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AGRIS on-line Papers in Economics and Informatics
Department of Economics of FEM CULS Prague
Kamýcká 129, 165 21 Praha 6 – Suchdol
Czech Republic
Phone: +420 224 382 050, 056
E-mail: agrisonline(at)pef.czu.cz

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Content

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Alternative Approaches to Technical Efficiency Estimation in the Stochastic Frontier Model

H. D. Acquah[1], E. E. Onumah[2]

[1]Department of Agricultural Economics and Extension, University of Cape Coast, Ghana

[2]Department of Agricultural Economics and Agribusiness, University of Ghana, Ghana

Abstract

Estimating the stochastic frontier model and calculating technical efficiency of decision making units are of great importance in applied production economic works. This paper estimates technical efficiency from the stochastic frontier model using Jondrow, and Battese and Coelli approaches. In order to compare alternative methods, simulated data with sample sizes of 60 and 200 are generated from stochastic frontier model commonly applied to agricultural firms. Simulated data is employed to compare the alternative methods. Empirical results show a strong correlation between the alternative methods regardless of the differences in the actual values of the efficiency estimates. Mean technical efficiency is sensitive to the choice of estimation method. Analysis of variance and Tukey's test suggest difference in means between the efficiency scores from different methods. Battese and Coelli's approach produces more homogenous estimates of technical efficiency when compared with the Jondrow's mean or mode approach. Our results suggest that differences in conclusion are possible when the alternative methods of measuring technical efficiency are applied.

Key words

Stochastic frontier, technical efficiency, Tukey's test, mean and mode approach, agricultural firms.

Introduction

One way to evaluate decision making units (DMU) is by analysing whether or not they use their resources in an economically efficient manner. Economic efficiency is understood in terms of jurisdictions providing a maximum amount of output for a given level of inputs and is one potential means to evaluate DMUs. The most common efficiency concept is technical efficiency. Subsequently, numerous authors (Onumah, Acquah (2011), Onumah, Acquah (2010), Kumbhakar, (2002), Bravo-Ureta, Rieger (1991), Bagi and Huang (1983), Demir, Mahmud (2002), Kirkley, Squires and Strand (1995) have investigated technical efficiency of decision making units. Technical efficiency measures the conversion of inputs into outputs relative to best practice. In other words, given current technology, there is no wastage of inputs whatsoever in producing the given quantity of output.

However, various approaches co-exist to measure the technical efficiency of a decision making unit. For example, Jondrow et al. (1982) and Battese and Coelli (1988) provide alternative approaches to estimating technical efficiency in the stochastic frontier model. Previous studies measuring technical efficiency adopted either Battese and Coelli's approach or Jondrow's approach but not both. An exception is Hoyo et al. (2004) who applied Battese and Coelli's as well as Jondrow's mean approach. However, their study did not consider Jondrow's mode approach. A rigorous comparison of the Jondrow's mean and mode approaches with Battese and Coelli's approach to measuring technical efficiency is lacking in the literature. For researchers to assess the best alternative approach, it is imperative that a rigorous comparison of the methods is provided. Given that the alternative approaches differ methodologically, it is important to assess whether the different approach taken affects the outcome of efficiency studies or lead to differences in conclusion. The comparison of these approaches not only adds to the literature, but also deepens our understanding on inferences that can be derived when alternative methods of technical efficiency estimation are applied in production economics. Therefore this paper aims at measuring technical efficiency in the stochastic frontier model by applying the Jondrow et al. (1982) and Battese and Coelli (1988) approaches to simulated data.

Materials and methods

Technical Efficiency

Technical efficiency is defined as a measure of how well decision making units (DMU) convert inputs to output with a given technology and economic factors (Kumbhakar and Lovell, 2000). It is measured as the ratio of observed output (Y_i) to the corresponding frontier output (Y_i^*) with given levels of input and technology ($TE_i = Y_i / Y_i^*$). Therefore, technical inefficiency exists if a DMU produces below the production frontier. The measurement of technical efficiency and its underlying factors are of critical significance in production theory. Technical efficiency of a DMU and the degree of use of variable inputs determine the output and capacity utilization. Identifying the various factors affecting it allows stakeholders to take measures to limit or improve on it.

The concept of technical efficiency can be explained using a two input (x_1, x_2) - two output (y_1, y_2) production process. Bogetoft (2012) asserts that efficiency could be looked at from the angle where optimal inputs are combined to achieve a given level of output (an input-orientation) and where optimal output could be obtained given a set of inputs (an output-orientation). Grosskopf et al. (1994), points out that both measures provide the same technical efficiency scores when the assumption of constant returns to scale is applied. Technical efficiency in this study is considered from the angle where a DMU minimises the quantity of inputs used to achieve a constant output (an input-orientation). This idea draws from Farrell (1957) and is referred to as Farrell efficiency.

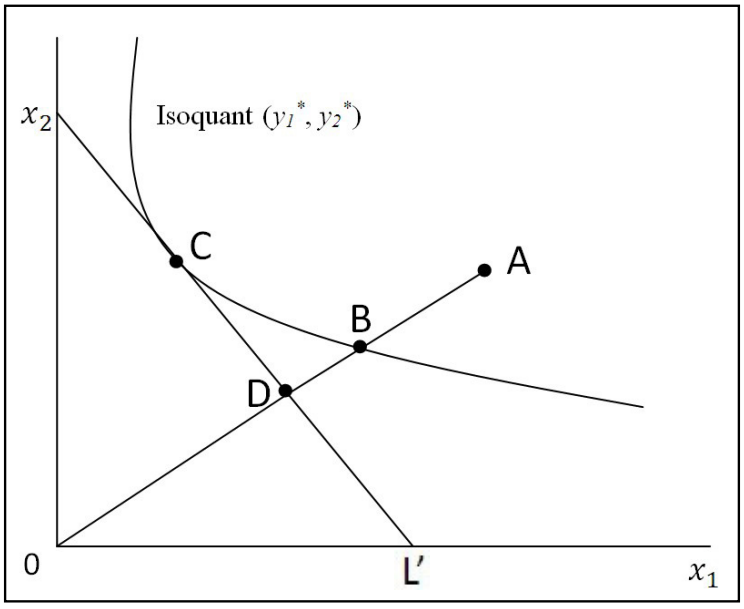
From Figure 1, the firm uses the combination of inputs defined by point A to produce a given level of output (y_1^*, y_2^*). The same level of output could have been produced by combining minimum level of inputs to produce (y_1^*, y_2^*) (Isoquant (y_1^*, y_2^*)). This is defined by point B and it lies on the isoquant. This is because isoquant shows the same level of output that an efficient firm can achieve by combining various quantities of inputs. Therefore, the input-oriented level of technical efficiency (y, x) is defined by OB/OA. The distance BA shows the technical inefficiency of the firm and it represents the amount by which all inputs could be proportionally reduced without a decrease in output. Noticeably, DB is the cost inefficiency and C is the economic efficiency point.

Alternative Approaches in Estimating Technical Efficiency

The stochastic frontier production function can be specified as:

$$y_i = f(x_i;\beta).\exp(v_i - u_i) = 1, 2, 3...n \qquad (1)$$

where y_i a scalar is output, x_i is a vector of inputs and β is a vector of parameters to be estimated. The composed error is made up of and u_i. v_i is



Source: Adapted from Coelli et al. (2005)

Figure 1: Input Oriented Efficiency Measure.

assumed to be independently and identically distributed (iid) and symmetric, and it represents statistical noise in the model. And $u_i \geq 0$ is a one side error term representing technical inefficiency. Note that u_i measures technical inefficiency in the sense that it measures the shortfall of output (y_i) from its maximal possible value given by the stochastic frontier. Technical efficiency can thus be measured as

$$TE_i = e^{-u} \tag{2}$$

Technical effciency of stochastic frontier models may be estimated by a maximum likelihood (ML) procedure. When using the ML procedure, the estimation is based on the mean or the mode of the conditional distribution of the inffciency error for each DMU (JLMS; Jondrow et al., 1982).

The mean is

$$E(u|\epsilon) = \mu_* + \sigma_* \frac{\varphi(\mu_*/\sigma_*)}{\Phi(\mu_*/\sigma_*)} \tag{3}$$

Where

$$\mu_* = -\epsilon \frac{\sigma_u^2}{\sigma^2} = -\epsilon \frac{\lambda^2}{1+\lambda^2} = -\epsilon\gamma$$

$$\sigma_* = \sqrt{\frac{\sigma_u^2 \sigma_v^2}{\sigma^2}} = \frac{\lambda}{(1+\lambda^2)}\sigma = \sqrt{\gamma(1-\gamma)}\sigma^2$$

and $\varphi(.)$ is the density function, and $\Phi(.)$ the distribution function of a standard normal distribution. σ_v^2 is variance of the random error v, σ_u^2 is the variance of inefficiency term u, ϵ is the total error, v-u, $\lambda = \sqrt{\frac{\sigma_u^2}{\sigma_v^2}}$ and $\sigma^2 = \sigma_v^2 + \sigma_u^2$.

When we substitute the estimated values for ϵ, σ^2, and λ then we have an estimate of u, call it $\hat{u}$, conditioned on the estimate of ϵ.

It can also be noted that

$\frac{\mu_*}{\sigma_*} = -\epsilon \frac{\sigma_u^2}{\sigma_2^2}\frac{\sigma}{\sigma_u\sigma_v} = -\epsilon \frac{\sigma_u}{\sigma_v}\frac{1}{\sigma} = -\epsilon \frac{\lambda}{\sigma}$ where $\lambda = \frac{\sigma_u}{\sigma_v}$

Such that

$$E(u|\epsilon) = \sigma_* \left(\frac{\varphi(\epsilon\lambda/\sigma)}{1-\Phi(\epsilon\lambda/\sigma)} - \epsilon\frac{\lambda}{\sigma} \right) \tag{4}$$

The above equation can be simplified to

$$E(u|\epsilon) = \sigma_* \left(\frac{\varphi(\epsilon_*)}{1-\Phi(\epsilon_*)} - \epsilon_* \right) \text{where } \epsilon_* = \epsilon\frac{\lambda}{\sigma}. \tag{5}$$

The estimates calculated in Eq. (5) are equal to the estimates calculated in Eq. (3).

Another estimator is the mode of the conditional distribution, which can also be interpreted as a maximum likelihood estimator:

$$M(u|\epsilon) = \begin{cases} \mu_* & for\ \epsilon \leq 0, \\ 0 & for\ \epsilon > 0. \end{cases} \tag{6}$$

$$M(u|\epsilon) = \begin{cases} \mu_* & for\ \mu_* > 0, \\ 0 & for\ \mu* \leq 0. \end{cases} \tag{7}$$

So that we have

$$M(u_k|\epsilon) = \max(0, \mu_{*i}) \tag{8}$$

As $E(TE) = E(e^{-u})$ is generally not equal to $e^{-E(u)}$ yet another estimator has been proposed in Battese and Coelli, (1988).

$$TE = E(e^{-u}/\epsilon) = \frac{\Phi(\mu_*/\sigma_* - \sigma_*)}{\Phi(\mu_*/\sigma_*)} e^{\left(\frac{1}{2}\sigma_*^2 - \mu_*\right)} \tag{9}$$

This estimator is optimal in the sense of minimizing the mean square error. This is the one that is most often used in applied production economics work. The actual values of the efficiency estimates may somewhat differ between the three methods, but very little work has been done to shed light on the estimates based on the three different methods.

Comparing Technical Efficiency in SFA using Alternative Methods

In order to estimate firm specific technical efficiency using alternative methods, we generated simulated data from a stochastic frontier model of the form

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + v - u \tag{10}$$

The simulated data with a sample size of 60 is generated with design parameters as follows:

$\hat{\beta}_0 = 2, \hat{\beta}_1 = 0.25, \hat{\beta}_2 = 0.75$. The inefficiency term is generated from the half normal distribution and remaining variables in the model are generated from the normal distribution with sample size of 60. Fundamentally, we denote y as the output of 60 agricultural firms and variables x_1 and x_2 as the input variables of these firms. Subsequently, the efficiency of the 60 firms from the simulated data are computed using alternative technical efficiency methods namely, Battese and Coelli (teBC), Jondrow's Mode approach (teMode) and Jondrow's Mean approach (teJ). For the purpose of brevity, we will denote Battese and Coelli approach, Jondrow's Mode approach and Jondrow's Mean approach by teBC, teMode and teJ respectively in the rest of this paper.

Results and discussion

The results in Table 1 indicate that the efficiency scores of the firms derived using the 3 methods, ranged between 20 to 100%. Clearly, the actual values of the efficiency estimates differ between the three competing methods. Fundamentally, these differences in estimates may be attributed to the methodological differences in the estimators used. At lower levels of efficiency (<50%), teBC obtained 20 firms, teMode obtained 13 firms and teJ had 29 firms. At moderate levels of efficiency (50 to 79%), teBC reported 40 firms, teMode reported 19 and teJ reported 31 firms. At higher levels of efficiency (>80%), teMode recorded 28 firms whilst teBC and teJ had none (0 firms). Importantly, these results suggest that the different technical efficiency estimates provided by the different methods might have different policy implications since they imply different levels of firm capacity. Generally, the different methods lead to differences in conclusion.

The average efficiencies of the three methods are presented in Table 2 below. The average efficiencies tend to differ among the three methods studied. The teMode approach provided a higher mean efficiency of 73.12 this is followed by teBC and teJ approaches with 53.12 and 48.18 respectively. The coefficient of variation (CV) which is defined as the standard deviation expressed as a percentage of the mean is also examined. When a computed CV is less than 33% we say the data set is homogeneous. The teMode method tends to have the largest CV of 34.33%. This followed by teJ and teBC methods with CVs of 23.47 and 19.75 respectively. These results suggest that efficiency estimates from teMode is more variable when compared with efficiency estimates of teJ and teBC methods. Noticeably, teBC efficiency estimates has the smallest variability among the three methods. These results are consistent with Hoyo et al (2004) assertion that the Battese and Coelli approach (teBC) has a higher mean efficiency and a lower coefficient of variation when compared with the Jondrow's Mean approach (teJ).

Model	Mean	S.d	CV (%)
teBC	53.65	10.60	19.75
teMode	73.12	25.10	34.33
teJ	48.18	11.31	23.47

Source: own processing

Table 2: Average efficiencies with standard deviation (s.d) and coefficients of variation (CV) according to the different estimation procedures.

In order to investigate whether there is a significant difference in means between the efficiency scores from different methods, the analysis of variance (ANOVA) and Tukey's HSD (Honest Significance Difference) test were applied. The anova test (p-value=1.07e-13) suggest a significant difference among the three efficiency techniques as illustrated in Table 3. Using Tukey's HSD follow up test indicates that differences exist between teBC and teMode, and teJ and teMode as shown in Table 4.

	Df	Sum Sq	Mean Sq	F value	Pr (>F)
Method	2	20610	10305	35.52	1.07e-13***
Residuals	177	51349	290		

Note: Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Source: own processing

Table 3: Analysis of Variance of Technical Efficiency Estimates of Firms obtained with teBC, teMode and teJ.

Percent	teBC Freq		teMode Freq		teJ Freq	
	F		F	C. F	F	C. F
20-29	1	1	2	2	4	4
30-39	6	7	8	10	9	13
40-49	13	20	3	13	16	29
50-59	20	40	7	20	23	52
60-69	18	58	2	22	7	59
70-79	2	60	10	32	1	60
80-89	0	60	5	37	0	60
90-99	0	60	8	45	0	60
100	0	60	15	60	0	60

Source: own processing

Table 1: Frequencies (F) and cumulative frequencies (CF) of efficiency estimates of firms obtained with different estimation methods.

Method	diff	lwr	upr	p adj
teMode - teBC	19.4667	12.1166	26.8167	0.0000
teJ - teBC	-5.4667	-12.8167	1.8834	0.1869
teJ - teMode	-24.9333	-32.2834	-17.5832	0.0000

Source: own processing

Table 4: Tukey's Honest Significance Difference test of Technical Efficiency Estimates of Firms obtained with teBC, teMode and teJ.

Table 5 provides the results of the correlation analysis between the actual values of the efficiency estimates from the three different methods. Though the actual values of the estimates differ among the methods but the estimates based on the three methods are highly correlated. The presence of a strong positive correlation among the efficiency estimates, suggest that the methods can be applied concurrently to provide a holistic view of firm specific efficiency analysis. Similarly, Bogetoft and Otto (2011) notes that the actual values of estimates differ among the methods but the estimates based on the three methods are highly correlated.

	teBC	teMode	teJ
teBC	1.0000	0.9706	0.9978
teMode	0.9706	1.0000	0.9670
teJ	0.9978	0.9670	1.0000

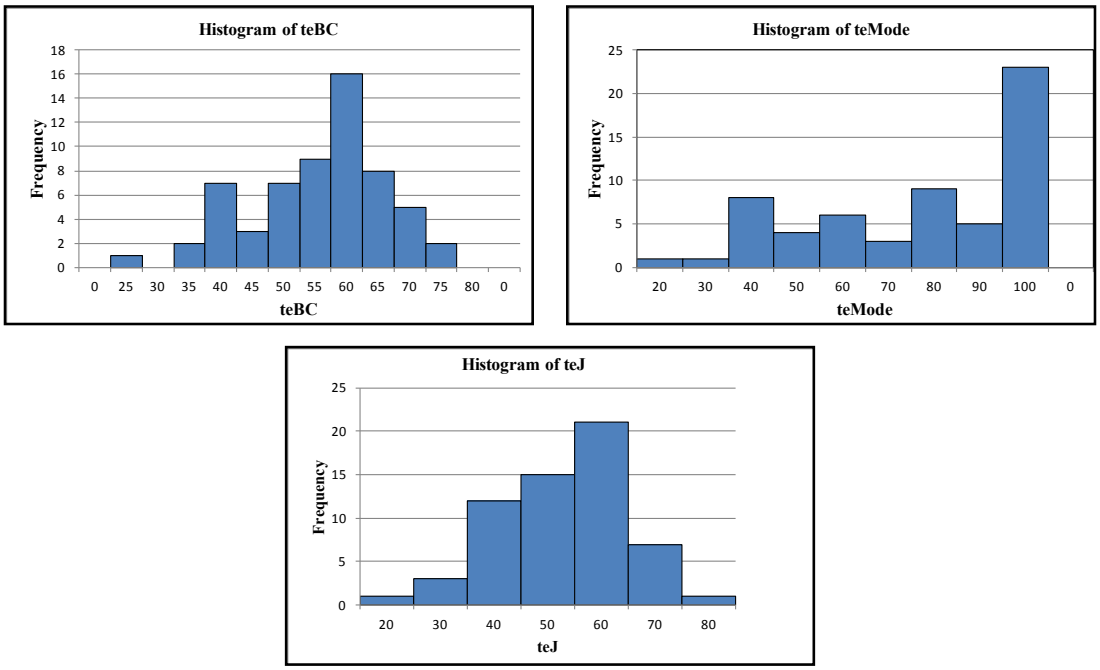
Source: own processing

Table 5: Correlation analysis of the efficiency estimates between the different methods.

The histogram of the efficiency estimates of the 3 methods differ in the shape of their distribution. Noticeably, the histogram of teBC shows a more uniform distribution of efficiency estimates when compared to those of teJ and teMode histograms in Figure 2.

The results of our analysis based on a sample size of 60 were consistent with those based on a sample size of 200 generated from the same stochastic frontier model specified in equation 10. At higher levels of efficiency (>80%), teMode recorded 69 firms whilst teBC and teJ obtained 0 firms respectively given a sample size of 200 as illustrated in Table 6. Similarly, as indicated in Table 1, at higher levels of efficiency (>80%), teMode recorded 15 firms whilst teBC and teJ obtained 0 firms respectively using a sample size of 60.

Using a sample size of 200, teMode approach provided a higher mean efficiency of 61.54 followed by teBC and teJ approaches with 47.21 and 41.41 respectively. Similarly, with a sample size of 60 as indicated in Table 2, teMode resulted in higher mean efficiency of 73.12 followed by teBC and teJ approaches with 53.12 and 48.18 respectively. These results suggest that teMode resulted in higher mean technical efficiency estimates than the teBC and teJ regardless of sample sizes. Furthermore, using the sample size of 200, teMode method tends to have the largest CV of 49.05%. This is followed by teJ and teBC methods with CVs of 35.74



Source: own processing

Figure 2: Histograms of efficiency estimates of the different methods.

Percent	teBC Freq		teMode Freq		teJ Freq	
	F	C. F	F	C. F	F	C. F
0-9	1	1	2	2	2	2
10-19	4	5	12	14	19	21
20-29	22	27	26	40	30	51
30-39	35	62	23	63	33	84
40-49	39	101	16	79	50	134
50-59	54	155	22	101	46	180
60-69	40	195	12	113	17	197
70-79	5	200	18	131	3	200
80-89	0	200	11	142	0	200
90-99	0	200	12	154	0	200
100	0	200	46	200	0	200

Source: own processing

Table 6: Frequencies (F) and cumulative frequencies (CF) of efficiency estimates of firms obtained with different estimation method.

and 30.54 respectively. These results suggest that efficiency estimates from teMode is more variable when compared with efficiency estimates of teJ and teBC methods across the different sample sizes of 60 and 200 respectively. Similarly, the analysis of variance (ANOVA) and Tukey's HSD (Honest Significance Difference) test were applied to investigate the difference in means between efficiency scores from different methods. The results of both the ANOVA test and Tukey's HSD based on a sample size of 200 presented in Tables 7 and 8 suggest a significant difference among the three efficiency techniques.

	Df	Sum Sq	Mean Sq	F value	Pr (>F)
Method	2	42930	21465	48.12	<2e-16***
Residuals	597	266299	446		

Note: Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Source: own processing

Table 7: Analysis of Variance of Technical Efficiency Estimates of Firms obtained with teBC, teMode and teJ.

Method	diff	lwr	upr	p adj
teMode - teBC	14.33	9.3677	19.2923	0.0000
teJ - teBC	-5.795	-10.7573	-0.8327	0.0172
teJ - teMode	-20.125	-25.0873	-15.1627	0.0000

Source: own processing

Table 8: Tukey's Honest Significance Difference test of Technical Efficiency Estimates of Firms obtained with teBC, teMode and teJ.

This significant difference among the three efficiency estimates hold across the different sample sizes of 60 and 200. Though the actual values of the estimates differ among the methods, estimates based on the three methods are highly correlated as indicated in Table 9.

	teBC	teMode	teJ
teBC	1.0000	0.9718	0.9980
teMode	0.9718	1.0000	0.9771
teJ	0.9980	0.9771	1.0000

Source: own processing

Table 9: Correlation analysis of the efficiency estimates between the different methods.

Conclusion

Previous research has developed alternative methods of estimating technical efficiency. In this study simulated data is employed to compare the alternative methods of calculating technical efficiency in the stochastic frontier model. The results show that though the actual values of the efficiency estimates differ between the methods, there exists a strong positive correlation among the efficiency estimates based on the three methods. Mean technical efficiency is sensitive to the choice of estimation method. On the basis of analysis of variance and Tukey's test this study finds significant difference in means between the efficiency scores from different methods. Furthermore, the efficiency estimates of the Battese and Coelli's approach has the smallest variability when compared with the Jondrow's mean or mode approach. An implication for efficiency analysis is that the Battese and Coelli's approach is more adequate to provide efficiency estimates with less variability. On the basis of this finding, the Battese and Coelli's approach is more suitable for technical efficiency analysis

of agricultural firms These results suggest that differences in conclusion are possible when the alternative methods of measuring technical efficiency are applied. These results hold in both small and large samples. Furthermore, the differences in technical efficiency estimates provided by the different methods might have different policy implications since they imply different levels of firm capacity. In the light of the findings it is necessary for further research to extensively investigate the mathematical and intuitive reasons underlying the differences in estimates derived from the different technical efficiency measures.

