.88025	2.03745
	Wheat ABC method	31.2076	34	12.60218	2.16126
Pair 6	Barley Mark-up method	36.8617	35	14.90594	2.51956
	Barley ABC method	36.0666	35	14.61394	2.47021
Pair 7	Sugar beet Mark-up method	7.1763	32	2.80197	.49532
	Sugar beet ABC method	5.9684	32	2.43243	.43000
Pair 8	Corn for grain Mark-up method	25.8278	32	12.15732	2.14913
	Corn for grain ABC method	25.5747	32	12.10481	2.13985

Source: the authors´ own research.

Table 4

Paired samples test

Paired Samples Test									
Indicators		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95 % Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Milk cows-milk Mark-up method – Milk cows-milk ABC method	-.00086	.06959	.01176	-.02476	.02305	-.073	34	0.942
Pair 2	Fattening beef cattle Mark-up method – Fattening beef cattle ABC method	.08971	.21696	.03667	.01518	.16424	2.446	34	0.020
Pair 3	Fattening pigs Mark-up method – Fattening pigs ABC method	.03229	.14701	.02485	-.01821	.08279	1.299	34	0.203
Pair 4	Fattening chickens Mark-up method – Fattening chickens ABC method	-.04387	.26241	.04713	-.14012	.05238	-.931	30	0.359
Pair 5	Wheat Mark-up method – Wheat ABC method	1.41206	2.75930	.47322	.44929	2.37483	2.984	33	0.005
Pair 6	Barley Mark-up method – Barley ABC method	.79514	3.44956	.58308	-.38982	1.98011	1.364	34	0.182
Pair 7	Sugar beet Mark-up method – Sugar beet ABC method	1.20781	1.63401	.28885	.61869	1.79693	4.181	31	0.000
Pair 8	Corn for grain Mark-up method – Corn for grain ABC method	.25312	3.92604	.69403	-1.16237	1.66862	.365	31	0.718

Source: the authors´ own research.

Comparing pairwise the costs calculated from marking up and ABC, statistically significant differences were found for cattle, wheat and sugar beets. In these three cases, the null hypotheses is rejected because the significance values from the paired t-test are lower than the determined level of significance alpha = 0.05. The positive value of the differences in the averages demonstrates a statistically higher average value of costs calculated on the basis of the mark-up method in comparison to the ABC method. In other cases, the null hypothesis of agreement between the mean values at the level of significance alpha 0.05 is not rejected because the significance of the paired t-test is greater than the determined level of significance.

Table 5 shows the results of the Wilcoxon Signed Ranks Test, a non-parametric test similar to the paired t-test, although with no assumption of normality. Comparing pairwise the agreement of the mean values of costs, which were calculated by marking up and ABC, using the nonparametric Wilcoxon test, the null hypothesis was rejected at the alpha 0.05 significance level for cattle, wheat and sugar beet due to the determined alpha significance level. The results of this test are identical to the results from the parametric test.

Table 5

Wilcoxon Signed Ranks Test

Test Statistics[a]		
Indicators	Z	Asymp. Sig. (2-tailed)
Milk cows-milk ABC method – Milk cows-milk Mark-up method	-1.348[b]	.178
Fattening beef cattle ABC method – Fattening beef cattle Mark-up method	-2.531[b]	.011
Fattening pigs ABC method – Fattening pigs Mark-up method	-1.215[b]	.224
Fattening chickens ABC method – Fattening chickens Mark-up method	-.304[c]	.761
Wheat ABC method – Wheat Mark-up method	-2.599[b]	.009
Barley ABC method – Barley Mark-up method	-1.548[b]	.122
Sugar beet ABC method – Sugar beet Mark-up method	-3.684[b]	.000
Corn for grain ABC method – Corn for grain Mark-up method	-.505[b]	.614

Notes: a. Wilcoxon Signed Ranks Test.
b. Based on positive ranks.
c. Based on negative ranks.
Source: the authors´ own research.

A statistical test was run on the collected value of overheads calculated per unit of output using both mark-up and ABC. A statistically significant difference between the methods was demonstrated for three pairs of variables. Statistically significant differences were found for cattle, wheat and sugar beets, so the null hypotheses are rejected in these three cases. The positive value of the differences in the averages in the three cases demonstrates statistically the higher average value of costs calculated by marking up in comparison to ABC. In the remaining cases, the null hypothesis of agreement between the mean values is not rejected at the level of significance alpha 0.05.