Corresponding author:
Dr. Henry De-Graft Acquah
Department of Agricultural Economics and Extension
University of Cape Coast, Ghana
Phone:+233 245543956, E-mail: henrydegraftacquah@yahoo.com

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The Influence of Children on the Parents Buying Behavior: Food Purchase in the Czech Republic

T. Balcarová, J. Pokorná, L. Pilař

Faculty of Economics and Management, Czech University of Life Sciences in Prague, Czech Republic

Anotace

Článek zkoumá vliv dítěte na kupní chování rodičů v České republice. Dosavadní výzkumy tvrdí, že jsou čeští zákazníci při nákupu potravin pouze slabě ovlivněni marketingovými nástroji, jakým je i obal produktu. Vzhledem k tomu, že jsou děti stále častěji těmi, kdo ovlivňují nákup a spotřebu, vyvstává otázka, zda rodič podléhá žádosti dítěte a s ní spojenému nátlaku. Cílem článku je zhodnotit vliv dětí při výběru a nákupu potravin v samoobsluze. Dílčím cílem je: identifikovat způsoby nátlaku vyvíjené dětmi; identifikovat reakci rodiče na nákupní tlak dětí v oblasti potravinářských výrobků; identifikovat preference dětí u obalů potravinářských výrobků. Primární data jsou pořízena prostřednictvím elektronického dotazníku určeného rodičům. Komplexní faktory jsou identifikovány s využitím explorativní faktorové analýzy. Faktorová analýza odhalila 4 faktory: (1) "snaha dítěte ovlivnit nákup", (2) "dětské preference designu obalu", (3) "preference nezdravých potravin", (4) „nákup zdravých potravin s dětmi". Výsledky testování odhalily silnou závislost u způsobů, kterými se dítě snaží ovlivnit nákup nátlakem a vyhověním jejich požadavkům a provedením nákupu.

Klíčová slova

Marketing potravin, druhy potravin, potravinové produkty, děti, kupní chování dětí, nátlak, zákaznická socializace.

Abstract

The article examines the influence of a child on the buying behavior of parents in the Czech Republic. Previous studies claim that Czech consumers are only slightly influenced by the marketing tool of the product package when purchasing food. Whereas children are increasingly becoming influencers of consumption, the question arises, whether or not the parent succumbs to their requesting through their pester power. The main goal of this article is to evaluate the influence of children during deciding and purchasing the food in a supermarket. A secondary goal is to identify the techniques of pester power used by children and to identify the reaction of parents to children's food product requesting; to identify children's packaging preferences for food products. The primary data have been collected through an electronic questionnaire for parents. Complex factors are identified using exploratory factor analysis. Factor analysis explored 4 factors: (1) "The effort of the child to influence shopping", (2) "Children's preferences in package design", (3) "Preference of unhealthy foods", (4) "Buying healthy foods with children". Results of hypotheses testing revealed a strong dependence relating to techniques of pester power, accommodating their requests and transact the purchase.

Key words

Food Marketing, Foods, Food products, Children, Children's Purchase Behavior, Pester Power, Customer Socialization.

Introduction

Present shift of consumption trends leads to healthy foods that not ranks among the HFSS category (High Fat, Salt and Sugar foods) (Ogba, Johnson, 2010). This happens due to the general growth of obesity, especially in children (Ogba, Johnson, 2010). Due to changes in the lifestyle of the population, the demand for food, not belonging to HFSS categories, as well as information of the composition displayed on the food packaging increases (Ogba, Johnson,

2010). In the Czech Republic, the consumption of the majority of agricultural products distributed to consumers, which is meant as food products, has not changed too much (Stavkova et al., 2007). Previous studies showed increase in consumption of cereals, dairy products, fruit, mineral water and soft drinks, can indicate positive changes in the lifestyle of Czech population. Buying decision is mostly influenced by product attributes (such as price, quality, brand, discounts and package), habits, advertisement, recommendation of other people, innovations etc. on the one hand and demographic/ economic ones, i.e. income category, settlement size, age, education, and profession on the other (Stavkova et al., 2007).

The role of packaging can be more or less important depending on the type of product, for example, buyig home accessories is not strongly influenced by its packaging (Novotný, Duspiva, 2014). Although study conducted by Stavkova et al. (2007) claims, that Factors "Advertising", "Brand" and "Package" were not important when buying food and the level of their influence was considered as low for Czech customers, question is, to what extend the package influence customer - parents implicitly through purchase preferences of their children? According to previous studies, children are considered to be main influencers of family decision-making, therefore can food marketers target on children as on a specific market segment using both above and below the line techniques to affect the preferences of children and thus mediate the family purchase decisions. (Ogba, Johnson, 2010). Among other promotional tools used at point-of-sale (e.g. trays, woblers, product sampling), product packaging is substantial communicating tool, providing information to consumers about attributes, content and branding. Thus comply with children-oriented marketing due to the use of lettering, iconography and themes of interest to children, and cross-promotions, tie-ins, competitions and premium offers that appeal to children (Silayoi, Speece, 2004; Berry, McMullen; 2008).

In their study, Ogba and Johnson (2010) claim, that marketers purposely target more at children than parents when designing the package of the product as they are maintaining children´s interest to influence parents' buyer behavior. As Ogba, Johnson (2010) stated, there are other studies arguing that due to children's lower abilities to process information, they are likely to assess products and their packaging mainly on a visual level. Marketers, therefore, tries to use the children's visual imagination, the ability to recognize different characteristics, colors and design for enhancing children's interest in products. Such child-targeted marketing includes bright colors, shapes of packages, cartoon or movie characters, desirable box color schemes, free gifts, stickers, etc. (Ogba, Johnson, 2010; Berry, McMullen, 2008). Customer socialization can be defined as a process wherein children acquire knowledge and opinions on products and services, as it can be seen by their parents within their consumer behaviour. Consumer behaviour is determined as a decision-making process of those who purchase items according to their personal consumption (Šrédl, Soukup, 2011; Zámková, Prokop, 2013). Children and young people learn by copying the behavior of their parents (Turner et al., 2006), but also exert pressure in the opposite direction, to influence behavior of parents in making purchases in three fundamental categories – toys, clothes and food (Nicholls, Cullen, 2004). This study aims at parents without gender differences, however Turčínková et al (2012) stated, that women are more likely to buy impulsively various goodies mostly for children.

McNeal (1999) defined 5 stages of children consumer socialization. The first stage is specific in that the child accompanies parents on shopping trips and just observes. In the second phase, the first requests take place through pointing, talking and gesturing (Lee, Colins, 2000). This behavior is known as "pester power", or the "nag factor" (Nash, Basini, 2012). Children enter this phase at approximately 24 months of age. In the third stage, the child accompanies parents on shopping trips, but already participates in the selection of foods, which are subject to parental approval. In the fourth stage, independent purchasing takes place, which is still partially accompanied by parents. In the final, fifth, stage, full independence takes place, where the child shops independently. Nash, Basini (2012) define "pester power" as a child-parent game, where natural interaction takes place. This engenders greater understanding in the parent-child relationship, and involves a positive process, where it is necessary to understand a complex process of a child's behavior, using various tactics with the goal of causing the desired feelings in a child. This study was a reaction to previous research (Bandyopadhyay et al., 2001), which defines pester power as a phenomenon, which has a negative affect on the family. Consumer organizations

and the media in general, benefit from the pester power and believe that promotions stimulate pestering resulting in purchases on the basis of creating indirect pressure through children (Pilgrim, Lawrence, 2001). On the basis of these studies, it can be said that the pester power is not a negative phenomenon, as long as the parent is aware of it and is able to use of the appropriate tools to managethe consumer socialization of a child. Currently, the need of children pester power coping arrises, as the modern concepts of buying goods (shopping trips) give leisure and entertainment value to the whole family (Wanninayake, Chovancová, 2012).

Aim of the study

The main aim of the contribution is to evaluate the influence of children during deciding and purchasing the food in a supermarket assuming the direct children participation. The secondary goal is to: identify techniques of pester power used by children; identify the reaction of parents to children's food product requesting; to identify children's food product packaging preferences. For this purpose, 4 hypotheses are formulated.

Hypotheses

The formulation of following hypotheses is based on the previous studies conducted in the field of food marketing to evaluate the influence of children on buying behavior and the packaging aimed at children:

H1: The ways of product requesting have impact on the parents purchase transaction.

H2: The type of requested food product has impact on the parents purchase transaction.

H3: The level of childrens´s influence of the purchase has impact on the parents purchase transaction.

H4: Packaging has impact on the children´s product preference.

Materials and methods

Primary data are gathered by the surveying using an electronic questionnaire. The electronic questionnaire is intended for parents who at least sometimes shop for groceries with their children. The basic set consists of parents with children from 1 to 18 years old. Due to large base of potential respondents, the questionnaire is circulated through community websites and social networks. The questionnaire is based on the research of Ogba, Johnson (2010), contains 26 core questions and is structured into 4 sections: (1) identification questions, (2) influence of food packaging on child preferences, (3) influence of the child on the buying behavior of parents (4) probability that the parents comply with children´s request. The attitudes of the respondents are recorded on a 5-degree Likert scale in the range of "strongly agree – somewhat agree – half and half – somewhat disagree – strongly disagree". A questionnaire structured in this way enables evaluation of data through factor or correlative analysis. To determine the influence of children on the final purchase and the influence of food packaging on the preferences of children, the Pearson correlation coefficient is used. In terms of the factor analysis suitability, individual variables are tested with the Kaiser-Mayer-Olkin level (KMO). The KMO coefficient ranges in the interval <0.1> and its value should exceed 0,5. In case of this research, the KMO value can be considered good at 0.834. Latent factors are found using the main components method with the Varimax rotation of factors. The number of factors is selected to ensure that the value of Eigen values of the identified latent factors is higher than 1. Exploratory factor analysis was performed in the statistical program SPSS 19. The structure of factors is analyzed in the SPSS AMOS program.

The sample size is 246 respondents. The sample consisted of 80 % women (20 % men), evaluated is the behavior of their child (59 % girls and 41 % boys) in an average age of 6 years and 2 months. The majority of respondents live in cities with populations over 100,000 (46 %), 24 % live in cities with 10,000 – 100,000 thousand residents and 30 % in cities under 10,000 residents. Most frequently, the respondents shop for groceries 2 - 5 x weekly (64 %), 1 x weekly (24 %), 5 - 7 x weekly (12 %), together with children the most often shop 2 - 5 x weekly (40 %), 1 x weekly (36 %), 1 x in 14 days (11 %), 1 x monthly (10 %) and 5 - 7 x weekly (3 %).

Results and discussion

Results of testing the hypothesis focused on identifying the ways product requesting affect the parent's purchase transaction (H1) are evident from table no. 1. For all variables, a strong to medium impact on the parent's purchase transaction is found for the way of product requesting, at a significance level of 0.01.

The strong impact is identified for verbal requests (r = 0.754) and pointing to the product (r = 0.732). A medium impact is found with reaching for items (r = 0.669). The lowest value measured was for placement of the product in the shopping cart / basket (r = 0.531). From graph no. 1 it is evident that it is verbal requests, which are stated by each respondent/parent for all age categories of their children as the most frequent way of influencing purchase, whereas this type of pester power escalates with increasing age. A minimum share is recorded for the youngest category of children, aged 1 to 3 years, and that is 36 %. For the oldest age group, verbal requests are made by 53 %.

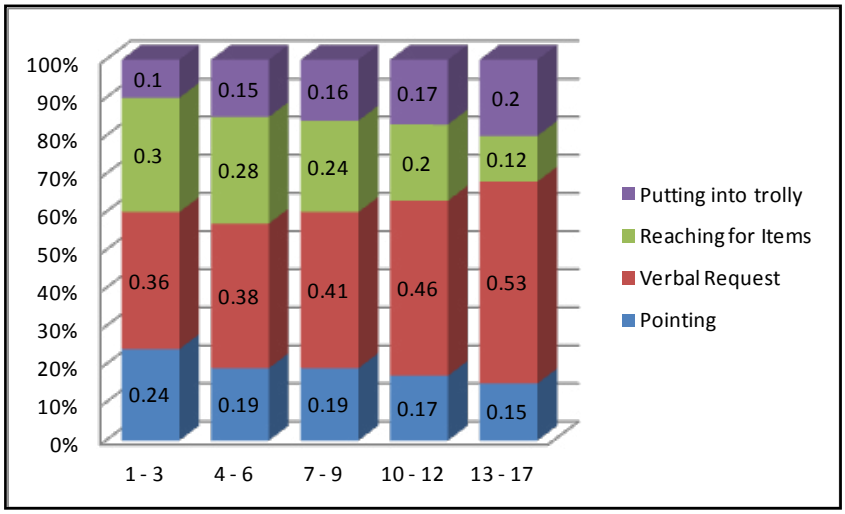
When evaluating the impact between the level of parents purchase transaction in the store and the type of foods requested (H2), a medium impact on buying of sweets (r = 0.617), is identified. A medium level of impact between parents purchase transaction in the store and the type of food required is found in yoghurt (r = 0.433) and Lunch foods (snack foods) (r = 0.416) and at a significance level of 0,01 for all three variables as seen in table no. 2.

In evaluating whether a significant impact can be found resulting from the influence of a child on shopping and whether parents transact a purchase (H3), a medium dependency on the influence of the child is identified for the final purchase of products preferred by children (r = 0.464) at the significance level of 0.01 (table no. 3).

		VAR00004	VAR00005	VAR00006	VAR00007
VAR00003	Pearson Correlation	,732**	,754**	,669**	,531**
	Sig. (2-tailed)	0	0	0	0

Source: own calculation, questionnaire survey, 2014

Table 1: The ways of product requesting have impact vs. parents purchase transaction.



Source: own calculation, questionnaire survey, 2014

Graph 1: Types of product Requesting According to Children's age.

		VAR08	VAR09	VAR10	VAR11	VAR12	VAR13	VAR14	VAR15	VAR16
VAR03	Pearson Correlation	,617**	,309**	,302**	,433**	,191**	,146*	0.122	,416**	,270**
	Sig. (2-tailed)	0	0	0	0	0.003	0.022	0.055	0	0

Source: own calculation, questionnaire survey, 2014

Table 2: The type of requested food product vs. the parents purchase transaction.

		VAR03	VAR25
VAR03	Pearson Correlation	1	,464**
	Sig. (2-tailed)		0

Source: own calculation, questionnaire survey, 2014

Table 3: The level of childrens´ influence of the purchase vs. parents purchase transaction.

		VAR00018	VAR00019	VAR00020	VAR00021	VAR00022	VAR00023
VAR00003	Pearson Correlation	,554**	,428**	,423**	,437**	,516**	,326**
	Sig. (2-tailed)	0	0	0	0	0	0

Source: own calculation, questionnaire survey, 2014

Table 4: Packaging vs. children´s product preference.

The results of testing the impact of packaging on the children's product preferences (H4) show a medium strength impact, especially for the overall influence of the package (r = 0.554), further, by interesting shape of package (r = 0.516). A significant impact is also identified for pictures associated with a specific product (the Nesquick Rabbit, Bebe Brumík, etc.), (r = 0.437), further for bright colors used on packaging (r = 0.428) and for familiar characters displayed on packages (Spiderman, Hello Kitty, etc.) at a value of (r = 0.423). All variables are tested at the significance level of 0,01 and the results are shown in table no. 4.

For the identification of factors determining children's preferences leading to purchase of foods, an exploratory factor analysis is performed. Original 26 variables were reduced to 22 usable. Four factors exceeded the recommended value of the Eigen value. The latent factors include variables with an absolute value of a coefficient of factor weight in an interval of < 0.511; 0.863 > and cumulatively explain 59 % of the total dispersionof monitored variables. The first group of variables represents 20.2 % of the total dispersion, includes a factor weight in the range of 0.679 - 0.802 with an Eigen value of 4.85. The first factor found can be interpreted as (1) "The effort of the child to influence shopping". This group characterize the ways which the child tries to influence purchase, such as reaching for items, pointing at them, or verbal requests. The second group of variables found (2) "Children's preferences in package design" focuses on the characteristic elements of packages attracting a child's interest such as bright colors, package shape or display of familiar characters. This factor represents 16.4 % of the total dispersion, a factor weight in the range of 0.720 - 0.863 and the value of the Eigen valueis 3.94. The third group of variables (3) "Preference of unhealthy foods" includes children's interest in salty foods, sweet drinks, flavoring such as ketchup, etc. (12.8 % of the total dispersion, factor weight 0.511 - 0.688, Eigen value 3.07) or the preferences of free gifts as part of the package. The fourth group of variables (4) "Buying healthy food with children" includes the interest of children in foods such as yoghurts or fruits and vegetables, the pleasure of parents shopping together with children and purchasing the food requested by children (9.50 % of the total dispersion, factor weigh 0.515 - 0.728, Eigen value 2.28).

For analyzing the correlation between latent factors, the structural modeling method is used. The factor structure of individual latent factors is taken from the results of exploratory factor analysis. The highest correlation (0.706) is identified between the factors (1) "The effort of the child to influence shopping" and (2) "Children's preferences in package design". This indicates that package design and all of its determinants (bright colors, display of familiar characters, etc.) has a close relationship to the effort of the child to influence the purchase. The second highest relationship was found between the factors (3) "Preference of unhealthy foods" and (2) "Children's preferences in package design" (0,510). On the other hand, an insignificant relationship was found between the factors (2) "Children's preferences in package design" and (4) "Buying healthy foods with children" (table no. 6).

	F1	F2	F3	F4
VAR01 – happy to take my child shopping with me				0.515
VAR03 – child influences the purchases	0.779			
VAR04 – influence by pointing	0.723			
VAR05 – influence by verbal requests	0.802			
VAR06 – influence by reaching for items	0.8			
VAR07 – putting in my trolly	0.679			
VAR08 – purchase of confectionary	0.682			
VAR09 – purchase of sweet drinks			0.562	
VAR11 – purchase of yoghurts				0.589
VAR12 – purchase of flavoring			0.655	
VAR13 – purchase of fruit and vegetables				0.586
VAR14 – purchase of frozen food			0.511	
VAR15 – purchase of snack food	0.6			
VAR16 – purchase of salty food			0.805	
VAR18 – influenced by the packiging		0.788		
VAR19 – influenced by bright colors		0.863		
VAR20 – influenced by characters licensed		0.803		
VAR21 – influenced by famous characters		0.762		
VAR22 – influenced by shape		0.72		
VAR23 – influenced by free gifts			0.688	
VAR24 – taking my child´s preferences into consideration				0.728
VAR25 – buying products that my child requests				0.66

Source: own calculation, questionnaire survey, 2014

Table 5: Rotated Component Matrix.

	Estimate	S.E.	C.R.	P
F1 <--> F2	0.706	0.104	7.929	***
F1 <--> F3	0.467	0.071	5.011	***
F1 <--> F4	0.264	0.026	2.258	0.024
F2 <--> F3	0.51	0.068	5.319	***
F2 <--> F4	0.193	0.02	1.95	0.051
F3 <--> F4	0.496	0.026	2.568	0.01

Source: own calculation, questionnaire survey, 2014

Table 6: Correlation between factors.

The results of statistical significance testing revealed a large dependence, in particular of the ways by which the child attempts to influence the purchase transaction. The study of Ogba, Johnson (2010) is dedicated to the strength of the influence of a child on the buying behavior overall, and the testing reported in this research shows significant differences in individual ways of purchases influencing. The results therefore build on McNeal (1999) stages of consumer socialization. There is a weak impact on the purchase transaction by the level of children influence on the buying behavior revealed from the results of verification of the 4th hypothesis. This assumption can be further expanded by the structure of the ways of influencing parents, where the most significant ways are verbal request and pointing to the product.

The results also confirm previous studies, where the child attempts to influence the purchase, in particular, of sweets, which are among the foods that are not in accordance

with a healthy lifestyle and are among the HFSS foods (Ogba & Johnson, 2010; Marshall et al., 2007). It was also confirmed that the package influences the level of pressure of the child on parents. The results also confirmed theses of Ogba & Johnson (2010) and Berry, McMullen (2008), that children are mostly influenced by the shape of the product, characters associated with a concrete product and weakly, also by colors, and does not agree with the research of Marshall et al. (2007), which states that the color acts as the most significant factor.

Exploratory factor analysis extracted 4 factors determining children's preferences leading to the food purchase transaction. The performed research is based on the work of Ogba, Johnson (2010) as they conducted the research in the UK. In the Czech environment the number and composition of factors arising from the same questionnaire and factor analysis varies. In the case of submitted research, similarity can be found, in particular, within factors (1) "The effort of the child to influence shopping" and (4) "Buying healthy foods with children". A dominant factor of the British researchers is "the influence of packaging on children", which in meaning corresponds to the factor (2) "Children's preferences in package design" and was expanded only by the preference of an interesting package shape. Agreement also occurred in the case of factor (4) "Buying healthy foods with children" and the British third factor "the likelihood the parent is to yield to child influence". In this submitted research, purchasing of foods requested by children is further associated with the willingness to take child shopping and the interest of the child in healthy foods. Contrasting with healthy shopping with children is our factor (3), which is, on the other hand, associated with the interest of the child in unhealthy foods, often supported with a free gift.

According to the results of the structural equation modeling, the effort of a child to influence the purchase of foods is determined by package design. These results are also based on the confirmed hypothesis H3. A child is influenced in decision making by the package, and, in particular, the shape of the package, which builds on the previous studies; however, the results of this research point more to the influence of the shape of the package, over the color scheme, as stated by Marshall et al. (2007). On the basis of other results of structural equation modeling, the package design has more influence in the case of unhealthy foods, which might indicate the effort of manufacturers to sell these foods on the basis of pressure, which they place on parents through the requesting of this product. The results also show, that the significant impact on the buying decision has the actual way of children´s product requesting. In correlation with the development of the child, the structure of pester power techniques changes. While in the youngest category, children point to a product, with increasing age the level of verbal requests also increases. At the same time it applies that with increasing age of the child, pointing to and touching the product decreases and, conversely, the independent placing of products in the cart takes place. The highest impact as well as the greatest level of consent of the parents was measured for verbal requests. The results have a growing character for individual age categories of children, and that from minimum values of 36 % (for the youngest category of children between the ages of 1 to 3 years), up to 53 % (for the eldest category of children between 13 to 17 years). The reaction of parents to a child's request increases with the growth of emphasis in the expression of the request. That is, if the child addresses the parent or points to a product, this could indicate fear of a potential conflict at the shopping location. This is also confirmed by the question of whether or not the parent sometimes buys products, the child wants, in order to avoid conflict. 71.3 % of parents agreed with this statement, where the average value of positive responses was 1,25. In relation to the previous studies (Nash, Basini, 2012; Pilgrim, Lawrence, 2001), pester power cannot be defined as a negative or positive phenomenon, but a phenomenon which, from the perspective of parents, must be understood and which they must learn to direct by certain tactics. Negative consequences may arise if we try to suppress this phenomenon by acceding to the requests of the child because we wish to avoid conflict. This no longer involves interaction, which leads to understanding (Nash, Basini, 2012), but rather behavior with possible negative consequences (Bandyopadhyay et al., 2001).

Conclusion

Exploratory factor analysis extracted 4 latent factors: (1) "The effort of the child to influence shopping", (2) "Children's preferences in package design", (3) "Preference of unhealthy foods"

and (4) "Buying healthy foods with children. On the basis of structural modeling, weak to medium-strong dependencies were found (0.264 - 0.706). The greatest correlation (0.706) was identified between factors (1) "The effort of the child to influence shopping" and (2) "Children's preferences in package design". From the perspective of package attributes, shape can be indicated as the most important element, generating child´s interest.

Submitted research shifts previous studies in view of children´s pester power structure. Previous research indicated the importance of packaging within the marketing mix framework (Ogba, Johnson, 2010). Research points to the high impact of verbal requests of children, but also reaching for food or putting it into the trolly/basket. Influencing parents' shopping by putting food into the trolley/basket escalates with the increasing age of the child. The results of this research have a significance for marketing practicioners in the food area. Not only the importance of a package and its design as a part of the promotion, but also the placement of the product at the point of purchase is a key aspect to be considered. Despite the ethical perspective (Piacentini et al., 2000), results demonstrate the possibility of stimulating pester power through placement of a product at the child's eye level and within reach of the child.

A starting point for further research could be the fact that 71 % of parents purchase foods requested by the child in order to avoid conflict. This fact indicates that the need of appropriate techniques for guiding the pester power of a child has to be managed. In the next phase, the research could be expanded on the observation method of children's buying behavior directly where shopping, and potentially conflict, takes place.

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Corresponding author:
Ing. Tereza Balcarová, Ph.D.
Department of Management, Faculty of Economics and Management,
Czech University of Life Sciences in Prague, Kamýcká 129, 165 21 Prague 6 - Suchdol, Czech Republic
E-mail: balcarova@pef.czu.cz

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Parents´ Attitudes to Introduction of Organic Food in School Catering

D. Dědina, P. Šánová, A. Kadeřávková

Faculty of Economics and Management, Czech University of Life Sciences in Prague, Czech Republic

Anotace

Biopotraviny mohou být považovány za platformu dlouhodobého trvalého rozvoje, stejně jako nástroj ke zvýšení kvality lidského života a stravování. Škola je ideální prostředí k osvojení správných dietetických návyků. V zahraničí se lze v řadě případů setkat s biopotravinami ve školním stravován jako běžnou součástí dětského jídelníčku. V České republice je tato problematika v současnosti diskutovaným tématem. Po ukončeném projektu Ministerstva zemědělství Bioškoly nedošlo k většímu používání biopotravin ve školách. Je otázkou, zda je problém na straně jídelen či rodičů. Hlavním cílem příspěvku je vyhodnotit přístup rodičů k uplatňování biopotravin na základních a mateřských školách v hlavním městě ČR Praze. Klíčovou metodou bylo provedení kvantitativního dotazníkového šetření v roce 2013 s 1500 distribuovanými dotazníky rodičům. Na jejich základě byly stanoveny a statisticky testovány tři hypotézy. Celý výzkum proběhl v rámci projektu CZU PEF IGA 20131014.

Klíčová slova

Bio, potravina, pokrm, škola, jídelna, rodiče, cena, překážka, obava, přístup, Praha.

Abstract

Organic food can be understood as a platform for long-term sustainable development, as well as a tool to enhance quality of human alimentation and life. School is an ideal environment to learn good dieting habits. Organic food is often a common part of school catering in foreign countries. This issue is currently widely discussed topic in the Czech Republic. Following the end of the Bioschools (Bioškoly) project of the Ministry of Agriculture, no significant increase in the use of organic food in schools has been observed. The question is whether the problem is on the side of the canteens or the parents. The main aim of this paper is to evaluate the approach of parents towards organic food in school canteens in primary and nursery schools in Prague, capital city of Czech Republic. The key method used was a questionnaire survey in year 2013 with 1500 questionnaires distributed to the parents. Based on the survey results three hypotheses were laid down and statistically tested. The research was conducted under the CZU PEF IGA 20131014 project.

Key words

Organic food, meals, school canteens, parents, price, obstacle, approach, Prague.

Introduction

Many diseases of affluence have their origin in bad diets. Overweight and obesity in childhood and adolescence are international problems. A series of studies conducted with the aim of finding ways to prevent obesity in childhood and adolescence have been conducted globally (Bauer et al., 2009; Fernandes et al., 2009; Sorensen, 1988) with many of these tests being carried out in the ‘‘captive setting’’ of schools (Aranceta et al., 2008; Bevans et al., 2011). Many urban dwellers, particularly children in the developed world, consume less fresh fruit and vegetables, eat more processed food, and live less active lives than children living in rural areas (Somerset et al., 2005). In some countries, children‘s consumption of fast food has increased by 300% in two decades (Sanigorski et al., 2007). Overweight adolescents have an 80% chance of becoming overweight adults (Guo, Chumlea, 1999) and many of them carry obesity-related problems into adulthood with severe consequences (Wisemandle, 2000). Therefore it is necessary to start and implement interventions to stop the increase in this dangerous trend (Sharma, 2006).

Lifestyles established during childhood and adolescence often continue into adulthood (Lee et al., 2011). School is an ideal environment to learn good dieting habits. Healthy school catering strategies have been suggested as potentially effective approaches for improving the eating and diet behaviours of young people (Fahlman, Dake, McCaughtry, Martin, 2008; Lamberti et al., 2010; Panunzio, Antoniciello, Ugolini, Dalton, 2009).

Organic food can be understood as a platform for long-term sustainable development, as well as a tool to enhance quality of human alimentation and life.

For example, several municipalities in Denmark have established their own policies in order to offer paid school lunches, and the inclusion of organic food is a cornerstone of these policies (Nielsen et. al, 2009).

Matters related to school catering in Germany are taken care of by each federal state on its own, which is why there is no standardized structure of catering e.g. uniform and mandatory standards (Bundesministerium für Bildung und Forschung, 2013). Less than five percent of products used in school catering are of an ecological origin. Berlin, which could be considered a pioneer, demanded using 10% of organic food in school catering in by the year 2005. One year later Nurnberg launched a project, which aims to reach a share of 50% of organic food used in school catering by the year 2014. Munich has also become involved, after introducing the financial support for using organic foods. National campaigns and programs have been launched simultaneously, which were aimed at healthy school catering through the use of organic food and were backed by Federal Ministry of Education and Research (Erhart, 2011). If we are to compare German schools to Czech schools, the biggest difference is in the price. One lunch at a German school costs students on average 3 euros (75 CZK with the exchange rate of 25CZK/EUR). It can be said that the price is almost 3 times as much.

Organic food in Austria spans every product group, (milk and dairy products; meat and eggs; corn, vegetables and fruit) and these are used in 10% of school lunches. There are 30000 lunches prepared in kindergartens every day and bio food makes up 50% of all the ingredients. There are also 18000 meals, which are prepared daily at schools with a 40% share of bio food. Price per lunch at school is between 3 to 3.9 euros per day (Kaiblinger, 2011).

There has been a project which supports cooking with organic food in school canteens in France since the 90's. The growth of this initiative is visible through the total increase of meals cooked from 400 thousand dishes in the year 2000 to 4.5 million in the year 2006. The project is provided by the nationwide organization "Un Plus Bio"; its campaign is called "organic food in public catering" (Chlumská et al., 2010).

Catering in schools in Italy is considered an inseparable right of citizens for education and health. School catering in this country, within this legal framework, has a double meaning. Firstly, it is expected that children will learn to appreciate the food, its origin and quality, secondly it is necessary to help children develop a sense of taste and the taste itself, which will help in the personal development of children (Morgan, Sonnino, 2008). School canteens and even hospital canteens are required to provide organic quality cooking according to the Italian law implemented in the year 2000. The number of dishes prepared with organic food raised almost ten times before the year 2010. In some cases it concerns organic quality cooking with only organic food. Although it is estimated that the number of meals, that are prepared at least with some bio food, reaches 1 million dishes per day in the whole of Italy (Chlumská et al., 2010).

"Food for Life" is a program launched in Great Britain in 2007, which focuses on improving the catering system in schools within the whole country. The main reason for implementing such a program was because of the growing obesity in children and children's bad eating habits in general. The 3600 schools involved in the project banned the sale of sweets, sweetened beverages and unhealthy snacks. The next goal of the project was to increase the use of regional products and organic products when preparing dishes (Royal Society for Public Health, 2013).

The Ministry of Agriculture launched the project Bioschools (Bioškoly) in the Czech Republic in 2009. The project's realization was entrusted to the Country Life company. The main objective was to create a framework for the implementation and use of organic food in school catering. Large stress was put on the creation of a distribution chain, which would give schools direct access to the supply of organic food available

on the domestic market and make the whole supply easier. After the end of the project, the main problem of schools participating in Bioschools (Bioškoly), according to the study of Country Life company in 2011, was the price of food. The study evaluated the whole process and the results of the project. There were 39 respondents (19 schools and 20 suppliers) participating in the study. The price is the ultimate limiting factor which needs to be taken into consideration in the future so it is possible to increase the use of organic food. But is it really the case?

The study showed that the private and smaller schools had no serious problems with the price. The positively rated part of the project by the schools was the educational contribution and mainly its practical approach. Schools have expressed their interest in all activities in the future. Children quickly adapted to the diet change despite negative responses at first. However, the parents' overall feedback is not clear (Pařízek, Valaška, 2011). Therefore, the objections of parents against the use of organic food at schools and kindergartens still remain an unanswered question.

Obstacles to the introduction of organic food into school canteens can be on suppliers side, the negative approach toward organic meals in school canteens can be influenced by parents, who might be concerned of organic food or they are not enough active in support of its introduction in school catering.

Materials and methods

This paper is only a partial result of the project conducted under the IGA 20131014 framework. This project maps and identifies the overall barrier of organic food in school canteens from the perspective of parents and schools /nurseries.

The main aim of this paper is to evaluate the approach of parents towards organic food in school canteens in primary and nursery schools in Prague as a capital city of Czech Republic in 2013.

Prague was selected as a place for this research because of its high organic food consumption and high purchasing power within its population.

The partial aim is to carry out a questionnaire survey among parents of children and confirmation of laid down hypotheses and suggest possible solutions:

Hypothesis 1: If parents use organic food at home, they want to introduce organic food in the school canteens as well.

Hypothesis 2: Parents are not the driving force behind the introduction of the organic food in the schools. There are parents who want to introduce the organic food in the school canteens, but they do nothing to promote it.

Hypothesis 3: Negative attitudes from parents towards the introduction of organic food in school canteens are caused by concerns about high prices of organic meals.

The main used method is a questionnaire survey carried out in the primary and nursery schools in Prague. This questionnaire survey was completed by the parents of children from 8 primary and 8 nursery schools. Three of these schools already have organic food in their canteens. The questionnaire was distributed in printed form during the parents and teachers meetings in June and September 2013 and subsequently was converted to electronic form using Microsoft Excel. Mainly the closed type of questions was used in the survey. Topics of questions were focused on parents' knowledge and attitude to the organic food, opinion on quality of school catering, research of parents´ attitude towards introduction of organic food in school catering, place of distribution (school canteen, buffet, vending machine) and willingness to accept meals' price growth.

1500 questionnaires were distributed in total, 1134 of them were successfully returned and 60 of them were discarded for incomplete filling. The gathered data was converted to graphs for visual representation.

Based on carried out survey at first was compared parents' satisfaction with the school catering between two groups canteens, where is organic food served and where is not.

The associative table was used to determine dependencies and tightness between qualitative characteristics. For easier data processing some answers were gathered in to major categories. For example in question: "Do you agree with serving of organic food in the school canteen of your children?" The answers "definitely yes" and "rather yes" were gathered under answer "yes" and vice versa answers "definitely no" and "rather no" were gathered under answer "no". In question: "Do you have an active approach towards introduction of organic food in school canteen

of your children?" the answers "I don't know" were assed same as answer "no" due to the search of a straight active approach of parents, while indecisive behavior is not considered as active.

The association table has the form given below (Picture 1), where "a, α" are permutations of the first character, "b, β" are variations of the second candidate character and "n" is an extent of a file.

	b	β	
a	(ab)	(aβ)	(a)
α	(αb)	(αβ)	(α)
	(b)	(β)	n

Source: own processing

Scheme 1: Used association table.

Relations were defined:

(a) = (ab) + (aβ)

(α) = (αb) + (αβ)

(b) = (ab) + (αb)

(β) = (aβ) + (αβ)

(n) = (a) + (α) = (b) + (β)

A null hypothesis $\mathbf{H}_0$ and an alternative hypothesis $\mathbf{H}_1$ were chosen. The null hypothesis says, that a relation among the studied characteristics doesn´t exist. The alternative hypothesis says, that a relation among the studied characteristics exists. The significance of level α was set as 0.05.

Data was analysed using SPSS statistical software to verify the above hypotheses. The chi-square test was chosen, as the sample size n > 40 and all of the theoretical frequencies are greater than 5.

Calculation of the theoretical frequency is as follows:

$$(ab)_0 = \frac{(a)*(b)}{n}$$

$$(\alpha\beta)_0 = \frac{(\alpha)*(\beta)}{n}$$

$$(a\beta)_0 = \frac{(a)*(\beta)}{n}$$

$$(\alpha b)_0 = \frac{(\alpha)*(b)}{n}$$

The calculated χ^2 test criterion is compared with tabular assay criterion $\chi^{2\alpha}$. If you pay a relationship $\chi^2 > \chi^{2\alpha}$, the null hypothesis is rejected and the alternative hypothesis is confirmed. This means that the positive correlation between the characters exists. Otherwise, when applied to the relationship $\chi^2 < \chi^{2\alpha}$, the null hypothesis is confirmed, thus the relationship between those two characters is rejected.

A force dependence of the characters with the association coefficient rab is subsequently determined.

$$r_{ab} = \frac{n\,(ab) - (a)(b)}{\sqrt{(a)(\alpha)(b)(\beta)}}$$

The association coefficient is in the interval < -1, 1 >. It becomes negative in indirect dependency. If $|r_{ab}| \in (0;\ 0{,}3)$, it is a weak dependency. If $|r_{ab}| \in (0{,}3;\ 0{,}7)$, it is a medium dependency. If $|r_{ab}| \in (0{,}7;\ 1>$, it is a strong dependency.

In carried out survey and statistical testing were researched parents' interest and attitudes regardless of their income. Based on test results of the third hypothesis was presented a price percentage growth model who would be accepted parents as indicated in the survey. The basic prices are laid down by the legislative norm Decree No. 107/2005 Coll., where the payment for school meals is set by the financial normative.

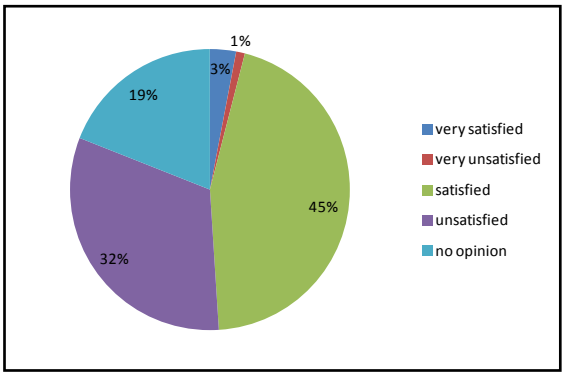
Results and discussion

The sample of respondents is composed from the parent's children who are attending Prague elementary or nursery schools. All of them know the term ‚organic food'. The sample includes 1074 parents, which have 2220 children, but only 1329 of those children are attending schools where the survey was carried out. 77% of the surveyed group were women and 23% men. Their highest achieved education being a university degree - 59% (11.8% Bachelor and 88.2% Master). 41% of parents reached secondary education (of which 91.8% had GCSE level).

Parents were asked for their opinion on the introduction of organic food and meals to a common diet for their children. The survey results say that 48% of parents agree that organic food should be included in the diet sometimes, but is not necessary. 38% of parents have the opinion that organic food might be an essential part of their children's diet. 11% of respondents consider common conventional food as sufficient for their children's alimentation. The remaining 3% of respondents have no opinion on this issue.

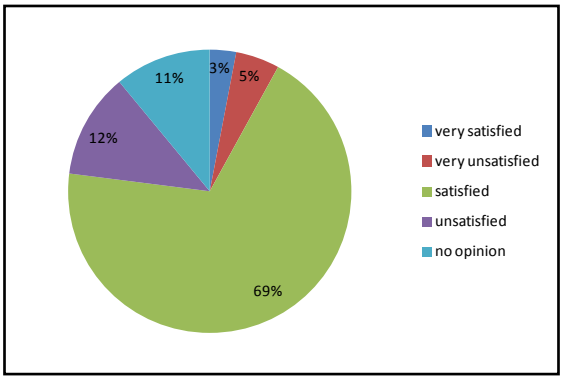
50% of respondents use the argument that organic food will increase the price of school catering as a reason for their concerns about the introduction of organic meals in school catering. Only 3% percent of parents are against the introduction of organic food, 9% do not have a strong opinion and 88% of respondents agree with the introduction of organic food in case of keeping the current meal prices. This, therefore, indicates a positive attitude towards organic food.

Another monitored criterion was the parents' satisfaction with the school catering. The ratio of satisfied parents to unsatisfied parents is 12:5. Parents' satisfaction with the school catering is directly influenced by the fact that if organic food is served in the school canteen or not (see Graph 1 and Graph 2).



Source: own processing

Graph 1: Parents' satisfaction with the school catering, where organic food not served.



Source: own processing

Graph 1: Parents' satisfaction with the school catering, where organic food not served.

1. Test of the first hypothesis

The first hypothesis says: If parents provide organic food at home, they also want to introduce organic food in the school canteens for their children.

The survey results say that about 48% of households consume organic food. It is necessary to note that among households consuming organic food we include those that consume organic food at least once a month or more often.

Another way to verify the first hypothesis would be through answers from parent´s agreement which includes organic meals in school catering.

About 81% of parents agree and welcome the use of organic food in school canteens. Only 12% of the surveyed parents refused organic food in school catering. The reason for their negative attitude towards the organic meals is the high price of these products and lack of children's interest in consuming organic food. As well as the opinion that organic food is not healthier than conventional food. The remaining seven percent of respondents had no clear opinion on this issue.

		Introduce org. food to school		Total
		yes	no	
Consumption of org. food at home	yes	480	21	501
	no	396	105	501
Total		876	126	1002

Source: self-elaboration, 2013

Table 1: Association table for the first hypothesis.

An association table (see Tab. 1) was compiled from the above information which has formulated the alternative and zero hypothesises:

H_0: Parents, who consume organic food at home, do not want to introduce organic meals in school cantering.

H_1: Parents, who consume organic food at home, wish to introduce organic meals in school cantering.

The significance level α was selected as 0.05. Using the program SPSS the calculated test criterion is $\chi^2 = 21.352$.

The table criterion is $\chi^2_\alpha = 3.841$. As $\chi^2 > \chi^2_\alpha$, the alternative hypothesis is confirmed: parents, which consume organic food at home, wish to introduce organic meals in school cantering. The strength of examined characters of the first hypothesis is weak, therefore rab = 0.2528.

2. Test of the second hypothesis

The second hypothesis says that parents are not the driving force behind the introduction of organic food in school catering. It means

that parents who want to introduce organic food into school canteens, don‘t actively do anything for it. This was evident from the results of the Bioschools (Bioškoly) project.

Although 81% of parents agree and welcome the use of organic food, nearly two-thirds of respondents (64%) have taken no steps towards supporting the introduction of organic foods in the schools.

		Active approach		Total
		yes	no	
Introduce organic food to schools	yes	375	501	876
	no	9	117	126
Total		384	618	1002

Source: self-elaboration, 2013

Table 2: Association table for the second hypothesis.

First of all an association table (see Tab. 2) is compiled from the above mentioned information and alternative and zero hypothesises are formulated:

H_0: Parents, who want to introduce organic meals in school catering, do not have an active approach.

H_1: Parents, who want to introduce organic meals in school catering, have an active approach.

The significance level α was selected as 0.05. Through the program SPSS the calculated test criterion is $\chi^2 = 19.760$.

The table criterion is $\chi^2_\alpha = 3.841$. As $\chi^2 > \chi^2_\alpha$, the zero hypothesis is rejected and the alternative hypothesis is confirmed: *Parents, who want to introduce organic meals to the school, have an active approach.*

The strength of examined characters of the second hypothesis is weak, therefore $r_{ab} = 0.2432$.

3. Test of the third hypothesis

The most frequently mentioned obstacle about the introduction of organic food is the price. 55% of respondents state this argument as a reason of their concerns for the introduction of organic meals in school catering. On the other hand, about 38% of respondents have no concerns about the rise in meal prices. 7% of respondents were unsure or didn‘t know.

The second most frequently mentioned obstacle is the concern about the negative attitude of children towards organic food (25%). Children do not know many organic food products (e. g. couscous, buckwheat, etc.), because their parents don´t provide them at home. The trend of the last years shows that at school children eat only one hot meal during the day. In such a case the school or the school catering takes over the role of a mediator between child and new kinds of food.

The rest of the answers (7%) includes a distrust in organic food. Parents do not trust the origin of organic food and its certification.

Resulting from the above mentioned, the main problem is the concern about the high price of organic school meals, therefore the third hypothesis is tested.

		The fear of price increases		Total
		yes	no	
Introduce organic food to schools	yes	447	375	822
	no	99	21	120
Total		546	396	942

Source: self-elaboration, 2013

Table 3: Association table for the third hypothesis.

An association table (see Tab. 3) was compiled from the above information, as a result the alternative and zero hypothesises are formulated:

H0: Parents, who worry about the increase in the price of lunch as a result of the introduction of organic food in school catering, do not have a negative attitude towards that.

H1: Parents, who worry about the increase in the price of lunch as a result of the introduction of organic food in school catering, have a negative attitude towards that.

The significance level α was selected as 0.05. Through the program SPSS the calculated test criterion is $\chi^2 = 11.328$.

The table criterion is $\chi^{2\alpha} = 3{,}841$. As $\chi^2 > \chi^{2\alpha}$, the alternative hypothesis is confirmed:

Parents who worry about the increase in the price of lunch as a result of the introduction of organic food in school catering have a negative attitude towards that.

The strength of examined characters of the third hypothesis is weak, therefore $r_{ab} = -0.1899$.

A negative value indicates an indirect dependency - if the fear of rising the price is higher, the introduction of organic meals in the schools is promoted less.

3.1. Model calculation of prices

The most discussed issue concerning the introduction of organic food within school canteens is the price. Thus, parents were asked how much they would be willing to pay for lunch for their children if the school provided organic food instead. Only 20% of parents are not willing to pay extra money for children‘s food, or they were unsure. Other respondents were willing to pay a little more than the current price.

The actual meal prices in Prague school canteens are in the range of 24 CZK, 26 CZK and 28 CZK. The question was how far can meals´ price growth influence family budget, thus was done the model calculation of prices in respect to the parents´ willingness how much to pay more.

The results show that 42% of parents are willing to pay 10% above the current price, which is on average 2.6 CZK. It is assumed that the average length of one school month is 21 days. 10 days of Christmas holidays and 5 days are taken into account. Spring Break, public holidays and possible absence of children is not taken into account. Calculation of the extra charge by the willingness of parents is shown below:

195 days * 2.6 CZK = 507 CZK per year, means an average of 50.7 CZK per month.

In the case that the lunch price is increased by 20%, in which 29% of parents would be willing to pay more, the supplement to the current price was:

195 days * 5.2 CZK = 1,014 CZK per year.

In the case that the lunch price is increased by 30%, which 9% of parents would be willing to pay, the supplement to the current price was:

195 days * 7.8 = CZK 1,521 CZK per year.

The whole situation is paradoxical; the biggest obstacle to the introduction of organic meals to school canteens is the price, but the majority of parents do not know the current price of their children‘s school meals. Only 42% of parents know the exact price, or at least they can roughly estimate the price with a tolerance of +/- 2 CZK. The majority of surveyed parents don’t know the price at all. One argument for this unfamiliarity with lack of knowledge about lunch price is the fact that the parents pay for lunch by a direct debit bank transfer (inkaso) and due to this they have no clear estimate about the costs. The second major argument was that the second parent from the couple arranges the payments for school catering. Estimations which even exceeded the actual lunch price by 100% appeared in the survey.