In spite of these statistical testing results, the ABC calculation method is considered by us to be more accurate in practice, bearing in mind that the average differences have been subjected to statistical testing. Absolute deviations may appear large, but either the effect is impaired after averaging or the deviations run in both directions.

We continue to argue that the ABC method more accurately allocates overheads for a specific product because it assigns costs to cost-generating activities. The method brings nothing new to the table when it is used to allocate direct costs. Its importance and added value lies in overhead costs because it uses a different cost allocation key to convert overheads to direct costs. The main contribution is the insertion of activities between the recognised cost of resources and products, thus on one hand creating a logical link between costs per type and activity (each cost is incurred by a certain activity) and a relationship between the cost of activities and products on the other hand.

Especially for companies in fast-selling industries like agriculture and food processing, but also for consumer chemistry, the benefits of the ABC methods are indispensable as these businesses require calculations of their results from operations, price modelling of sold quantities and delivery conditions, monthly customer evaluations and network profitability assessments. These methods can also be used to motivate salesforces by the profit they bring instead of according to revenues. Traditional calculation methods cannot provide all this information.

The traditional mark-up method's most critical problem is finding a suitable base budget. These should be objective, easy to identify and of a sufficiently large size so even a minor base identification error causes no large error in budgeted indirect costs. It is usually not possible to apply all of these requirements when looking for a suitable budgetary base. Therefore, budgeting of indirect costs to calculation units in application of this method is more or less approximate. In an effort to make the calculations more accurate, emphasis is given to the requirement to look for options for how to directly add as much of the costs to the calculation unit as possible. The mark-up method is suitable for smaller, simpler and less dynamic firms with low indirect costs.

The structure of cost flow in an agricultural enterprise should be considered a significant methodological cost calculation problem. It is related to a variety of productive activities, especially auxiliary service activities such as internal services and activities other than manufacturing and overhead costs across the entire enterprise. Direct costs can be allocated directly to output, while internal services and overheads require the establishment of adequate allocation keys to assess the causality of costs incurred by the enterprise's business activities. Establishing appropriate budgetary bases has proved a cardinal problem due to their objective budgeting of final products and, for this reason, it requires a separate assessment.

Conclusions. Three pairs of variables – cattle, wheat and sugar beets – showed a statistically significant difference between the two calculation methods, while differences from the remaining products were not statistically significant. The first step involved the assumption of normality for applying the method, known as a pair t-test. Wherever this assumption was not met, a non-parametric alternative was used, no longer assuming normality.

Although statistical testing has shown no significant difference between tested methods, ABC is still considered a more accurate costing method for overhead allocation. Our argument follows from the very principle and ABC's method of allocating overheads.

In general, overhead costs are increasing in businesses as a percentage of total costs and agricultural enterprises are no exemption. As this percentage rises, conventional cost allocation methods become ever more inaccurate. When choosing a cost controlling method, an enterprise should consider the structure of its costs and select accordingly. The competitive environment is another factor influencing how appropriate a method is. Strong competition in the sector may bring very negative consequences if pricing or the product range selection is not correct. Under strong competition, the need to know exact product costs is growing. Any planned changes in the production or marketing strategy makes the ABC more applicable. Were management to adopt significant changes, it would need accurate information about how these changes are going to affect costs.

Viewing costs through the ABC method, unlike traditional mark-ups, offers multidimensional and varied monitoring of costs based on real, relevant data. Directly allocating costs (using shared budgetary bases) to products or services fails to capture the essence of the business's actual cost flows and, where the proportion of overheads is higher, management may be provided with misleading data. Practical experience shows ABC to be currently the most cost-effective tool for controlling costs and providing opportunities to use its results in budgeting, planning, modelling and decision making on structured product ranges, and also in other options.

In conclusion, it is nonetheless necessary to point out a certain disadvantage to the ABC method. Although it looks simple at first glance, it is not easy either to implement or employ, requiring extensive preparatory work and analysis, the use of information technology that captures the measured parameters in operation, a dedicated project team and intense support from management. A survey by the International Association of Financial Executives Institutes (IFAEI, 2012) showed companies using ABC in a variety of ways, with 19 % having implemented it completely, 25 % in a modified version and 56 % using a simplified version.

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