Discussion

Parent´s satisfaction with the school canteens was detected firstly. Parents are more satisfied with school canteens which provide organic food. Of course, the satisfaction may not be only due to the use of organic food. This is probably the overall performance of the school canteen. The cooking from organic food only proves that the canteens try to offer quality food and they work towards a future alimentation strategy.

The main aim of this paper is to evaluate the approach of parents to use organic food in school canteens in primary and nursery schools in Prague. For this purpose three hypotheses were laid down and verified.

The first hypothesis examined the relationship between the use of organic food at home and willingness to introduce organic meals into school canteens. The relation was found. We can say that parents who use organic food at home want to introduce it in school canteens. This shows a positive approach towards use of organic food, but it is still necessary to provide information on organic food for the people and encourage their interest in organic farming.

The second hypothesis investigated the relationship between activities of parents in implementing organic meals in the school canteens and their willingness to have organic food in schools. From the final experience of the two-year project Bioschools (Bioškoly) it has been discovered that parents are not the driving force behind the introduction of organic food. However, this hypothesis was not confirmed.

These results are the same as the results of the pilot survey for the Bioschools (Bioškoly) project. The reason for these surprising results could be due to a different perception of the term, active approach‘. Some of the parents who were considered as an active approach gave just positive answering towards organic food in the survey.

The third hypothesis pointed to the possible relationship between parent´s concerns about higher prices of organic meals and a negative approach towards organic food in school canteens.

This hypothesis was confirmed. So we can say that the parent´s fear of increased meal price negatively affects the parent´s approach to the introduction of organic food in school canteens. The fact that parents in most cases don´t know the current price of their children meals is an important finding and shows a paradox. And only a few parents reported that the price is lower than the real price. It is interesting that parents are always referring to the price, but they do not have a clear overview of this issue. The example showed that if the price of meals is increased by 10%, the alimentation costs will increase only by 50.7 CZK more per month. Thus an information campaign is needed to present this result and its impact on the family budget. A public website, regional television and regional newspapers could be a good tool for this campaign.

It is important to note that managers of school canteens cannot set their „own lunch price" due to legislative norm Decree No. 107/2005 Coll., which sets a maximum and minimum price of meals. Although organic food is more expensive than conventional food, some managers of school canteens are able to introduce organic food and not increase the price of lunch at the same time. This fact demonstrates that sometimes it depends on the efficiency of the school canteen managers, how they calculate the meal price and how they can balance the week/month budget (e.g. for the day after the organic meal serve a cheaper lunch).

Conclusion

The issue of organic food in school catering is currently widely discussed, but it is a contentious issue as well. The Czech Ministry of Agriculture has tried to promote the usage of organic food in school catering by a two-year project, which has just been completed. At the same time there was a plan to run another project to support organic food by the Ministry of Education, but unfortunately it has not been realized. All initiatives from the state have now been stopped. While the examples from Italy, Austria, Great Britain show growth of organic food consumption in school catering, there is a stagnation in the Czech Republic. Reasons can be caused by food suppliers, schools or parents. This paper aimed to evaluate the parents' attitudes to the introduction of organic food in field of negative barriers.

Statistical data from the survey confirmed the following hypotheses:

Parents, who consume organic food at home, wish to introduce organic meals in school cantering.

Parents, who want to introduce organic meals in school catering, have an active approach.

Parents, who worry about the increase in the price of lunch as a result of the introduction of organic food in school catering, have a negative attitude towards that.

The most problematic factor regarding organic food in school catering is the price. Generally speaking, organic food is more expensive than conventional food. Therefore, parent´s concern for lunch prices is growing. This factor often results in opposition towards the introduction of organic food in the schools. However, experiences from some schools show that the price may not to be always higher.

From the survey results show that even though the parents are afraid of higher prices of organic meals, they are willing to pay more (about 10% of the current price). The model calculation of prices shows, if the lunch price increases by 10%, the family budget will increase by 50.7 CZK per month. Although that parents´ income was not priority researched in the survey, the influence of meals ´price growth on the family budget can be discussed.

The interesting paradox is the fact that parents often don´t know the current school meal prices. So there is an unfamiliarity with lack of knowledge with school lunch prices and a lack of knowledge with unfamiliarity with the impact of this price increasing on a family budget. This ignorance is a potential tool to mitigate or erase the negative approach of parents towards the organic food in school catering.

The main obstacle to introduction of organic food in school catering is definitely the price. But the concerns of meals´ price growth by (for example) 10% are almost irrelevant, when this growth presents in Prague about 51 CZK per month. To eliminate this barrier is necessary to inform parents using, for example, calculation in terms of real prices.

It is also necessary to more encourage parents' activities towards the introduction. Although they are persuaded about their self-activeness, the situation is different in real. It is important to present that it is essential to let parents understand that their children's diet is a very important factor of their lives. Since childhood people adopt dietary habits. Currently, the school

lunch is often the only hot meal during the day for school children, so it is necessary to consider and research its quality. It doesn't mean that an organic lunch must be healthier, but the introduction of organic food to children's diets can bring, at least, the positive effect of widening the horizon of children's health and eating habits. Information can be provided during parents and teachers meetings in appropriate ways, such as organic food presentations, lecture on childhood obesity held by paediatrician, etc. A public website, regional television and regional newspapers could be a good tool for this campaign as well.

Corresponding author:
Ing. Šánová Petra, Ph.D.
Department of Trade and Finance, Faculty of Economics and Management,
Czech University of Life Sciences in Prague, Kamýcká 129, 165 21 Prague 6 - Suchdol, Czech Republic
E-mail: sanova@pef.czu.cz

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A Neural Network Model for Forecasting CO_2 Emission

C. Gallo, F. Contò, M. Fiore

Department of Economics, University of Foggia, Italy

Abstract

Air pollution is today a serious problem, caused mainly by human activity. Classical methods are not considered able to efficiently model complex phenomena as meteorology and air pollution because, usually, they make approximations or too rigid schematisations. Our purpose is a more flexible architecture (artificial neural network model) to implement a short-term CO2 emission forecasting tool applied to the cereal sector in Apulia region – in Southern Italy - to determine how the introduction of cultural methods with less environmental impact acts on a possible pollution reduction.

Key wordslíčová slova

Air pollution, CO_2 emission, artificial neural network, autoregressive, cereal sector.

Introduction

Air pollution is a critical element in environmental damage, mainly caused by anthropogenic factors. Human activities are influencing both air quality and climate change at regional and global scales. The rapid growth of population and the increase in energy demand are the main causes of the emission of large amounts of harmful pollutants and greenhouse gases, with serious consequences on health and environment. There are a lot of empirical evidences showing that the resolution of the problems of over-exploitation of natural resources goes through their replacement with forms of investment in intensive physical capital, and therefore through actions of innovation and technological diffusion (Contò, Prota, 2004). Substantial progress has been made over the past few decades to prevent and control air quality in many parts of the world through a combination of technology improvements and policy measures (Dentner et al., 2006; Esty et Al., 2005). Classical statistical approaches are not considered suitable to model such complex phenomena efficiently because they often lead to approximations or too rigid frameworks (Stanley, 1997; Hussain, Reynolds, 1995). The adoption of flexible architectures as artificial neural networks results in a more effective and rewarding approach in air quality control (Hornik et Al., 1989; Ojha, Singh, 2002). The optimization of the use of environmental resources also meets the dual aim of reducing the impact of economic activities and streamlines the company‘s costs. In this work we focus on the complex problem of controlling air pollution (particularly due to CO_2 emission) and mitigating its adverse effects on human health and the environment by proposing an artificial neural network model for forecasting CO_2 emission to help environmental policy decisions. The adopted model falls in the category of temporal linear stochastic models, in particular of the “non-linear auto-regressive moving average with exogenous inputs” type. The model was applied to a group of companies located in Southern Italy – Apulia region - participants in an Integrated Project of Food Chain (IPF ‘Oritalia’) which provided for the testing and introduction of forms of conservation agriculture in these cereal farms. Specifically, it is the introduction of the no-tillage farming techniques that allows a strong reduction of agronomic inputs, thus ensuring greater protection of agricultural soils. The model has been applied to the Apulian cereal sector to determine how the introduction of cultural methods with less impact (e.g. tillage) acts on a possible reduction of emissions. In the following sections we briefly expose the rationale behind the mathematical model adopted, followed by the illustration of the dataset of Apulian cereal sector CO_2 emissions and related methods of analysis and investigation. Finally results and conclusions are drawn.

Atmospheric dispersion models

The most important activity for air quality management consists in collecting environmental data and analysing these data by fitting it into a mathematical model that can be subsequently

used to predict air quality under different scenarios and also to quantify the health and environmental risks (Mori, 2000; Holmes, Morawska, 2006). Air quality modelling is a well-researched and fully developed area, and several works are available that deal with this subject (Nema and Tare, 1989; O'Neils et Al., 2008; Krzyzanowski, 2008; Ramanathan, Feng, 2008). Popular statistical approaches have been recently adopted to cope with these problems, leading to the use of specific techniques such as ANN, fuzzy logic, and time series analysis (Comrie, 1997; Haykin, 2001). In the absence of any rigorous modelling, however, time series can be used locally for useful forecasts of concentrations of air pollutants.

Analytical models

In its simplest representation, an emission source reaching the atmosphere may extend horizontally and vertically through a process called *dispersion*, and the shape drawn is roughly conical and called a *plume*. How it spreads will depend on the meteorological and process conditions prevailing in the atmospheric boundary layer. The complete equation for Gaussian dispersion modelling of continuous air pollution plumes (Beychock, 2005) is shown below:

$$S = \frac{Q}{2\pi u} \cdot \frac{f}{\sigma_y} \cdot \frac{g}{\sigma_z} \quad (1)$$

where:

f = crosswind dispersion parameter $= e^{\frac{-y^2}{2\sigma_y^2}}$;

g = vertical dispersion parameter = $g_1+g_2+g_3$;

g_1 = vertical dispersion with no reflections $= e^{\frac{-(z-H)^2}{2\sigma_z^2}}$;

g_2 = vertical dispersion for reflection from the ground $= e^{\frac{-(z+H)^2}{2\sigma_z^2}}$;

g_3 = vertical dispersion for reflection from an inversion aloft =

$$\sum_{m-1}^{\infty}\left[e^{\frac{-(z-H-2mL)^2}{2\sigma_z^2}} + e^{\frac{-(z+H+2mL)^2}{2\sigma_z^2}} + e^{\frac{-(z+H-2mL)^2}{2\sigma_z^2}} + e^{\frac{-(z-H+2mL)^2}{2\sigma_z^2}} \right]$$

S = concentration of emissions, in g/m^3, at any (x downwind, y crosswind, z above ground) meters located receptor;

Q = source pollutant emission rate, in g/sec;

u = horizontal wind velocity along the plume centreline, in m/sec;

H = height of emission plume centreline above ground level, in m;

σ_z = vertical standard deviation of the emission distribution, in m;

σ_y = horizontal standard deviation of the emission distribution, in m;

L = height from ground level to bottom of the inversion aloft, in m.

When wind is very low, S will tend to increase to infinity. To deal with such situations, the concept of puff modelling has evolved:

$$S = \frac{p}{15.75\sigma^2_{xy}\sigma_z} \cdot e^{-\frac{(x_c-x_r)^2}{2\sigma_{xy}^2}-\frac{(y_c-y_r)^2}{2\sigma_{xy}^2}} \cdot e^{-\frac{(z_c-z_r)^2}{2\sigma_z^2}} + \cdot e^{-\frac{(2z_{inv}-z_c)^2}{2\sigma_z^2}} \quad (2)$$

where x_c, y_c, and z_c are the coordinates of the center point of a puff, x_r, y_r, and z_r are the coordinates of the receptor (the concentration contribution of a single puff at a point), P is puff inventory, σ_{xy} is the puff dispersion parameter in horizontal direction, σ_z is the puff dispersion parameter in vertical direction, and z_{inv} is the height of the inversion lid. These two approaches are useful in understanding the nature of dispersion, where the plume model has been commonly used to analyse steady-state continuous gas diffusion and the puff model for calm wind conditions. By the way, these simplifications cannot be used with variable meteorological conditions and numerical solutions are the only practical possibility (Mori, 2000). Nema and Tare (1989) outline the need of computational simulation procedures to deal with situations of non homogeneous and unsteady conditions which also influence the atmospheric dispersion. Holmes and Morawska (2006) presented a detailed review of dispersion modelling, based on which we may sketch a broad classification of air pollution models, such as Box, Gaussian plume, Gaussian puff, Lagrangian, Eulerian, and Computational fluid dynamics (CFD) which all model dispersion on a local or regional-scale.

Statistical models

Deterministic air quality models have recently been used in support of emission regulation and policy decisions. Their applicability for air quality forecasting (but depending on the quality of inputs) has become useful due to the recent

advances in computational capacity. Comrie (1997) compared deterministic with statistical models in their performance, showing that the latter outperform deterministic models. Statistical models have been developed with the intention of predicting concentrations based strictly on observations. The main types of statistical models are regression-type models and neural network-type models (Gallo et al., 2013). The first are models that use correlations to infer information for future concentrations. In particular, auto-regressive models (Comrie, 1997) are widely used stochastic models for forecasting, providing excellent results when used for long-term prediction, while not satisfactory when used for short-term forecasts and in the presence of non-stationary situations. This can be superseded by the introduction of an exogenous variable in the model, which lowers the erratic component. The model is represented as follows:

$$X_t - c_1 X_{t-1} - c_2 X_{t-2} - \ldots - c_p X_{t-p} = a_t - \theta_1 a_{t-1} - \ldots - \theta_q a_{t-q} + \beta_1 u_{T_1} + \ldots + \beta_m u_{Tm} \quad (3)$$

where $\beta(.)$ is a polynomial of order m, u_{T_m} represents the $m-$th exogenous input and T_m is the time delay between the output and the m−th input. On the other hand, neural network models "learn" from previous experience, correlating tomorrow's forecast with the outcome of similar patterns and trends.

Artificial Neural Networks (ANN)

As previously indicated, the final objective of any modelling is to determine the concentrations of a given pollutant for a known set of input data. By training with some known results an artificial neural network model (ANN), you can perform this task much more easily. To understand the capabilities of ANN, we first begin with a brief introduction. Later, we show a particular forecasting model whose use is relevant to the subject of air quality modelling. Artificial Neural Networks represent an advanced machine learning computing approach extensively used in the field of pattern recognition, dynamic system prediction, control, and optimisation (Zhang, Patuwo, 1998). The network is made by computational units (artificial neurons) through which information processing occurs by passing signals (often binary or real values) through links connecting network nodes. Each connection link has an associated weight representing its strength, and each node typically applies a nonlinear transformation, called an *activation function*, to its input to determine its output value. A neural network has an architecture describing the nodes' connection pattern, its connection weights' computational technique, and the activation function. The nodes are arranged in layers, namely *input* layer, *hidden* layer, and *output* layer forming the so called MLP (Multi Layer Perception) architecture. The input layer receives the input variables and provides information to the network. The output layer consists of the values predicted by the network. In a typical feed-forward neural network the nodes of one layer are connected to the nodes of adjacent layers but not to the nodes of the same layer. The number of hidden layers and hidden neurons are determined empirically. The output of each node depends on the output of the nodes of the previous layer connected to it and the corresponding weights. Each input to the network form a multi-dimensional vector $X = x_i$, $i = 1,..., m$, with the corresponding weights represented as a matrix $W = [w_{ij}]$, $i = 1,..., m$, $j = 1,..., n$. The network output is a vector $Y_j = f(X \bullet W_j - \theta_j)$, $j = 1,..., n$, where θ_j is the "threshold" value, X is the input vector, Wj is the weight vector for the j-th output node and f is the activation function. In a feed-forward ANN the most commonly used is the sigmoid function $f(x) = 1/(1+e-x)$. The choice of the sigmoid function is due to three important factors:

- it is a continuous function and therefore is everywhere differentiable;
- it is a nonlinear function;
- it is limited to [0, 1] and this translates into benefits in terms of learning.

In order to train and validate the ANN model, the data are divided into *training* and *validation* datasets. The suitability of the ANN model derives from its ability to reproduce the validation dataset with reasonable accuracy. Neural networks are widely used when you have no evident mathematical relationship between the variables. So, in the area of air quality forecasting the ANN model can be applied being not known a priori the connections between the operating parameters. In a neural network, determining the number of input and output neurons depends on the particular problem, so the number of hidden layers, whose choice significantly impacts on the network's performance. Besides, the training error can be influenced by the scaling of output values (Ojha, Singh, 2002). Too few nodes can lead to a poor approximation, while too many nodes can over fit the training data. So an empirical procedure is generally applied to decide on the optimal architecture.

The proposed ANN forecasting model

The neural network model chosen for the estimation of the pollutant emission into the atmosphere has a MLP feed-forward structure, with Levemberg-Marquardt learning algorithm and sigmoid activation function. The Levenberg-Marquardt training algorithm has been adopted because the classic steepest descent approach has a rather slow convergence to an absolute minimum due to its use of the gradient. This algorithm also uses the information on the error function Hessian without computing it explicitly, being therefore particularly fast when the number of inputs is not high. In the chosen neural network model the main features are:

- the number of hidden layers, set to one, as it has been shown that a neural network with one hidden layer is able to better approximate any continuous function;
- the number of hidden neurons, set to 20 for empirical reasons, to avoid over fitting;
- the number of input data used for the training dataset, for the resulting network to correctly "generalise" after the validation phase.

In particular, each input record consists of the last three forecasts (y), the related moving average (ma). Moreover, the CO_2 values are emissions in tons.

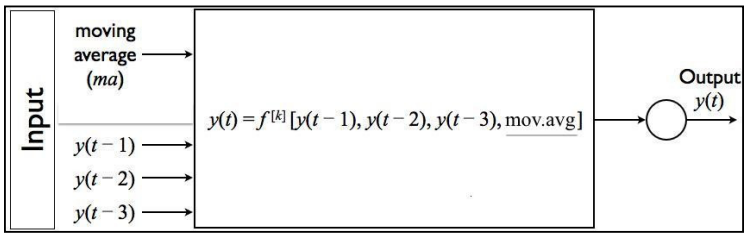
In this work, these parameters have been defined experimentally, by trial-and-error after various tests by minimisation of the mean square error indicator:

$$\mathrm{MSE}^{[k]} = \frac{1}{n}\sum_{j=1}^{n} (s_j^{[k]} - y_j^{[k]})^2 \quad (4)$$

where $s_j^{[k]}$ represents the desired j−th output value and $y_j^{[k]}$ is the obtained j−th output value for the k−th input pattern given to the network for training.

Results and discussion

In this work we have adopted a neural network model of "nonlinear auto-regressive with exogenous inputs moving average" type (see Fig. 1) in order to make predictions (Zhang, 1998) in the time domain of CO_2 pollutant inferred by the energy consumption of the companies under study. The reference database is composed of 220 cereal Apulian companies that are introducing, or have introduced, on part of the cultivation area less polluting methods with low energy content. We simulated different scenarios that could draw on emissions in cereal sector as a result of this transformation. The results of the most significant experiment follow in detail. The underlying mathematical model is shown in Fig. 1. The experimental results are detailed in Table 1, while the correlation between achieved outputs and desired targets are illustrated in Fig. 2.



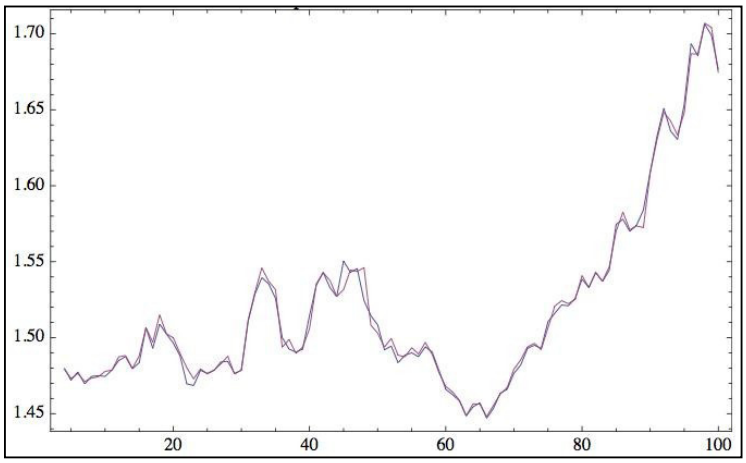
Source: our processing

Figure 1: The block diagram of the chosen network architecture.

Input	$CO_2(t-1)$, $CO_2(t-2)$, CO2($t-3$), ma[$CO_2(t-3)$, $CO_2(t-2)$, $CO_2(t-1)$]		
Target	$CO_2(t)$		
	%	# of samples	MSE
Training	70	154	3.433333333
Validation	30	66	3.841666667

Source: our processing

Table 1: Experimental results after the application of the prediction model.



Source: our processing

Figure 2: The network model's performance as a function of iteration.

Conclusions

Air quality control shows that pollution is mostly caused by anthropogenic factors. In this paper we introduce a model based on artificial neural networks to predict pollution's short-term rate for supporting environmental policy decisions. The adopted forecasting model is of non-linear auto-regressive type with exogenous input, and has demonstrated its validity for short-term previsions. The model provides good results (as to the MSE indicator) for estimating CO_2 pollution given by a sample of Apulian companies in the cereal sector. Its application shows that it is possible to make predictions up to three time periods. It is not possible to predict at a longer time period given the low correlation that exists between the outputs obtained and the desired targets. In addition, the adopted model is stable or time-independent, in the sense that the analysed phenomenon does not depend on the time but on a combination of meteorological factors present in that place and both the chemical and physical processes acting at that precise moment and in the moments before. The use of specific software designed and implemented for the management of cereal farms in all its aspects will monitor both the effects of optimisation of inputs in companies' life and in their financial statements and the environmental effects of the activities of these businesses. Future research trends will aim to investigate more thoroughly towards the interactions between environmental (exogenous) and company-related (endogenous) factors to better estimate the correlation between CO_2 emission and companies' size and operating parameters.

Corresponding author:
Mariantonietta Fiore
Department of Economics, University of Foggia, Largo Papa Giovanni Paolo II, 1 71121 Foggia, Italy
Phone: +39.0881.781806, fax: +39.0881.753711, E-mail: mariantonietta.fiore@unifg.it

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Effects of Public Support on Producer Groups Establishment in the Czech Republic and Slovakia

P. Kotyza, K. Tomšík

Faculty of Economics and Management, Czech University of Life Sciences in Prague, Czech Republic

Anotace

Deset států, které v roce 2004 vstoupily do EU, mělo možnost čerpat finanční prostředky z rozpočtu EU na podporu nově založených odbytových organizací (skupin výrobců) uznaných až do prosince 2006. Analyzované státy (Česká republika a Slovensko) otevřely dotační program za účelem podpořit vznik nových odbytových organizací a současně podpořit snížení administrativní zátěže. Hlavním cílem článku je porovnání podmínek a dopadů uvedeného dotačního programu v České republice a na Slovensku a navržení možných programových inovací. Článek vychází z literárního přehledu dané problematiky, porovnává legislativní podmínky, měří množství uvolněné podpory a porovnává dopady, jaké mají nově založené a podpořené organizace na zemědělský sektor po ukončení vyplácení dotace (tj. po 5 letech od založení). Z analýzy vyplývá, že lepší využití poskytnutých prostředků bylo dosaženo na Slovensku. Menší počet podpořených organizací a rozdílné podmínky vyústily ve větší podíl úspěšných organizací, větší průměrné tržby a vyšší podíl tržeb k celkové produkci zemědělského odvětví. Z tohoto důvodu byla navržena doporučení pro Českou republiku pro změnu podmínek poskytování příslušných dotací. Článek byl vytvořen jako součást grantu poskytnutého Interní grantovou agenturou PEF ČZU (č. 20121077).

Klíčová slova

Skupiny výrobců, odbytové organizace, ČR, SK, Program rozvoje venkova 2004 – 2006, tržby, úspěch, efekty.

Abstract

Ten countries that have joined the European Union in 2004, had a chance to use EU rural development instruments for support of establishment new producer groups of agricultural producers between 2004 and 2006. Both analysed countries (Czech Republic and Slovakia) have used the opportunity and co-financed programme that aimed on supporting establishment and alleviation of administrative burden. Main aim of the article is to compare conditions and outcomes of the programmes in the Czech Republic and Slovakia and to propose programme innovations. The article describes theoretical assumptions, compares legislative background in selected countries, measures amount of support available and compares outcomes of newly established groups after receiving last supporting payment. One of the conclusions finds Slovak approach more effective. Lower number of supported groups and different conditions result in higher share of successful organisations, higher average revenues of supported groups and higher proportion of revenues in relation to total output of agricultural industry. Finally there are proposed recommendations for the Czech Republic, how programme conditions should be innovated. The article originated as a part of the Internal Grant Agency (IGA) of the Czech University of Life Sciences Prague, Registration Number 20121077.

Key words

Producer groups, marketing organisations, Czech Republic, Slovakia, Rural development programme 2004 – 2006, revenues, success, effects.

Introduction

Czech and Slovak agriculture faces strong competition after accessing to the European Union in 2004. Since then, both countries have been trying to improve their situation on the common market. There have been offered different policies and supportive financial programmes both by national and EU bodies. One specific measure was aiming at development of joint marketing

organisations of producers, so called producer groups. This programme was open in both countries between 2004 and 2006.

Czech Republic and Slovakia are members of the EU Single Market and therefore they compete with other, more advanced, agricultural producers. Agricultural producers need to face imperfect competition, they struggle with producers from other member countries and therefore they search for new strategies to increase their competitiveness (Huml, Vokačova, Kala, 2010). Vertical integration might become one of the successful strategies. Importance of farmers' cooperation has been confirmed by many authors (Latruffe et al. 2004; Andrew, 1976; Ratinger, Bošková, 2013). Latruffe (2004) defined two most important factors of technical efficiency – farmer's education and downstream market integration of farms. Special attention is paid to the integration of farmers into marketing organisations.

According to Bijman (2002), many vertically integrated organisations in EU exist. Marketing organisations oppose oligopolies or monopolies (Zamagni, 2012); ensure profits not to be distributed towards middleman or commodity processors (Chloupková, 2002). Marketing organisations might ensure information exchange, joint handling, joint agreements, cost reduction (time, labour, transportation), technical information requirements, increasing access to credit, and others (van Anrooy, 2003).

Marketing organisations were widely developed in former Czechoslovakia before the Second World War (WW2); traditions in cooperation reach as far as to the 19th century when first marketing co-operatives were established. Before the WW2, the co-operative structures were widely developed in the Czechoslovakia and significantly contributed to rural development (Hůlka, 1931). Communist regime started a process of collectivisation in 1950's; Czech and Slovak farmers were forced to join collective co-operatives (in fact collective farms) or they were persecuted.

Joint actions of producers have been limited, after communist takeover Czechoslovak government transformed marketing cooperatives to government-owned enterprises that supplied agricultural producers with both inputs and outputs, marketing of their products were controlled by state (Lošťák, Kučerová, Zagata, 2006). Privatisation that took place after 1989 has not returned nationalised assets to former co-operative owners.

Although Czechoslovakia fell apart in 1993, further development has not changed significantly. From 1993 to 1999, only small number of marketing organisations has been established and newly created organisations have not been entitled to any financial support. After 1999, both countries were implementing European legislation and they both established supportive tools for newly established organisations. The most significant change has been introduced after access to the EU. All new member countries had the opportunity to source money from the Rural Development Programme 2004 - 2006 (Council Regulation (EC) No. 1257/1999, chapter IXa, article 33d). European legislation calls marketing organisations or agricultural producers "producer groups" (PG); this expression will be used in the text below. Financial grants are supposed to initiate establishment and successful development of newly established entities, 25% of the support is provided by national government, the rest by the EU budget.

Defining successful agricultural marketing organisation is quite complicated as there exist many different approaches (Adrian, Green, 2001; Sexto and Iskow, 1988; Hendrikse, Veerman, 1997). In the article, there is employed basic assumption defined by Banaszak (2009). She specifies successful organisation as any group that organises joint sales of its members. Although she does not consider economic results of groups in her condition, it is obvious that producer groups are economic entities that should be able to survive without receiving any subsidies on the market. (Ejsmont, Milewski, 2005)

Size of a group also matters, as farmers behave very rationally seeking for their profits. As long as the marketing organisation offers significantly high premium, members are loyal. However, if new and better market opportunity occurs, producers tend to lose their loyalty toward organisations and sell outside the group. (Banaszak, Beckmann 2010). Larger groups have therefore higher chance to be successful (Bansazak, 2007) although such groups find more difficulties in co-ordinating and communicating their actions (Kollock, 1998; Olson, 1965).

Materials and methods

Main aim of the article is to compare conditions and outcomes of the programme in the Czech Republic and Slovakia after 5 year supporting period. Further objectives are defined as follows:

a) to compare legislative conditions; b) to sort marketing organisations according to their legal form and their success; c) to analyse impact of successful groups on total agricultural output of the Czech Republic.

Authors source information from publications of the Czech and Slovak ministry of Agriculture, Czech State Agriculture Intervention Fund (SAIF[1]), Slovak Agricultural Paying Agency (SAPA[2]) and Czech Commercial Register and Collection of Documents[3], Slovak Business Register[4]. Additional data were also sourced from Bisnode database[5] and EUROSTAT[6].

The first part is focused on legal aspects and requirements. As legal aspects in both countries result from EU legislation, this part compares differences in main and secondary objectives (Czech Republic, Slovakia and EU) and differences in conditions.

The second part analyses available data on support and programme's outcome. Because the programme was designed for 5-year period and started latest in 2006, it can be argued that all companies registered shall already have received awarded amount of support and programme's performance analyses can be executed.

First of all, sample of companies is described and sorted according to their legal form. Second, supported groups are sorted into categories according to their status of December 2013. Based on the Banaszak's assumption (2009) and own experience, authors define 3 basic groups of organisations (successful, not successful, organisations that cannot be evaluated) and some additional subcategories (see Table 1).

After the categorisation, successful companies are further analysed. Their revenues are collected and help to measure programme's effect. For the calculation, following formula is used: (1)

$Effect = \frac{TR_{SO}}{OPT_{AI}} \times 100\ (\%)$, where $\mathbf{TR_{SO}}$ represents *Total revenues of successful companies* and $\mathbf{OPT_{AI}}$ *Output of agriculture industry in basic prices*.

Both countries are also compared by indicator – Financial Support on Creating One Successful Organisation (FSS). Because there are companies that cannot be evaluated, authors do not include them in the calculations. Therefore, formula (2) is designed as follows:

$FS_S = \frac{TFS - FS_{CBE}}{N_{SO}}$, where **TFS** represents *Total Financial Support*; $\mathbf{FS_{CBE}}$ *Financial Support of Companies that Cannot be Evaluated* and $\mathbf{N_{SO}}$ stands for *Number of Successful Organisations*.

[1] List of Beneficiaries (seznam příjemců dotací)

[2] Data were required after email communication with Ms. Milkova, Public Relation Office

[3] www.justice.cz

[4] www.orsr.sk

[5] www.ipoint.cz

[6] Total Agricultural Output

Classification	Condition
- Successful	Main activity (joint sales of members' products) prevails also after granting period, relatively constant level of sales or their increase.
- Not Successful	
In liquidation	The companies are in the process of liquidation or has been already deleted from the Commercial Register
Significant decrease of main activity	Main activity decreased during the examined period by more than 90% after receiving final support from the programme
Not active	The main activity is not carried out at all. Either the organisation posted no sales or their limited sales were from other activities.
One member or owner only	One member organisation cannot be evaluated as a group*
- Cannot be evaluated	
Data are not available	Although every company is obliged to provide annual data to Collection of Documents, subjects in this category have not provided any information.
Question mark	a) the newest financial data concerns year 2009 or older; b) y-o-y change of the main activity has decreased between 50% and 90%.

* Based on ruling of the Highest Administrative Court of the Czech Republic no. 8 As 103/2012 – 45 and official statement of the Czech Ministry of Agriculture.

Source: Authors based on Banaszak (2009)

Table 1: Classification of marketing organisations into Groups.

Results and discussion

Legal aspects of the programme

After 2004, both surveyed countries exploited the chance to use EU support to support newly established producer groups. Although both countries had based their requirements on the same Council Regulation (EC) 1257/1999, they became not identical. Czech government implemented conditions into government act no. 655/2004 Coll. Slovakia stated relevant requirements in the programming and methodological documents, published by Slovakia Agricultural Paying Agency (SAPA, 2004)

As presented in the Table 2, objectives have been overtaken from EU pattern. In the Czech Republic, primary objective deals with creating conditions and increasing competitiveness of Czech agricultural producers, while the programme is mainly aimed at supporting establishment and mitigation of administrative burden in the EU and Slovakia. However, there is no doubt that improvement of competitiveness stands also behind the EU and Slovak objective. Secondary objectives (both Czech and Slovak) are based on EU objectives, with some exceptions. Creation of producer groups should also result in increasing value added of marketed products (in both countries) and result in employment of new technologies and marketing structures (only in the Czech Republic).

Also rules and conditions for providing financial support have been partly adopted from EU legislation, although the regulation 1257/1999 states that rules and conditions shall be based on national or community law. But EU provided guidance with good practices for implementation. Recommendations clearly warn new EU members from setting up empty and only administrative structures (European Commission, 2003).

Both countries accepted many similar requirements that new groups need to fulfil to gain financial support. Those are, among others:

a) members of producer groups are only agricultural producers;
b) producer group has to be legal person;
c) producer group sells commodities of its own members, unless one or more members do not fulfil contracted amount or total amount of commodity purchased from non-members does not exceed 20% of total amount supplied to the market;
d) annual instalments, calculated on the principle of annual group‘s marketed production on which the group was recognised;
e) sound business and financial plan is prepared;
f) members need to sign articles of incorporation and contract with the group. Contract defines product quality, price setting, length of membership, etc.;
g) producer group commit to provide necessary statistical data; commit to allow auditors to check its bookkeeping documents;
h) any agricultural producer cannot be a member of more groups for one registered commodity;
i) projects are not supported from other sources.

	No.	Slovakia	Czech Republic	European Union
Main objective		Supporting the establishment and alleviation of administrative burden for Producer Groups	Create conditions for producer groups to be competitive on the single market of the EU.	Supporting the establishment and alleviation of administrative burden for Producer Groups
Secondary objectives	**1**	Adapting the production and output of the producers who are members of such groups to market requirements		
	2	Jointly placing goods on the market, including preparation for sale, the centralisation of sales and supply to bulk buyers		
	3	Establishing common rules on production information, with particular regard to harvesting and availability		
	4	Increasing Value added of marketed products		-
	5	-	Support development of technologies and marketing structures	-

Source: SAPA (2006), gov. Act No 655/2004 Coll., Council Regulation (EC) No 1257/1999, own processing

Table 2: Objectives - supporting measure Producer Groups (2004 – 2006).

On the other hand, some conditions are not alike or are accepted in one country only:

a) Groups in Slovakia consist always of at least 5 members; the more members, the higher support. In the Czech Republic, minimum total turnover of all group members/shareholders shall exceed CZK 3 million, or a group shall consist of at least 5 members[7].
b) Members market 100% (Czech Republic) or 70% (Slovakia) of produced and registered commodity through the group.
c) In Slovakia, producer group cannot discriminate its members and producers cannot have any liabilities toward state.
d) In the Czech Republic, producer group cannot market processed agricultural products.
e) Amendment Czech governmental act specified that producer group consists at least of 2 members and commodities sold back to members are not considered into total marketed production.

Governments and paying organisations could also select commodities that might be registered for joint selling. Slovakia included more commodities to the list and therefore provided more possibilities to producers for integration. It is important to mention that marketed products not included in the list cannot be counted in the total turnover and therefore they do not contribute to the amount of annual instalments.

Similarly to requirements, majority of commodities is alike (cereals; oil bearing products; potatoes; flowers, wood, herbal, aromatic and spice plants, pigs, poultry and beef for slaughter). But also milk (cow, sheep and goat milk), sugar beet, hops and tobacco, legumes and other products from goats and sheep (meet and wool) were included in Slovakia. On contrary, the Czech government included hemp and flax (only for fibre), slaughter goats, sheep and running birds.

Annual instalments have been calculated on the principle of annual group's marketed production on which the group was recognised. The support shall be granted in annual instalments for the first five years after the group was recognised. The regulation allowed member countries to decrease amount of support provided, if necessary. This possibility has been exploited by the Czech government (Gov. Act No 318/2008 Coll.). Therefore, maximum annual support was decreased to EUR 11,220 from 2008, mainly due to high number of newly registered groups.

Programme outcome in the Czech Republic

Over 200 groups were supported in the Czech Republic; the groups were established in three different legal forms – joint stock companies (2; 1%), co-operatives (91; 44%) and limited liability companies (115; 55%). All groups received over CZK 509 million (EUR 18.6 million); average support per group exceed CZK 2.4 million (EUR 89.4 ths.). Joint stock companies and co-operatives received an above average support. However average results of joint stock companies need to be considered carefully. Only two joint stock companies that received any support achieved very different results, both of them are not considered as successful.

Based on the data presented in the table 3, average co-operative was able to source by 30% more comparing to an average Limited Liability Company. This fact indicates that an average co-operative was able to market agricultural products in higher values.

Authors cannot agree with results of the programme announced by the Czech Ministry of Agriculture in 2009. The Ministry finds the programme effective, arguing that number of producer groups has increased, simultaneously their negotiation power has been improved which resulted in higher

[7] Czech condition led to many legal proceedings, as single member organisation with turnover over CZK 3 million required to be registered as producer groups, while Czech Ministry of Agriculture accepted required at least 2 member organisations.

Legal form	Organisations		Total support			Average support	
	∑	%	CZK	EUR	%	CZK	EUR
Limited liability company	115	55.30%	247,423,238	9,029,617	48.60%	2,151,506	78,518
Co-operative	91	43.80%	254,713,547	9,295,674	50.00%	2,799,050	102,150
Join stock company	2	1.00%	7,161,803	261,367	1.40%	3,580,901	130,684
Total	**208**	**100%**	**509,298,588**	**18,586,658**	**100%**	**2,448,551**	**89,359**

Source: authors, based on SAIF data

Table 3: Funds provided to groups according to legal form, Czech Republic, December 2013.

economic stability of its members. Below, there are presented facts that disprove such statement.

Performed analyses proved (see table 4) that a majority of supported groups cannot be considered as successful. From the total 208 established companies, 45 companies (22%) have already started or finished winding-up process, 29 companies (14%) have only one owner, 49 companies (24%) experienced significant decrease in value of goods sold through the organisation after or during 5 year period. This means, 129 (59%) companies did not experienced success or were created on purpose with aim of receiving financial support. There were 25 organisations classified as successful, they stabilised their turnover or increased volume of sales, have not limited number of members after or during the 5 year period. Total amount of unsuccessful and successful organisation could differ as 60 companies cannot be evaluated – 21 companies were labelled as "question-marks" and 39 companies did not publish their annual data.

Total support provided to new agricultural marketing organisation exceeded EUR 18.5 million (over CZK 509 million). As presented in the table 4, average support of one successful organisation reached EUR 97.68 ths (CZK 2.68 million). Organisations with "question mark" received over EUR 100 ths. (CZK 2.7 million). Organisations not providing annual data into Commercial Register gained the lowest average support.

There can be suggested, the programme should not be qualified as successful, as only 12% of companies can be classified as successful and 59% as not successful. It is worth noting that many unsuccessful groups have been put into liquidation, have terminated their business or have kept limited amount of owners just after receiving last payment. Up to December 2013, governmental expenditures on creating one successful organisation (FS_s) from the programme reached EUR 537.6 ths. (CZK 14.73 million). For a comparison, expenditures on creation of one successful organisation are by 85% higher (in CZK) than expenditures within preceding national programme employed between 1999 and 2003.

All companies considered as successful did not provide their annual financial data. In surveyed years, total revenues of all considered companies approached to EUR 60 million in 2009, 2010 and 2011. Although an average revenue exceeds EUR 2.7 million per one group, as depicted in graph 1, only 4 groups (g7, g11, g15, g23) exceed the average value presented as a horizontal axis in all analysed years. The lowest revenue gained by producer group was EUR 29,651 (g12, 2011). The highest value was reached by group 7 (almost EUR 14 million, 2010) and it spoils average significantly. Based on the fact that each producer group could be registered for multiple commodities, there is not evident from available data, which commodities are mostly marketed through successful organisations.

Impact of the programme is measured according to *Effect* formula. As indicated in the table 5, the share of successful groups did not exceeded 1.7%, although there was not possible to get financial data for all (25) groups. According to authors' estimations, the share would not exceed 2% even if there are available data for all groups. It is also important to mention that 4 groups with the highest revenues (g7, g11, g15, g23) contributed by 45% and 40% to the effect in 2010, respectively 2011.

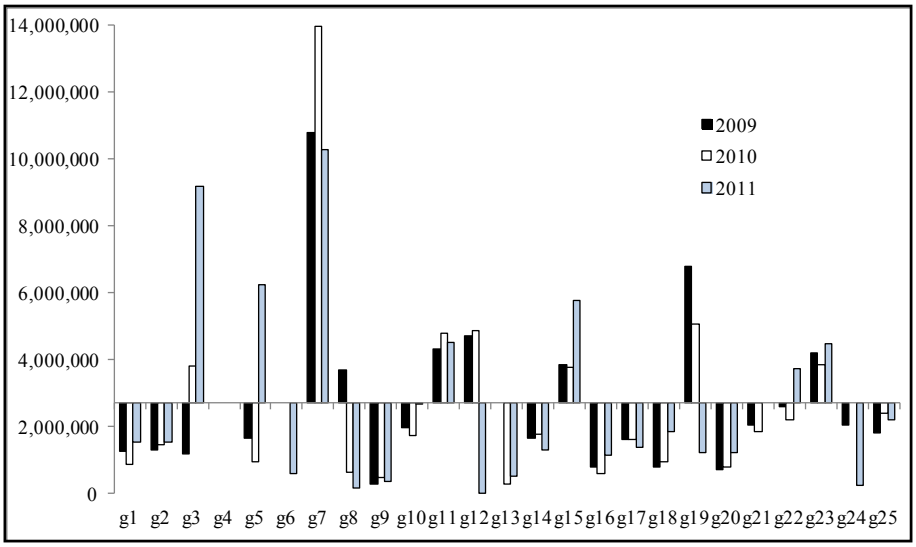
Programme outcome in Slovakia

Within the Slovak programme, 34 groups were approved for granting. 31 producer groups were established in the form of co-operative, while only

	∑	%		Total EUR	Average EUR
Successful organisation	25	12%		2,441,940	97,678
Organisations with the only member/shareholder	29	14%	59%	2,342,746	80,784
Organisations in liquidation	45	22%		4,432,225	98,494
Organisations with significant decrease in sales	49	24%		4,223,014	86,184
Organisations with question mark	21	10%	29%	2,111,095	100,528
Organisations with no data available	39	19%		3,035,842	77,842
Total	**208**	**100%**		**18,586,861**	**89,360**

Source: authors based on data from SAIF and Commercial Register of the Czech Republic

Table 4: Effects from the financial support on establishing producer groups in the Czech Republic, December 2013.



Note: horizontal axes equals to average revenue of successful companies

Source: Authors, based on data from Commercial Register of the Czech Republic

Graph 1: Revenues of successful producer groups, Czech Republic, 2009 – 2011, EUR.

	2007	2008	2009	2010	2011
N (%)	21 (84%)	21 (84%)	22 (88%)	23 (92%)	23 (92%)
Output of the agriculture industry (mil. EUR)	4,328.40	4,801.41	3,700.23	4,058.13	4,834.46
Revenues and Production (mil. EUR)	54.31	64.51	60.09	58.87	62.24
Programme's effect	**1.25%**	**1.34%**	**1.62%**	**1.45%**	**1.29%**

Note: "N" = number of available financial statements for successful companies (25 = 100%)

Source: authors, based on Eurostat (2013), Commercial Register of the Czech Republic

Table 5: Impact of the programme, Czech Republic, 2007 – 2011.

3 groups were established as Limited Liability Company. All producer groups received both EU and Slovak contribution about EUR 9.3 million (EUR 3.512 million + SKK 205.12 million). Average contribution received within 5 years was about EUR 274 ths., co-operatives were able to market higher volumes of agricultural products, therefore their average benefit exceeded by EUR 67 ths. average benefit of limited liability companies.

Lower number of beneficiaries did not result in need to cap annual payment, as it was carried out in the Czech Republic. Therefore, the average total payment to a group was almost triple to Czech beneficiaries.

Based on the definition of a successful enterprise (Banaszak, 2009), 16 (47%) production groups can be defined as successful if they are still in operation and conducted sales in 2011 and/or 2012, which is at least 5 years after group was recognized. Eleven groups are classified as not successful (32%), ten groups have started or finished their winding-up process and one group consists of only one shareholder. Seven companies (21%) cannot be evaluated as they do not publish their annual data. Successful groups, in average, received payment of EUR 294 ths.

Up to December 2013, governmental expenditures on creating one successful organisation ($\mathbf{FS_s}$) from the programme reached EUR 500.6 ths. This value is only by 7% lower than in the Czech Republic. However (as argued below), similarly high costs led to better performance of groups in Slovakia.

All 16 groups identified as successful made their financial data available in 2010 and 2011, but only 13 companies published data for the year 2012. It can be concluded, that total revenues of all considered companies exceeded reached EUR 74 million and EUR 76 million respectively in 2010 and 2011. Based on the preliminary data of 2012, there can be stated that further increase in revenues should be expected.

Companies	∑	%	Paid (EUR)	Average (EUR)
Co-operative	31	91%	8,709,753	280,960
Ltd.	3	9%	639,831	213,277
Total	**34**	**100%**	**9,349,583**	**274,988**

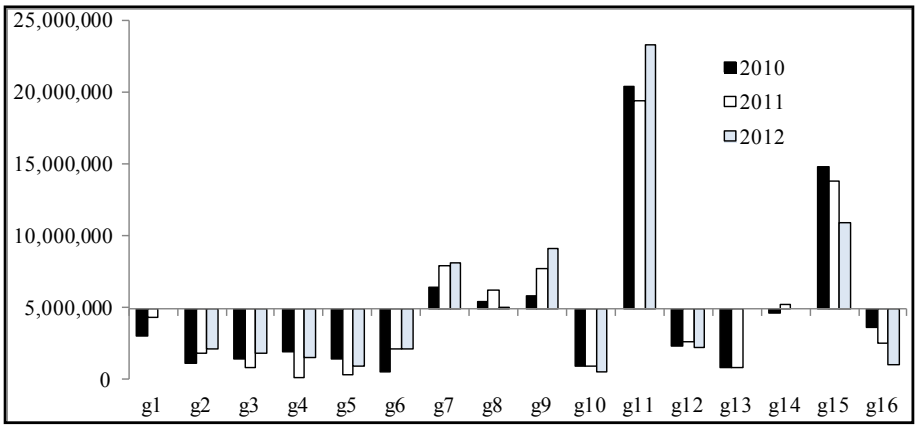
Source: Authors based on SAPA (2013)

Table 6: Funds provided to groups according to legal form, Slovakia, December 2013.

Companies	∑	%	Paid	Average
Successful	16	47%	4,705,808 EUR	294,113 EUR
Question mark	7	21%	1,338,691 EUR	191,242 EUR
Not successful	11	32%	3,305,084 EUR	300,462 EUR

Source: Authors based on SAPA (2013), Business Register of the Slovak Republic, Bisnode ČR

Table 7: Effects from the financial support on establishing producer groups in Slovakia, December 2013.



Note: horizontal axes equals to average revenue of successful companies

Source: Authors based on Business Register of the Slovak Republic, Bisnode ČR

Graph 2: Revenues of successful producer groups, Slovakia, 2010 – 2012, EUR.

	2010	2011	2012
N (%)	16 (100%)	16 (100%)	13 (81%)
Output of the agriculture industry (million EUR)	1,886.63	2,295.37	2,397.06
Revenues and Production (million EUR)	74.28	76.17	68.57
Programme's effect	**3.90%**	**3.30%**	**2.90%**

Note: "N" = number of available financial statements for successful companies (16 = 100%)

Source: authors, based on Eurostat (2013), Business Register of the Slovak Republic, Bisnode ČR

Table 8: Impact of the programme, Slovakia, 2010 – 2012.

Although an average revenue would exceed EUR 4.5 million per one group, as depicted in graph 2, only 6 groups exceed the average value presented as a horizontal axis. Group 13 (g13) is considered as the smallest group (with respect to revenues); it did not exceeded annual revenues of EUR 1 million. On the other hand, the biggest group (g11) marketed agricultural products for more than EUR 20 million. All groups exceeding the average (g7, g8, g9, g11, g14 and g15) contributed by 77% and 79% to the effect in 2010 and 2011.

Impact of the programme could be measured by share of groups' revenues to the output of the whole agricultural industry in basic prices in years 2010 – 2012. As indicated in the table 8, share of successful groups was

almost 4% in 2010 and decreased to 3.3% in 2011. For 2012 not complete data were available, but 81% of groups reached share of 2.9%. It needs to be admitted that newly established producer groups that are classified as successful have higher impact on the Slovak agricultural market than groups established in the Czech Republic.

Conclusions

Both countries introduced different approach to the programme. While over 200 producer groups were supported in the Czech Republic, only 34 groups received this support in Slovakia. It is possible to track different approach also in the case of rules and conditions. As a result of the study, it can be concluded that the programme was not very much effective in the Czech Republic, as 59% (123) of supported marketing organisations are considered as not successful, while only 32% is considered as not successful in Slovakia. Very low success of Czech groups could have different reasons.

First, the financial support was significantly limited (from 2008 on) in the Czech Republic; therefore groups could have difficulties with observation of their business plans. Also vague definition of the producer group led to establishment of many two-member groups that were established only for the purpose of sourcing money from the fund with no real intention to continue with marketing activities after termination of the programme. Producers were also forced by the law to sell 100% of their production through marketing organisation. This requirement surely discouraged more producers to join marketing organisation.

On the other way, there were some aspects that supported stability of producer groups in Slovakia. First, financial support was not only conditioned by fulfilling all requirements, but different aspects were evaluated by points and then best performing groups were entitled to the support. All 34 groups could source full amount of support, it was not limited during the course of the programme. Most of producer organisations was established in the form of co-operative, that means, democratic decision making process are exploited and primary aim is not to maximize profits.

In total, over EUR 18 million were paid to the Czech groups, while EUR 9.3 million was provided to producer groups in Slovakia. Although the average payment per group was smaller in the Czech Republic, use of money was more efficient in Slovakia. First, expenditures on creating one successful organisation were lower in Slovakia. Moreover, revenues of 16 successful groups exceeded 3% of the Slovak agricultural output, while revenues of 25 successful groups have not reached 2% of the Czech agricultural output. In absolute terms, all Slovak groups outperformed Czech groups in total revenues by 26%.

In 2014, new Rural Development Programme is being discussed in both countries and it is being decided, whether support of producer groups will be included. If the programme is opened in the Czech Republic, Czech government (or paying agency) should take in consideration problems of producer groups registered between 2004 and 2006. Authors recommend:

a) to set up conditions that would give priority to larger groups (create categories according to amount of members, e.g. 2 – 5, 6 – 9, 10 – 20, 21 and more);
b) to set up conditions that would give priority to co-operatives (they provide democratic principles and are not primarily profit-driven);
c) to set up maximum amount of supported groups (according to funds allocated; ideally each group should be able to source in average between EUR 250 and 350 ths.);
d) to extend list of commodities that might be registered for joint selling;
e) to allow individual producers selling small part of their production (10 – 30%) not through the marketing organisation;
f) to introduce appropriate tool that would monitor impact of the organisations also after paying period. As currently there is no tolls to control supported groups, impact of the measure cannot be easily reached. Therefore it is recommended to introduce obligatory registration (similarly to producer organisations) and annual checks of producer group activates and their impact on the market.

If there are stated recommendations implemented into the guidelines for the next programming period in the Czech Republic, authors expect increase of farmers' concentration on the market.

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Corresponding author:
Ing. Pavel Kotyza
Department of Economics, Faculty of Economics and Management,
Czech University of Life Sciences in Prague, Kamýcká 129, 165 21 Prague 6 - Suchdol, Czech Republic
E-mail: kotyza@pef.czu.cz

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Seeding Courses on Moodle: the AgriMoodle Case

A. Koutoumanos[1], V. Protonotarios[2], A. Drakos[2], M. Toader[3]

[1] Computer Technology Institute and Press „Diophantus“, Greece

[2] Agro-Know, Greece

[3] University of Agronomic Sciences and Veterinary Medicine in Bucharest, Faculty of Agriculture, Romania

Abstract

The agricultural education covers all levels of formal education but focuses mostly on the higher ones as well as the vocational education and training. Online courses play an important role in the educational context and compared to traditional courses they eliminate the location and time restrictions and allow a self-paced attendance of a curriculum. At the same time, the existence of online courses raised the need for the design and implementation of the appropriate platforms which may be used for the organization and deployment of online courses. This paper presents the case of agriMoodle, a course management platform based on the widely used Moodle platform, which provides a number of enhancements in the form of modules or widgets specialized for the agricultural domain. These modules aim to enhance the user experience and the functionalities of a standard Moodle installation.

Key words

Vocational educational training, Moodle, agricultural education, online courses, agriMoodle.

Introduction

1. The status of the agricultural educational resources and courses

Agricultural education is of major importance for the agricultural community; covering all levels of formal education, ranging from primary (or even pre-school) to tertiary, vocational education and training (VET) (Hopkins, 2013) as well as adult education, it aims to meet the requirements of a diverse learning audience and to provide the knowledge required in each case. Additional knowledge may be acquired through various forms of informal learning and non-formal education (Latchem, 2014). Due to its nature and trans-disciplinary approach, the agricultural education covers a wide variety of topics, including plant and animal breeding, plant protection, crop management, as well as related topics such as environmental issues, ecology, biodiversity, management, marketing, economics/statistics etc. Despite the fact that there can be agricultural educational resources even for preschool context, focusing mostly on basic concepts and environmental topics, the majority of the formal education systems all over the world usually provide an agriculture-specific educational context at the college level or equivalent (Phipps et al., 2008).

Courses consist a significant component of the educational framework, allowing tutors to interact with the learners. Courses usually consist of a presentation which may be further supported by additional material in the form of documents (e.g. related publications), multimedia files (e.g. videos and images) and any other type of educational material. Online courses provide a number of advantages over the traditional ones, such as eliminating location/distance issues and the need to attend real-time (asynchronous courses) etc., while at the same time exhibiting unique characteristics (Richardson and Swan, 2003). In this direction, online courses provide a valuable tool for tutors that can organize and deploy their courses online, while at the same time distance learners can attend courses remotely and asynchronously, eliminating barriers that might prevent them from doing so in a traditional way such as in a classroom for several reasons. Offerings of online courses continue to increase in higher education settings, as institutions attempt to meet students‘ (and faculty members‘) increasing demands for online access (Inoue-Smith, 2014).

The growth of the online courses led to the need for the development of online course management platforms which allow the organization, hosting and delivery of online courses.

This paper aims to describe the developments and adaptations made in Moodle, the most commonly used online course management platform, leading to the development of the agriMoodle platform. These adaptations were based on the requirements collected from the agricultural learning community and aimed to provide a number of enhancements over α traditional Moodle installation.

2. The Moodle platform and the need for a domain-specific version

Moodle, originally an acronym for "Modular Object-Oriented Dynamic Learning Environment", is a learning platform designed to provide educators, administrators and learners with a single robust, secure and integrated system to create personalized learning environments (Dougiamas, Taylor, 2003). It is a user-friendly tool which allows tutors to create, host and deliver courses, which can be enhanced with various functionalities and additional supporting material. A number of available functionalities also facilitate its usage by the learners who decide to participate in one of the courses hosted in a Moodle instance. During its about 10 years of existence, Moodle has more than 85,000 registered and verified sites all over the world, serving more than 7 million courses tomore than 70 million learners (Moodle, 2014).

Moodle is free and licensed as open source software, which makes it really flexible as it can be customized and adapted so that it can meet specific requirements. In addition, thanks to its modular structure, it can be further adapted through the development and use of custom plugins and add-ons, a high number of which is already available for free.Addressing the needs of the educational community for over a decade, Moodle has nowadays become the native working environment for many educators at different countries, domains and educational levels. Another advantage of the Moodle platform is that it allows data mining, which allows the enhancement of the services provided through the educational analytics analysis (Romero et al., 2008).

The standard Moodle installation includes a wide variety of options and customization features. Courses are supported through various means of communication within the platform between the tutor and the learners, including a forum, private messages and blogs. Tags and notes can also be used for providing information about a course and its contents. A user of the Moodle platform can create his/her own profile and customize it further if needed.

A tutor has access to a variety of tools which facilitate the deployment of a course and the monitoring of the learners' progress. For example, there are options for monitoring the completion of a course and assignments on individual basis, a grading tool, the option to assign badges when a learner achieves a specific goal within a course (e.g. completion of an assignment), and has access to various types of logs and reports related to his course. Customization options include the setting of the location and the language of the user interface, the revision of the appearance of the Moodle page, addition of plugins and add-ons etc. In addition, the use of Moodle was shown to enhance the spirit of collaboration during distance learning through online discussions, combined with the use of social media web sites, like Facebook (Deng and Tavares, 2013). This collaborative learning behavior was studied by Lu and Law (2013), who focused their study on specific aspects of the Moodle platform. Another important feature of the Moodle platform for delivering online courses is that it can be used alongside data mining methods in order to extract useful information about the courses and the learners, such as the prediction of marks that a student may receive in the final exam of an online course (Romero et al., 2013).

While Moodle is considered as one of the main LMS platforms, especially now with the increased popularity of the Massive Open Online Courses (MOOCs) (Wulf et al., 2014), there are times that the general installation cannot cover the specific needs of some communities. What makes Moodle a success story of an LMS is the capability to be customized and the ability for developers to provide back to the community and create specialized components or even Moodle versions. Following this concept, the agriMoodle was born, as an extension of the Moodle platform to cover the needs of the agricultural community. In the next sections, the customized components of such customized platform are presented as well as an example use case where the specialized platform has been used.

Materials and methods

1. AgriMoodle: adapting the Moodle platform

The agriMoodle is an extended bundle of the Moodle software, developed by Agro-Know (**www.agroknow.gr**) and provides a feature-rich, fresh Moodle installation, integrating a set of green/agro-templates and themes, linking to interesting green/agri-information sources, and extended with specific modules and widget to serve the needs of the agricultural community.

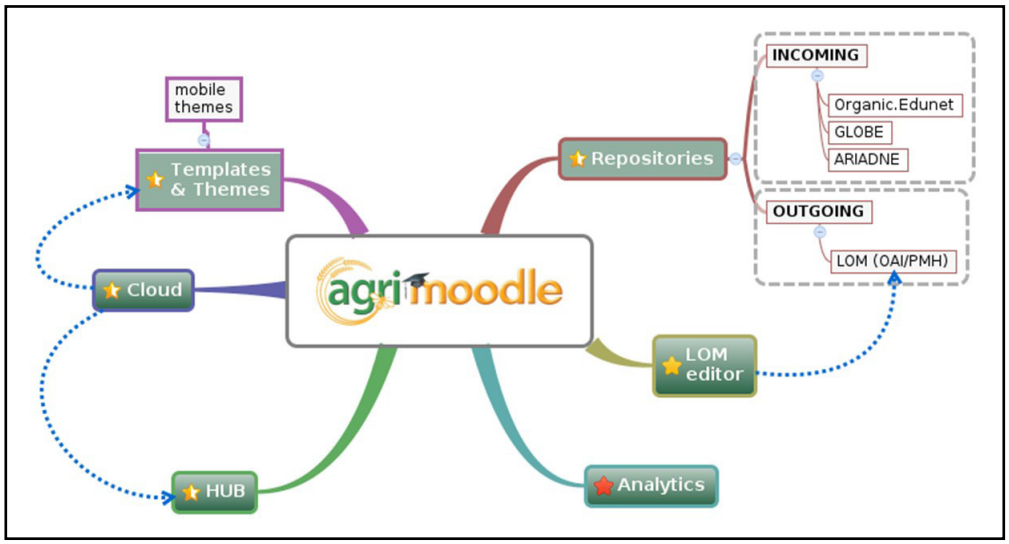
The objective of the agriMoodle is to integrate different services for discovery of agricultural content that is suitable for educators and learners into Moodle, thus making it directly available through Moodle's native environment, without requiring educators or learners to adopt to another environment or learn to use new tools, such as the ARIADNE Finder (**http://ariadne.cs.kuleuven.be/finder/ariadne**).

With the functionality that is integrated in the agriMoodle platform, trainers can use readily available widgets to import resources from relevant repositories and use an easy LOM editor to describe as well as export metadata for their resources. Learners can also benefit from (automatic) references to useful material, through various widgets.

In short, agriMoodle is a Moodle installation with a custom configuration and special modules that make it suitable for agri- related courses. agriMoodle's development follows closely the life-cycle of Moodle, so that any new releases, security upgrades, bug fixes, etc. of Moodle are readily integrated into the agriMoodle installation package. Moreover, special consideration has been taken into account, so that all agriMoodle features use the standard extension mechanism of Moodle and/or use the recommended methods for adopting and configuring Moodle. This allows for any existing Moodle installation to easily become an agriMoodle one, just by installing the needed extensions and modules and choosing to adopt any customisation of user interface and themes.

The main features of agriMoodle include the following:

- Out-of-the-box installation of agri-themes and course layouts, through well- documented process, designed for not requiring highly skilled IT capacities.
- Modules that implement easily configured widgets, which can be integrated in courses and display links to relevant learning resources from open-access agri-related repositories and collections, like that of GLOBE (**http://globe-info.org**), ARIADNE (**http://ariadne.cs.kuleuven.be/finder/ariadne**), Organic. Edunet (**www.organic-edunet.eu**), OER Commons Green (**http://www.oercommons.org/green**) and other related sources.
- Modules geared towards course creators, which allow identification of learning resources relevant to the course under



Source: own processing

Figure 1: The general architecture of the agriMoodle platform.

development and easy integration into specific course's location.

- An integrated metadata authoring widget that enables easy definition of metadata both for courses and learning resources, through an intuitive user interface, efficiently pre-loading metadata elements with information from the associated Moodle context, allowing description and classification of courses and resources against standard agri- related vocabularies and taxonomies, such as AGROVOC (**http://aims.fao.org/standards/agrovoc/about**). One of the most suitable and appropriate metadata format for describing data in the agrarian sector and rural areas is VOA3R Metadata AP - Virtual Open Access Agriculture and Aquaculture Repository Metadata Application Profile (Simek et al., 2013).
- A transparent mechanism for exporting collected metadata, through standard protocols, such as OAI-PMH in IEEE LOM and DC-based forms.
- Configurable publishing of selected information of agriMoodle instances to generic search-engines such as Google, including search-engine-optimization, push notifications to social portals and services, such as Facebook and Twitter, as well as through standard mechanisms, such as RSS.
- Out-of-the-box translation of all user-interface elements to many languages and a well-documented process, in conformance to Moodle's guidelines, for implementing new translations.
- Cloud-ready installation and specially designed operation of all agriMoodle extensions to allow for best benefit from a Cloud-based operational environment.

The platform includes three different tools - widgets to allow better connection to repositories and improve sharing data in an openly way, widgets that are pre-installed and can be configured with every new deployment of an agriMoodle instance. More specifically, the three widgets are the following:

- OER-Finder Widget, which provides an Open Educational Resources (OER) finder to search agricultural related content and can be used both by the content authors in order to locate useful resources and integrate them in their course, as well as by the learners who are given the opportunity to browse through a rich set of resources related to their current course.
- Metadata Editor Widget, which provides an intuitive, context-sensitive user interface to facilitate editing of the metadata of every learning resource by the manager of each course, in accordance to the Organic.Edunet IEEE LOM Application Profile.
- OAI-PMH Target Module, which allows the agriMoodle installation to provide an OAI-PMH (Open Archives Initiative - Protocol for Metadata Harvesting) target, thus serving as a source of metadata records, which can be harvested by any OAI-PMH compliant harvester across the globe.

2. The OER-Finder widget

The first widget is a Moodle "block" plugin which implements a component that filters and recommends educators and students with educational resources related to their courses and lessons that are available in any of the compliant repositories such as the ones provided by the Organic.Edunet portal (**www.organic-edunet.eu**).

The related items are displayed as a simple list of items on the side of the page with stars that indicate the relevance of the item to the user. The relevance is identified based on a dynamic user profile built for each user. Analytics algorithms are applied to build this dynamic user profile.

A search box at the top of the list allows the educator or student to change the search terms based on their interests. The default search term will be the title of the current course. Moreover, the educator is able to adjust the widget's parameters, like the keyword for default search, number of items to be displayed, etc.

In addition, a very interesting feature that is available for the educators is the ability for direct inclusion of the relevant items into the Moodle course content. When the learner clicks on an item, a modal popup dialog is displayed with details about the selected item. It's important to note that educators and learners are able to navigate and get recommendations from all educational resources available through the widget.

The figure below presents the OER Finder Moodle widget when used to search educational content using the term "organic farming".

Source: own processing

Figure 2: The OER Finder widget.

3. The OAI-PMH Target Module

The OAI-PMH Target Module adds support for any agriMoodle instance to provide an OAI¬-PMH target. OAI¬-PMH stands for the Open Archives Initiative Protocol for Metadata Harvesting protocol (Open Archives Initiative, 2002) and, indeed, this plugin is directly related with metadata and harvesting; it allows exposure of metadata that are intrinsic in Moodle's description of courses and resources, through a standards compliant OAI¬-PMH mechanism.

The objectives for the implementation of the Moodle OAI-¬PMH plugin are twofold. From one hand it is geared to facilitate exchange of resources and courses, among different Moodle installations (and, in fact, across different standards compliant LMSs), promoting the awareness of metadata across educators, since it is expected to reward coherent, well-¬defined descriptions of resources with greatly improved visibility, exploitability and credibility for the resources' creators. On the other hand, it will facilitate the exploitation of backend and front-end services, such as the Finder, to provide an integrated overview of existing resources and courses.

The OAI-PMH plugin is the interface of the agriMoodle platform for harvesting. A harvester is a client application that issues OAI-PMH requests and is operated by a service provider as a means of collecting metadata from repositories. In that sense, the Moodle installation becomes a „repository" from which any associated harvester can request information related to the metadata of the courses and the resources available through your installation.

The main important concepts, as they are used by OAI-PMH, are the following:

- Resource: a resource is the object that the metadata describe.
- Item: an item is a constituent of a repository from which metadata about a resource can be disseminated. The metadata may be disseminated on-the-fly from the associated resource, cross-walked from some canonical form, actually stored in the repository, etc.
- Record: a record is metadata in a specific metadata format. A record is returned as an XML-encoded byte stream in response to a protocol request to disseminate a specific metadata format from a constituent item.
- (Unique) Identifier: Each item has an identifier that is unique within the scope of the repository of which it is a constituent. Note that Items may contain metadata in multiple formats. The unique identifier maps to the item, and all possible records available from a single item share the same unique identifier.

This software component is implemented as a standard Moodle plugin, in compliance to the Moodle coding specifications and guidelines. All relevant code lives on a GIT version controlled repository, openly available in GitHub (**https://github.com/agroknow/agrimoodle/wiki**). The integration of the plugin in an existing installation is straightforward and described in the plugin's documentation.

The plugin offers the following six functionalities, though the corresponding OAI-PMH verbs:

1. GetRecord: this verb is used to retrieve an individual metadata record from a repository.
2. ListRecords: this verb is used to harvest records from a repository.
3. Identify: this verb is used to retrieve information about a repository.
4. ListIndentifiers: this verb is an abbreviated form of ListRecords, retrieving only headers rather than records.
5. ListMetadataFormats: this verb is used to retrieve the metadata formats available from a repository.
6. ListSets: This verb is used to retrieve the set structure of a repository.

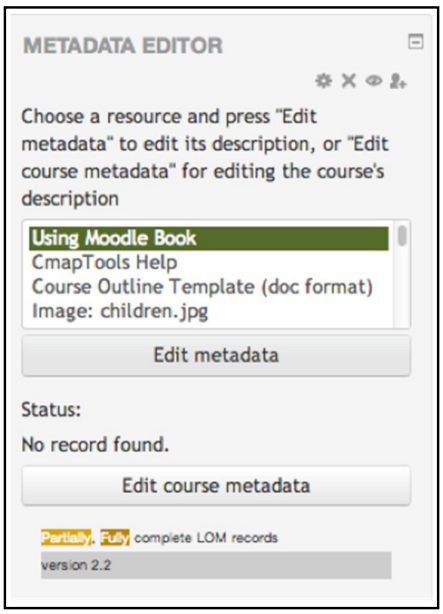
For harvesting purposes, the Service Provider will usually invoke the ListRecords verb (with a metadata prefix and usually a timespan) on the Metadata Provider. Moreover, the current implementation effort is targeted towards integrating this plugin

with the extended metadata that are captured through another plugin, the metadata editor.

4. The Metadata Editor Widget

The Learning Object Metadata (LOM) Editor Widget provides an intuitive mechanism for capturing metadata for the learning resources that are used within each course of an agriMoodle installation. Metadata are like hash-tags or keywords and is a way to describe a specific resource so that discovery services will be able to find the resource. One of the main problems that we face today is that while there are a lot of online resources, many of them do not have good metadata descriptions making them very difficult to be discovered. Widely-used resources have good metadata descriptions but still some excellent resources are not accessible due to the bad descriptions.

The agriMoodle platform brings metadata capture and editing directly into the Moodle LMS. The Metadata Editor plugin facilitates the tedious task of metadata provision for learning resources and courses that are available in the agriMoodle instance, and undertakes management and storage of all the metadata using the Organic.Edunet IEEE LOM AP format (Palavitsinis et al., 2009) which is compliant with the IEEE LOM standard, one of the most widely used formats for educational content.Thus, the Metadata Editor Widget, implements an integrated LOM metadata authoring tool that enables easy definition of metadata both for courses and learning resources, through an intuitive user interface.



Source: own processing

Figure 3: The Metadata Editor Widget.

When a user – the widget is addressed to course providers, teachers, etc. – opens the editor, it will efficiently pre¬loads metadata elements with information from the associated Moodle context. Even more, it links to existing vocabularies & ontologies allowing description and classification of courses and resources against standard agri-related vocabularies and taxonomies, such as AGROVOC. Finally, through the editor, users can view mandatory and recommended fields in order to make the description compliant to the Organic.Edunet IEEE LOM Application Profile (AP).

Results and discussion

1. Using agriMoodle in practice: The case of the Herbal.Mednet project

A case of using the agriMoodle platform for the vocational education needs of a specific agricultural domain is the case of the Herbal. Mednet project. With the support of the project the agriMoodle LMS was used and adapted to cover the needs of the organic agricultural domain in order for educational institutions or organizations (such as the Spanish Society of Organic Agriculture – SEAE, **www.agroecologia.net**) and companies (such as the cosmetic company APIVITA **www.apivita.com**) to take advantage of the platform to provide online education courses to people involved in organic agriculture and organic medicinal and aromatic plants (MAPs). The usage of the platform to cover the needs of SEAE is explained in the following sections following the personas approach (Pruitt, 2003).

2. Personnas identification

SEAE is the Spanish Association for Organic Agriculture, which organizes and offers trainings regarding the thematic area of organic agriculture and organic medicinal and aromatic plants. While SEAE offers a lot of trainings, they are targeted only to specific regions of Spain where they take place, limiting the number of people who can afford to attend them. SEAE will be most interested in expanding the targeted users and be able to offer online trainings to farmers and agronomists in the field of organic MAPs.

Juan is a PhD student in a Spanish Agriculture University having his thesis in the cultivation of specific MAPs that can be found in the region of Valencia, Spain. Juan is informed about the trainings of SEAE in the same area. Unfortunately, Juan has financial problems

and in order to sustain the expenses of his studying, he has to work during the mornings. Faced with the problem that he will not be able to participate to the trainings, which could have provided him with a lot of content for his PhD. and get in touch with a lot of people who are interested in the same area.

Victor is an agronomist expert in the field of organic cultivation of MAPs working for SEAE. In order to improve the SEAE's dissemination and to attract new students, Victor wants to start an online course. The course will also be available to current participants in trainings, especially for who cannot attend the events.

Marta is Victor's colleague and the technical administrator and responsible for the setup and support of new tools in SEAE's network. Marta is responsible for providing technical support to all the SEAE users and is the administrator in all the online platforms SEAE is using.

3. Current situation

Juan, while he is very excited about his PhD., due to his work he does not have a lot of time available to search over the internet for resources. Even more, since there is no integrated system, he has to use public search engines combined with public keywords, which usually produce much unrelated search results. Juan knows about some of the available educational portal, such as the Organic.Edunet portal, but unfortunately the resources he can find on thematic area of MAPs are very limited. Through one of his searches, Juan stumbles upon a press release about upcoming trainings in the area of MAPs from SEAE which could be of high importance for his PhD. Juan is now faced with a new problem, due to his work and luck of money he can not attend the SEAE trainings.

After a long search in the internet and conversations by phone, Juan manages to find that Victor is responsible for the trainings that SEAE provides. Juan contacts Victor regarding his problem and asks Victor for his help. Victor gets in touch with Marta and together try to see what educational content they can provide to Juan. They try to find a technical solution for recording or streaming the trainings so that Juan may be able to participate later but due economical factors (bandwidth, cameras, infrastructure, etc.) they cannot provide such help. In addition, the content that Victor has gathered is long presentations, which due to their size cannot be sent through e-mails. Victor, again with the help of Marta, needs to create an account in a sharing service, to upload the content there (which will take a couple of hours) and then send the link to Juan to download the files. Whenever another person contacts Victor and wants some additional or less information, he has to do the same procedure which is most time consuming and non productive.

4. The agriMoodle solution

For SEAE, being a partner in the Herbal.Mednet project, an instance of the agriMoodle platform has been made available. Marta will provide training to all trainers and help them to upload their educational content in the platform. When Juan contacts Victor, he redirects him to the platform and asks him to register in the platform for an account. Victor selects the courses for Juan to view based on his needs.

Juan is very excited with the SEAE platform. Not only he can access the SEAE trainings but he can also search metadata and learning resources from a number of collections through an integrated system. In addition, as Juan uses the finder widget he discovers additional trainings and educational content from other regions and countries, such as content provided by APIVITA, resources that he would never be able to find before. He can use all this content to make comparison studies for example of practices in Spain and Greece regarding the cultivation of organic MAPs.

Apart from the above, the SEAE agriMoodle instance also helps Marta in her work. She can connect the LMS platform with other tools they have been using in the association, by exposing the API in order to search and discover additional educational content.

Conclusion

The constantly growing number of learning communities and online courses has led to the development of a number of platforms which aim to support the uploading and organization of all course-related material as well as the actual deployment of these online courses. Several different solutions exist, meeting different needs of different learning communities, such as the MOLE (Multimedia Open Learning Environment) (Mylonakis et al., 2011), which has already been used in the agricultural context (Toader et al., 2012). However, the most widely used online course management platform remains

Moodle, with millions of registered users and courses available worldwide. Moodle exhibits a number of advantages over its competitors, such as the creation and delivery of adaptive courses, thanks to its module-based concept (Despotovic-Zrakic et al., 2012).

Despite the fact that Moodle is highly customizable and there are already thousands of modules and other types of plug-ins which aim to enhance the user experience and facilitate the deployment of online courses, a number of functionalities that were missing from the existing Moodle instances were identified in the context of the Organic.Lingua project, and they were successfully designed and implemented. These functionalities significantly increased the user experience, through the following modules:

- The OER Finder module, which allows users to retrieve open educational resources from quality data sources;
- The LOM editor, which enhances the discoverability of the agriMoodle courses through the use of educational metadata;
- The automatic translation functionalities of the LOM editor, which support the multilinguality aspects of the platform;
- The LOM OAI-PMH target module, which allows the exposure of educational metadata using the widely used OAI-PMH standard, enhancing the interoperability of the Moodle platform.

Through the use of educational metadata for the courses and individual resources of each course, which are exposed through the OAI-PMH target, the development of an agriMoodle hub is envisaged and is expected to be implemented in the next months. This will allow the interconnection of several agriMoodle instances through their OAI-PMH targets and the direct exchange of information about the courses available in these instances. Additional technical implementations regarding agriMoodle are expected to take place in the next months, based on the requirements identified by the current agriMoodle users and other stakeholders of the agricultural learning community.

The online learning communities are further served by aggregators of information related to online courses, such as Coursera (**https://www.coursera.org/**), Class Central (**https://www.class-central.com/**) and edX (**https://www.edx.org/**). These sites aggregate information about online courses, including the topics, the tutors and their cost, thus allowing learners to easily retrieve the courses that are related to their learning needs. The success of these aggregators only highlights the fact that the online courses are constantly increasing their popularity and usefulness among the learning communities.

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Corresponding author:
Dr. Vassilis Protonotarios
Agro-Know, Grammou 17, 152 35 Vrilissia, Greece
Phone:+302106897905, Email: vprot@agroknow.gr

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Business Informatics and its Role in Agriculture in the Czech Republic

K. Kubata, J. Tyrychtr, M. Ulman, V. Vostrovský

Faculty of Economics and Management, Czech University of Life Sciences in Prague, Czech Republic

Anotace

Předkládaný článek se zabývá analýzou využívání podnikové informatiky v zemědělských podnicích v České republice. Zdrojová data pro tento článek byla získána v rámci průzkumu v zemědělských podnicích z různých regionů České republiky. Článek představuje výsledky průzkumu využívání podnikové informatiky v resortu zemědělství včetně poskytnutí přehledu o řešené problematice. Zjištěno bylo, že v zemědělských podnicích pracuje s podnikovou informatikou převážně majitel farmy. Pro většinu respondentů představuje informatika nutné technologické řešení. Z pohledu hardwarového vybavení jsou investice v současnosti směrovány v daleko větší míře do využití mobilních technologií. Mezi nejčetnější používané programové vybavení patří informační systémy pro účetnictví, skladové hospodářství a dále specializované programy pro rostlinnou a živočišnou výrobu.

Klíčová slova

Podniková informatika, informace, eGovernment, informační systém, zemědělství, zemědělský podnik.

Abstract

Presented paper deals with analysis of use of business informatics in agricultural enterprises in the Czech Republic. The source data for the paper were gathered in the survey among agricultural enterprises from various regions of the Czech Republic. There are results of the survey and the overview of the current state of the use of business informatics is described here. Main findings are that it is the owner of the farm who mostly works with business informatics and for most of them the informatics is a necessary technological solution. The investments in farms are currently directed to mobile hardware equipment. Most frequently used programs are accounting information systems, stock control and specialized programs for plant production and livestock.

Key words

Business informatics, information, eGovernment, information systems, agriculture, farm.

Introduction

Data and information are indispensable part of current society and companies. Agrarian sector in the Czech Republic is based on principles of Common Agrarian Policy in the European Union member states. It provides access to subsidy programs as a certain guarantee for agricultural enterprises. Despite convenient operation conditions, the limiting factor is a large bureaucracy of the state authorities that results in lack of time of farm managers. The shortage of time and inefficient methods of processing of business data and information may lead to wrong management decisions.

Research and development of information systems for the support of company management have been goals of Business Informatics (BI) or in German Wirschaftsinformatik (Heinrich, Riedl, 2013). With respect to Business Intelligence that is abbreviated in literature as BI, we will rather use the shortcut (BInf) for Business Informatics that is proposed by (Maryška, Novotný, 2013).

The constraint of effective usability of information in the agriculture is the level of business informatics in particular enterprises where the quality of business informatics is given by following equation (Vostrovský et al, 2013):

$$BInf = f(HW,SW, U),$$

where HW – is a particular level of technical equipment (HW) in given subject,

SW – is a particular level of software equipment (SW) in given subject,

U – is a quality level of ICT skills of users in given subject.

Actual usability of information (UI) in agricultural enterprise can be stated as:

$$UI = f(U_{EG}, U_{BInf}),$$

where U_{EG} is the actual level of agricultural eGovernment and U_{BInf} is the level of business informatics in given business entity.

Business informatics includes the way of representing information, its processing, communication and use in the business (Pour et al., 2009; Heinrich & Riedl, 2013; Maryška, Novotný, 2013). The agricultural eGovernment is *"a type of e-government that is based on the use of information technology by state administration to facilitate reciprocal information exchange between the involved agricultural public authority and agricultural enterprise to improve efficiency of its internal use and to provide fast, accessible and quality information services."* (Ulman et al., 2013) Frameworks for implementing e-government systems and services in agriculture are described in (Ntaliani et al., 2010; Ulman et al., 2013).

To evaluate particular level of business informatics in a qualified way, to solve its problems, to define proposals for further development, it is necessary to specify at least basic requirements for quality, performance, and effects that should be brought. The business informatics has to (Pour, Novotný, 2010):

- provide certain functionality for users (it has to support control, business or administrative functions at all levels and for all profession of company workers in given extent and quality),
- contribute to rationalisation of business processes (e.g. shortening of average time of contract realisation),
- ensure an adequate level of information availability, technical and other tools (availability for the user in right time and right place),
- operate information systems (IS) at a required level of security, reliability, performance and response time,
- bring expected economic and non economic effects,
- increase of qualification of employees,
- maintain and develop informatics resources with reasonable costs.

There are diametric differences among enterprises in circumstances for application of effects of business informatics, and also the opinions of business representatives vary in terms of informatics and its capabilities and limitations (Pour and Novotný, 2010). We can conclude that business informatics in the agricultural enterprise should be beneficial for its profitability depending on implementation and use of informatics. The goal of the paper is to analyse the current state of the use of business informatics in the agricultural sector and to identify relevant assumptions of its quality in agricultural enterprises.

According to the study (Hoffmann et al, 2013), there is a lack of knowledge about the state of mobile business in agriculture and low number of available mobile applications for agriculturists. The potential is in mobile documentation. In the Czech Republic, the access to the broadband Internet connection (256 kbit/s) has been increased recently among agriculturists to 70.5 % (Vaněk et al, 2011). But there is still a gap mainly in Czech rural areas and the digital divide remains an issue.

Among issues that relate to the use of Internet, there are: privacy protection, expected uncertainty in data transmissions and relatively large amount of time spent on Internet with searching information, communication and business transactions. Other problems might be the lack of personal interest or limited amount of information, insufficient ways of professional training of Internet skills, its complexity, unsolved legal questions, improper provision of stable transmission speeds, partially low recency of web sites and too few attention paid to agriculture in Internet services. Regarding future use of Internet the main stress is put on information retrieval, business management and communication, while private habits will play a secondary role (Doluschitz, Pape, 2001).

Business informatics in agriculture provides all information needs in the enterprise related to management and control of business processes. Business informatics in agriculture is specific with its acceptation of changing climate and local conditions, and with unpredictable length of production process. Another aspect to be taken into account is that the business informatics differs with the size of farm and its specialization. In small farm managed by physical persons, these needs can be fulfilled with one accounting program

and the use of others depends on farmer's experience. In middle-sized farms, these needs can be satisfied with information systems enhanced with plugins according to the focus of the enterprise (e.g. plant production, animal raising). Third group are large enterprises (capital ventures) that do business in agriculture and use all common information systems, namely ERP (Sørensen et al., 2010), CRM (Kumar, 2010), EDI (Choudhary et al., 2011), statistical software, database systems and business intelligence tools (Chaudhuri et al., 2011; Duan, Da Xu, 2012).

Sufficient financial resources and subsidies that has been coming to Czech agriculture from the European Union and national funds since 2004 has made the agricultural production more perspective and they helped agriculturists to overcome poor economic results from the transformation period in 1990s. These have become reasons why farms could modernise their equipment (Věžník et al., 2009). By using financial subsidies and sources, and by efficient conduct of agribusiness, it is possible to build and run quality business informatics.

Materials and methods

There was a thorough questionnaire survey conducted between members of Association of Agricultural Business Owners in the Czech Republic in 2013. It was prepared and done by Department of Information Technologies and Department of Software Engineering at the Faculty of Economics and Management at Czech University of Life Sciences in Prague and supported with grant no. 20131038: Analysis and design of model for evaluation of e-services in agriculture. Previous survey was realized and published by Rysová et al. (2013). There are only few similar surveys done in Czech agricultural sector such as Agrocenzus made by Czech Statistical Office (ČSÚ, 2013) and study on information and communication technologies in rural areas (Vaněk et al, 2011). Another similar study about the use of information and communication technologies in Czech enterprises is done by Czech Statistical Office on annual basis but it excludes enterprises from agriculture, forestry and fishery. Agricultural sector reaches a high level as to the adoption and the use of information and communication technology such as precision agriculture.

There were 500 subjects asked to fill the form and 135 relevant replies were obtained. The respondents could fill in paper form, via e-mail or in online web form at the address **http://dotaznik.czu.cz**.

We used methods of exploratory analysis, frequency tables and Pearson's chi-square test to evaluate current state of business informatics in farms. Statistical computations were done in program STATISTICA 12. General methods of synthesis and analysis were utilized to examine the quality and the level of use of business informatics in agriculture and it also provided means to overview the current state of the art and to identify strengths and weaknesses.

Results and discussion

Questions were primarily focused on the level of business informatics. Agricultural producers mostly (85 %) farmed at land of size up to 500 hectares (see Table 1). Highest relative frequency was measured in the category from 100 to 499 hectares (49.6 %), which signalizes that the respondents were mostly privately held small farms.

90 % of respondents run plant production, 52 % animal raising and 16 % deal with other types of production (see Table 2).

Next question was: *"Who works with computer (PC) at your farm?"* It was a multiple choice question with more answers allowed. PC is handled by the farm owner in 85 % of all cases, by accountant (26 %) or by other workers (26 %) (see Graph 1).

There is an obvious argument that the owner who is responsible of management of farm can hardly work efficiently with all business informatics tools. It is a relevant question whether he or she can gain higher effect for the business from the IT equipment.

Answers to the question *"Which information do you mostly use from the Internet?"* are depicted at the Graph 2. There were also multiple choices allowed. We can conclude that the farm can dispose with large amount of information sources that some might used for their own business informatics.

The technical equipment and investments to it in agricultural enterprises is not an issue due to profitability of farmers. Respondents provided the year of purchasing devices such as PC, laptop, smartphone and tablet (see Graph 3). We can see that most of ICT investments were towards mobile platforms in years 2012 and 2013.

Category	Frequency	Cumulative frequency	Relative frequency	Cumulative (rel.frequency)
less than 50 ha	24	24	17.77778	17.7778
50 - 99 ha	29	53	21.48148	39.2593
100 - 499 ha	67	120	49.62963	88.8889
more than 500 ha	12	132	8.88889	97.7778
ChD	3	135	2.22222	100.0000

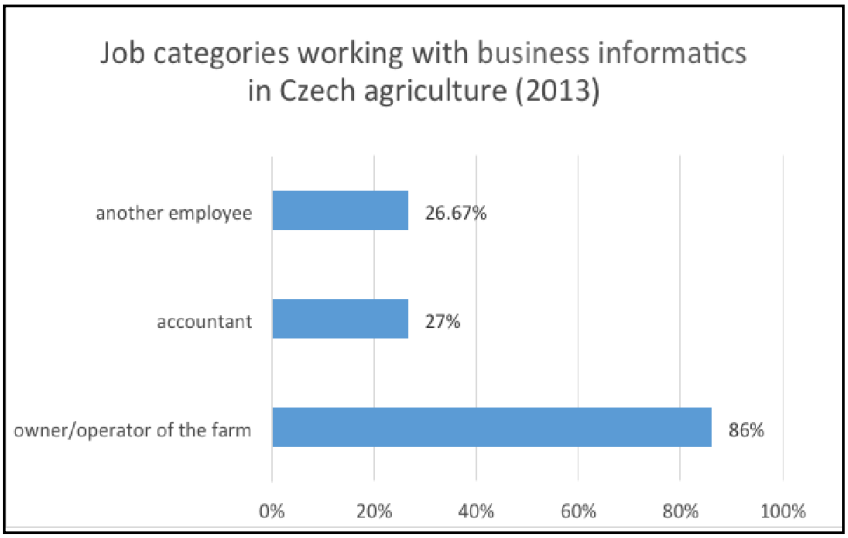
Source: own processing

Table 1: The structure of farms by agricultural land.

The structure of the company by type of production	Count	Percent
Crop production	122	90.37%
Livestock	70	51.85%
Other	21	15.56%

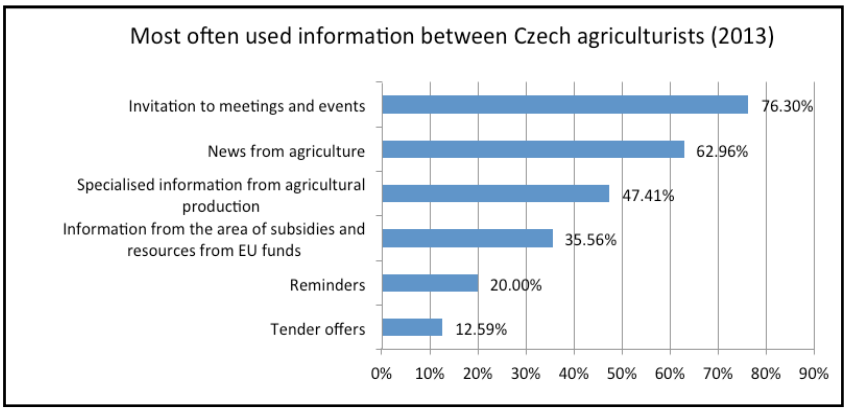
Source: own processing

Table 2: The structure of farms by agricultural land.



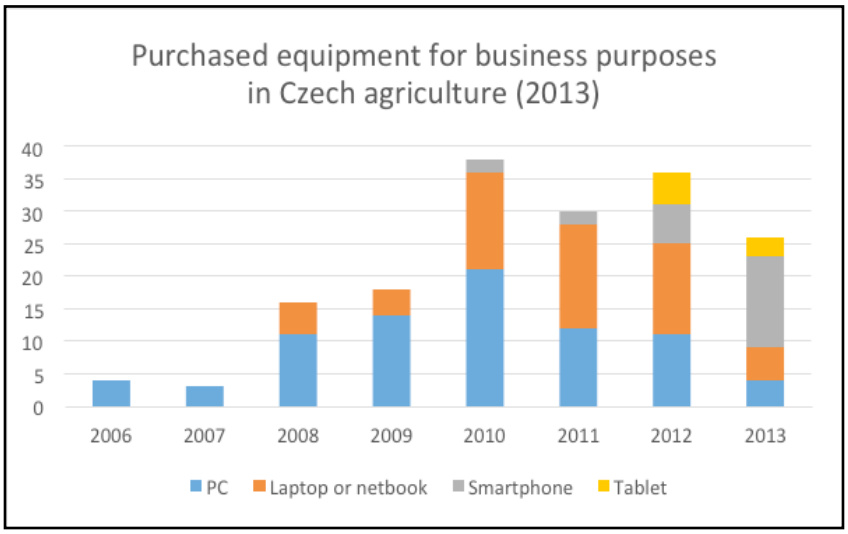
Source: own processing

Graph 1: The structure of job categories working with business informatics in agriculture.



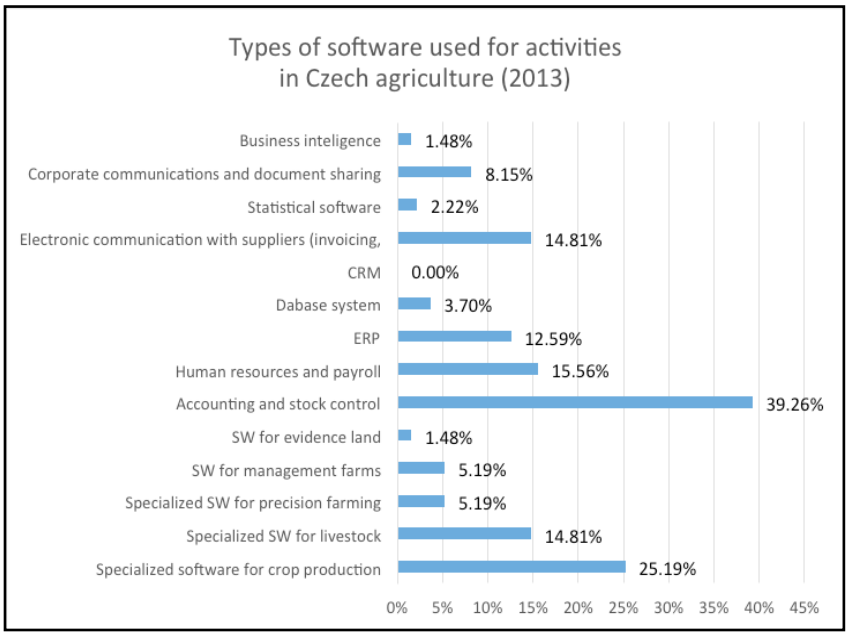
Source: own processing

Graph 2: The structure of information from the Internet.



Source: own processing

Graph 3: Structure of purchase hardware for the last period.



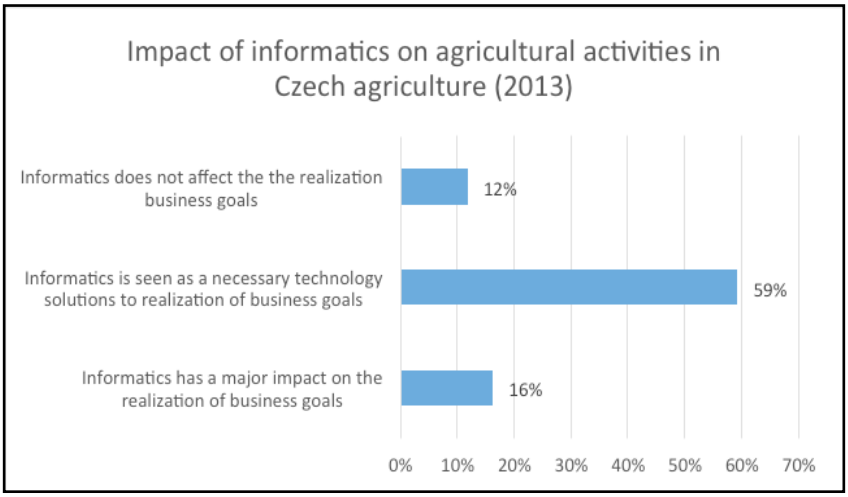
Source: own processing

Graph 4: Types of software used for activities in agriculture..

Next topic of the survey dealt with types of software in farms. The use of accounting software and stock control were unanimously the most frequent, and also specialized software for livestock and crop production (see Graph 4).

These findings match the production structure specified in Table 2. Another useful finding is that farmers use further specialized information systems such as database systems (as a solution for customized queries and outputs), statistical software (SPSS, Statistica, SAS), ERP and software for precision agriculture. These are more sophisticated components run in business informatics.

One of the significant findings of the survey is that *"informatics is perceived as a necessary technological solution to realize business goals."* That was the answer of 59 % farmers, while 16 % think that *"informatics has a substantial influence on realization of business goals"* and only 12 % have opinion that *"informatics has no influence on realization of business goals."* The rest 13 %



Source: own processing

Graph 5: Impact of business informatics on agricultural activity in Czech.

of respondents cannot answer or cannot evaluate the impact of informatics on their agricultural business (see Graph 5).

To explore more in details which reasons influence perception of business informatics among farmers, we conducted regression analysis. Null hypotheses were set such as:

H1: There is no significant relationship between perceived influence of business informatics and number of employees.

H2: There is no significant relationship between perceived influence of business informatics and size of farmed land.

Due to values of Person's chi-square test ($p = .21574$ and $p = .89025$) both hypotheses were accepted at 5 % significance level. Thus, no statistically significant relationship was proved between level of business informatics perceived by farmers and size of the farm or number of employees.

We found the above stated findings as relevant for further research and for effort to identify barriers to effective use of information and communication technologies, concepts and methods in agricultural enterprises.

Conclusion

The aim of the paper was to present current state of business informatics in agricultural enterprises. Similar studies have been rare in Czech agricultural sector so far. Based on the result presented above we can tell that most of farmers work with IT tools by themselves, they are interested mostly in information about subsidies and EU funds, and they use mainly accounting and stock control software. The purchase of new hardware and software is not an issue for farmers nowadays.

We can conclude that the current state of the use of business informatics potential is not fully reached and there is still a capacity for its use with higher efficiency and in broader extent, which provides further space for research.

As a next research topic in this field, we can see in looking for opportunities to utilize mobile hardware platforms (tablets, smartphones, etc.) in agricultural operational routines. The main purpose of business informatics is to provide effective support by ICT to reach savings and higher labour productivity in the agricultural business.

We propose to conduct regular analyses and studies on information needs and information tools in agricultural sector.

Acknowledgement

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Corresponding author:
Ing. Karel Kubata
Department of Information Technologies, Faculty of Economics and Management,
Czech University of Life Sciences Prague, Kamýcká 129, 165 21 Prague 6, Czech Republic
Phone: +420 22438 2861, E-mail: kubata@pef.czu.cz

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Stochastic Frontier Modeling of Maize Production in Brong-Ahafo Region of Ghana

B. A. Oppong, E. E. Onumah, S. Asuming-Brempong

Department of Agricultural Economics and Agribusiness, University of Ghana

Abstract

Maize is a major staple crop in Ghana which needs to be produced optimally towards food security and commercialization. In relation to this the study adopts the stochastic frontier model to analyze technical efficiency of maize farms in the Brong Ahafo Region of Ghana using a cross sectional data of 232 farms. The findings demonstrate that the input variables scaled per hectare: seed, herbicide, labor and cost of intermediate input influence maize output positively at a decreasing returns to scale. The study further finds that maize producers realize 83% of the frontier output averagely and there is the possibility to increase maize output by 17% at the given technology and input levels in the short run through the adoption of the best farm practices. The study concludes that producer specific factors impede the full potential of the farmers and the inefficiency effects can be mitigated by focusing on policies that enhances the use of best farm practices.

Key words

Maize, frontier, technical efficiency, productivity, returns to scale.

Introduction

Maize is the most important cereal and staple food crop for more than 1.2 billion people in sub-Saharan Africa (SSA) (IITA, 2013). Worldwide production of maize is 785 million tons, with the largest producer, the United States, producing 42%. Africa produces 6.5% and the largest African producer is Nigeria with nearly 8 million tons, followed by South Africa (IITA, 2013). Ghana produces about 2 million tons of maize in the year 2010 (MoFA, 2010). Average maize yields among the developing countries, as an aggregate, are about one-third of those of the major maize producers. China, who is among the largest maize producing countries in the world produces around 5 tons/ha while in Ghana it stands at around 1.7 tons/ha against achievable yields of 5-6 tons/ha. This is compared to realized average yield of 9 tons/ha in the United States, the highest world producer. Maize as a major staple food in Ghana facilitates food security and provides employment opportunities to generate income for most farming households. It also serves as raw material for industrial purposes (WABS Consulting Ltd., 2008). Growth in population, per capita income and the production links from other related economic activities requires annual maize output to grow by 2.6% between 2010 to 2015 (MiDA, 2007). Again, Brong Ahafo Region is well endowed for maize production and if maize production intensifies, it can contribute immensely to increase maize output in the country.

Although research has come out with new ways of cultivating maize for maximum production; constraints on use and access to technology are among the factors contributing to low yields and productivity in maize production in the region. The gap between potential yield and the actual yield has been estimated at 200-300% for staple crops (Al-hassan & Diao, 2007). The average yield of 1.7 tons/ha against the achievable yield of 5-6 tons per hectare of land in the region presents opportunity for growth through gains in productivity. This study, therefore seeks to determine the drivers of maize output through productivity and technical efficiency gains in the Brong-Ahafo Region of Ghana. Belbase and Grabowski (1985) indicate that it is more cost-effective to improve efficiency than introducing new technologies if farmers are not optimizing the use of existing ones. Specifically, the study tries to estimate the partial productivities of the individual input factors, the individual technical efficiency scores and the determinants of technical inefficiency. The estimates of the productivities of the input factors to maize

output contribute to revealing the relationships between the inputs to output to adjust the inputs efficiently in the maize production process. This also determines the scale elasticity of production which informs policy on how to produce efficiently given the returns to scale in the production process. The understanding of the level of technical efficiency and its determinants is needed to know the existing gap of maize output from the frontier output at the given technology to inform policy interventions to increase output in the short run without employing additional resources. Production of maize from technological progress will increase output at the given input level to benefit the producer and the average consumer to improve the standard of living.

Materials and methods

1. Study area

The study is based on farm level data on maize cultivation in the Brong-Ahafo Region of Ghana. The study uses data from both the major and minor seasons. Maize cultivation in the major season usually occurs from March to June and a short dry-spell occurs in July is used for harvesting and sun-drying. This is followed by a minor season from August to November. Nkoranza, Kintampo North and South, Wenchi Districts are in the transition zone of Ghana where soils are deep and friable and well drained, and there is less dense forest cover. Districts such as Sunyani West and Berekum Districts occur in the semi-deciduous forest zone which also satisfy the weather requirements for maize production and also permit two season maize production. The average annual rainfall and temperature are 1,300 mm and 270c respectively to promote maize cultivation.

2. Theoretical framework for Stochastic Production Frontier Model (SFP)

The stochastic frontier approach for crossectional data is adopted for this study. The model is represented in equation (1):

$$y_i = f(x_i;\beta).\exp(v_i).\exp(u_i) \quad (1)$$

The actual output y_i produced by the *i-th* farmer depends on the vector of input factors denoted by x_i. The actual output y_i deviates from the frontier output as a result of pure noise represented by v_i and inefficiency effects also represented by u_i. β represents the unknown true parameters of the production technology.

The technical efficiency of the *i-th* farm is given by equation (2):

$$TE_i = \frac{E(Y_i/x_i,u_i)}{E(Y_i/x_i,u_i=0)} = \frac{f(x_i,\beta).\exp(v-u_i)}{f(x_i:\beta).\exp v_i} = \exp(-u_i) \quad (2)$$

And technical efficiency becomes;

$$TE_i = \exp(-u_i) \quad (3)$$

Thus the technical efficiency effects become $TE_i = E\left(\exp\{-u_i\} \mid \varepsilon_i\right)$ and the technical inefficiency effects are truncated at zero of the normal distribution with mean μ_i and a variance σ_u^2, u_i (μ_i, σ_u^2), where the mean is defined as $\mu_i = \delta z_i$, z_i, represents the exogenous variables and δ denotes the unknown estimates of the exogenous variables on technical inefficiency as employed by Battese and Coelli (1995). The application of FRONTIER 4.1 to an appropriate production model produces the ML estimate of the frontier model, the technical inefficiency function and the individual farm specific technical efficiency estimates. The estimates become unbiased unlike the two stage estimation procedure for incorporating exogenous variables in technical efficiency analysis (Kumbhakar and Lovell, 2000). The log likelihood function is parameterized in terms of $\sigma_2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2/\sigma^2$ (Battese, Corra, 1977). If γ =1 it means that the deviations in output are as a result of technical inefficiency only whilst at the other extreme value of zero, indicates that technical inefficiency is absent and deviations in output are controlled by the distribution of the pure noise component. But if γ is in between zero and one it implies that output variability from the frontier is explained by both pure noise and technical inefficiency effects.

3. Empirical model specification

The translog production model is assumed for the deterministic part of the production frontier and it is specified as:

$$\ln Y_i = \beta_0 + \sum_{j=1}^{4}\beta_j Inx_{ji} + 0.5\sum_{j=1}^{4}\sum_{k=1}^{4}\beta_{jk}\ln x_{ji} Inx_{ki} + \varepsilon_i \quad (4)$$

β_j denotes the unknown true estimates of the *j-th* input in the production function. If $\beta_{jk} = 0$, then the translog stochastic frontier model reduces to the Cobb-Douglas model given as:

$$\ln Y_i = \beta_0 + \sum_{j=1}^{4}\beta_j Inx_{ji} + \varepsilon_i \quad (5)$$

The composed error term, includes the pure noise

and technical inefficiency effects which are given as;

$$\varepsilon = v_i - u_i \quad (6)$$

Y_i refers to output of maize produced, measured in kilograms per hectare[1]. This includes the aggregation of the two production seasons. X_{1i} refers to the quantity of seed per hectare (kg/ha) used by the *i-th* farm for the production year. X_{2i} refers to the total liters of herbicide per hectare used by the *i-th* farm during the production year. x_{3i} is captured based on the total labor input in man-days employed by the *i-th* farm per hectare during the production year[2]. Hired and family labours are assumed to be equally productive and are aggregated together. X_{4i} refers to the cost of intermediate inputs per hectare/mean including depreciated value of capital inputs such as cutlass, knapsack sprayer, cost of transportation and shelling and cost of ploughing for the *i-th* farm during the production year and measured in cedis. The sum total of the output elasticity from the input variables is the estimated scale elasticity (κ) which is defined as the percentage change in output as a result of 1% change in all input factors. When $(\kappa) \succ 1 \Rightarrow$ increasing returns to scale (IRS), $(\kappa) \prec 1 \Rightarrow$ decreasing returns to scale (DRS), and $(\kappa) = 1 \Rightarrow$ Constant returns to scale (CRS).

The technical inefficiency effects are explained by the exogenous variables in the model represented by equation (7);

$$q(z_j, \delta) = \delta_0 + \sum_{j=i}^{10} \delta_j z_i \quad (7)$$

Where $\delta's$ are to be estimated coefficients of the technical inefficiency model and $z_i's$ are the exogenous explanatory variables and z_{1i} is the squared of the age of the farmers measured in years. z_{2i} denotes access to in-kind credit and farmers who used in-kind credit for the production year are assigned a value of 1 and zero otherwise. z_{3i} represents gender where by 1 is assigned for males and 0 for females. Z_{4i} Education, represents the maximum level of formal schooling of the farmer[3].

Z_{5i} represents the number of contact made by the farmer with the extension officer during the production year. Z_{6i} is represented as Dumplough where a farmer who ploughs the land before sowing for the production year is assigned a value of 1 and zero for those who did not plough Bkdistrict, farmers who belong to the Berekum district are assigned a value of 1 and 0 otherwise. This hypothesis is used to capture the differences in districts in relation to technical inefficiency. z_{8i} Nkdistrict, farmers who belong to the Nkoranza district are assigned a value of 1 and 0 otherwise. z_{9i} Kindistrict, farmers who belong to the Kintampo district are assigned a value of 1 and 0 for otherwise. z_{10i} Wendistrict, farmers who belong to the Wenchi district are assigned a value of 1 and 0 otherwise.

4. Statement of hypothesis

The following hypotheses are considered for investigation to the study; H_0: $\beta_{jk} = 0$, the coefficients of the second-order variables in the translog model are zero. The deterministic component of the frontier model reduces to the Cobb-Douglas model. H_0: $\gamma = \delta_0 = \delta_1 = \delta_2 = \ldots \delta_{10} = 0$, the null hypothesis that technical inefficiency is absent at every level. The use of stochastic frontier model is justified for the analysis if technical inefficiency is present in the data. H_0: $\gamma = 0$, he null hypothesis specifies that inefficiency effects are non-stochastic and hence the model is appropriate to be estimated using the ordinary least squares method whilst nesting the exogenous factors into the mean output function. H_0: $\delta_0 = \delta_1 = \delta_2 = \ldots \delta_{10} = 0$ the null hypothesis that the simpler half normal model is an adequate representation of the inefficiency effects and hence the variance of the inefficiency effects are zero or the technical inefficiency effects are unrelated to the exogenous variables.

5. Data and sampling technique

A multi-stage sampling procedure is employed to obtain cross sectional data on the relevant variables for the study from 232 maize farms which is a fair representation of the maize farms in the region. The districts and communities are selected purposively due to their varying intensity of maize production at those areas. The selected

[1] The output and input variables are all normalized by their respective means to justify the first order parameters in the translog production model as elasticities.

[2] Man days for labour is calculated with the formula; one adult male working for one day (8 hours) equals one man day; one female and one child (< 18years) working for one day (8 hours) equals 0.75 and 0.5 man days respectively. The following researchers applied the above method for the calculation of man-days: Coelli and Battese (1996) and Onumah et al. (2010).

[3] Ranking of level of formal schooling for the study follows the study of Onumah & Acquah, (2011) is outlined as: None_0; Primary level_1; Junior Secondary/Middle School level_2; Senior Secondary/Vocational level_3;;Polytechnic level_4; University (bachelor) level_5.

districts are Sunyani West District, Wenchi East District, Berekum Municipal, Nkoranza South, Kintampo South and North Districts where the weather and soil conditions are favorable. Within each district three major maize producing communities are selected to select the maize farmers randomly to obtain a distribution of farmers as 50, 50, 47, 39 and 46 for Sunyani West, Nkoranza South, Kintampo North and South Wenchi and Berekum districts, respectively.

Results and discussion

1. Summary statistics of the output and the input variables

The quantity of seed used for the production year ranges between 4.85 to 43.13 kg/ha with a mean of 21.35 kg/ha and standard deviation of 6.54 kg/ha. Mean labour of 67.95 mandays/ha is applied which ranges from 13.06 to 236.86 mandays/ha while the farmers apply average herbicide of 8.57 liters also ranging from 0.10 to 40 liters. The mean cost of intermediate input per hectare is GHS 170.98 with minimum and maximum values of GHS 6.54 and GHS 1598.75, respectively. Maize output also ranges from 337.5 kg/ha to 6750 kg/ha with a mean of 1975kg/ha and standard deviation of 1027.74 (Table 1).

2. Testing of hypothesis

The null hypothesis that the Cob-Douglas model is suitable for the data is rejected at 1% level of significance in favor of the translog model. The implication for this is that the translog model is flexible to represent the production process better. The second hypothesis specifies that technical inefficiency is absent from the production process at all levels and it is rejected at 1% level of significance. The estimated gamma is 0.81 and it is significantly greater than zero and that the variations in the observed output from the frontier output are due to technical inefficiency and random noise but 80% of the variations in output are due to technical inefficiency. Therefore maize output variability is subject to farm specific factors that influence the efficiency to convert the inputs to output. The third hypothesis assumes that the technical inefficiency effects are non-stochastic but this hypothesis is rejected. This implies that the inefficiency effects are not unrelated to the exogenous variables but have a particular distribution which is determined by the exogenous variables. The fourth hypothesis accepts that the technical inefficiency effects are truncated with variable mean dependent upon the exogenous variables (Table 2).

Variable	Unit	Minimum	Mean	Maximum	SD
Output	Kilograms/ha	337.50	1957.51	6750.00	1027.74
Seed	Kilograms/ha	4.85	21.35	43.13	6.54
Labour	Man-days/ha	13.06	67.95	236.86	35.11
Herbicide	Liters/ha	0.10	8.57	40.00	5.82
Cost	Cedis/ha	6.54	170.98	1598.75	160.93

Source: Authors computation, 2012

Table 1: Summary statistics of output and input variables.

Null Hypothesis	Loglikelihood	Test Statistic (λ)	Critical Value	Decision
1. H_0: $\beta_{jk} = 0$	110.69	43.86***	23.21	Reject H_0
2. H_0: $\gamma = \delta_0 = \delta_1 = \delta_2 = \ldots \delta_{10} = 0$	-	26.61a	25.56	Reject H_0
3. H_0: $\gamma = 0$	102.06	6.49a**	5.41	Reject H_0
4. H_0: $\delta_0 = \delta_1 = \delta_2 = \ldots \delta_{10} = 0$	98.81	20.12*	19.68	Reject H_0

Note: [a] Values of test of one sided error from the FRONTIER 4.1 Output file. The correct critical values for the hypotheses involving a γ follows a mixed chi-square distribution and are obtained from Kodde and Palm (1986), whilst the rest are obtained from the conventional chi-square table. *, ** Significant at 5% and 10% levels, respectively.

Source: Authors computation, 2012

Table 2: Hypothesis Test for model specification and statistical assumptions of stochastic frontier model.

3. Frontier estimates

The frontier estimates are presented in Table 3. However, discussion is done using the output elasticity presented in Table 4. The output elasticity for seed, herbicide, labour and cost of intermediate inputs which have been scaled per hectare are 0.25%, 0.21%, 0.02% and 0.23%, respectively. The results of the study are similar to the findings of Anupama et al. (2005) who find that labor, fertilizer and intermediate inputs contribute to output as 0.08%, 0.21% and 0.20%, respectively, in maize production in Tanzania. Seed makes the highest contribution to output in this study and a 1% increase in the input will cause a 0.25% increase in output and this is followed by cost of intermediate inputs which yields 0.23% of output for every 1 % investment in cost of intermediate inputs. However, labor contribution to output is the lowest and this contradicts with the findings of Chirwa (2007) study of small holder maize production in Southern Malawi which reveals that labor causes the most significant change in maize output because the production technology is more labor intensive.

The study further revealed that the scale elasticity is 0.71, to demonstrate that the maize farms in the area exhibits decreasing return to scale. This means if all the input variables with the exception of land increase by 1%, maize output would increase by 0.71%. Therefore the proportionate increase in output is less than the proportionate increase in the inputs. Hence scale diseconomies exist on the technology frontier and that the use of best farm practices to raise the productivity of both fixed and variable inputs through land management practices, training for labour and improved seeds can enable the farmers to take advantage of economies of scale. Chirwa (2007) study finds the returns to scale to be 0.97~1 which exhibits constant returns to scale whilst Anupama et al. (2005) find the returns to scale to be 0.5 as a result of decreasing returns to scale.

Variables	Elasticity
Seed/ha	0.25
Herbicide/ha	0.21
Labour/ha	0.02
Cost/ha	0.23
RTS	0.71

Source: Authors computation, 2012 All the input variables are significant at 1 percent with the exception of labour.

Table 4: Elasticity of production and returns to scale.

Variable	Parameters	Estimates	Standard Error
Constant	β_0	0.163***	0.055
Lnseed/ha	β_1	0.253**	0.110
Lnherbicide/ha	β_2	0.208***	0.053
Lnlabour/ha	β_3	0.021	0.066
Lnothercost/ha	β_4	0.230***	0.048
0.5Ln(seed)2	β_5	0.679**	0.300
0.5Ln(herbicide)2	β_6	0.149***	0.041
0.5Ln(labour)2	β_7	0.278**	0.166
0.5Ln(cost)2	β_8	-0.024	0.055
Lnseed*Lnherbicide	β_9	0.249***	0.087
Lnseed*Lnlabour	β_{10}	-0.432**	0.201
Lnseed*Lncost	β_{11}	-0.228**	0.104
Lnherbicide*Lnlabour	β_{12}	-0.040	0.076
Lnherbicide*Lncost	β_{13}	-0.033	0.036
Lnlabour*Lncost	β_{14}	0.001	0.074
Gamma	γ	0.80***	0.053
Loglikelihood value	λ	-0.89	

Note: **, *** corresponds with 5% and 1% levels of significance, respectively.
Source: Authors computation, 2012

Table 3: Maximum likelihood estimates of translog mean output function.

4. Technical Efficiency Estimates

Majority of the respondents represented by 48.3% produce at efficiency level ranging from 81% to 90% of their frontier output. But the technical efficiency estimates range from 24% to 96% at a mean of 83% and 3.1% of the producers attain technical efficiency levels below 50% of their respective frontier output. The findings implies that there is the possibility of increasing the output of maize farms in the study area by 17% on the average in the short run by adopting the practices of the best farm. In a related study of smallholder maize production in Southern Malawi, Chirwa (2007) finds the mean technical efficiency to be 46.23% between the range of 8.12% -93.95% (Table 5).

Estimates	Frequency	Percent
0.21-0.30	2	9
0.41-0.50	5	2.2
0.51-0.60	5	4.3
0.61-0.70	14	5.6
0.71-0.80	25	17.2
0.81-0.90	133	48.3
0.91-0.99	48	21.1
Minimum	24%	
Mean	83%	
Maximum	96%	
Total	**232**	**100.0**

Source: Authors computation, 2012

Table 5: Technical efficiency estimates.

5. Determinants of technical inefficiency

The results in Table 6 indicate that age-squared influence technical inefficiency because as age increases, technical inefficiency increases up to certain level but it decreases with further increase in age. Therefore the very old become efficient in the cultivation of maize due to their long experience to learn and adopt the best production practices on their farms. Villano & Fleming (2006) found that as farmers grow to gain experience it influences technical inefficiency negatively if the farmers gain experience to know the best farm practices and better perform them. Khan & Ali (2013) found younger farmers in Pakistan involved in tomato production to be more efficient. This is because the younger farmers tend to be more receptive to improved methods of tomato production to influence efficiency positively. Therefore farmers can grow to gain experience enough to become less risk averse to use improved production practices. Most producers of maize who use in-kind credit in the form of inputs such as seed and fertilizer revealed that the delivery of the inputs from suppliers was late to meet favorable weather conditions. As a result the applied inputs were not efficiently converted into maize output due to the late planting and this resulted to the positive influence of in-kind credit on technical inefficiency. Therefore access to in-kind credit does not guarantee gains in technical efficiency. Meanwhile in a related study of maize production in rural Vietnam, Duy (2012) finds both cash and in- kind credit to influence technical inefficiency negatively. Khan & Ali (2013) finds that farmers who lack access to credit are not able to realize their full production potential in tomato production due to their inability to invest in productive inputs like fertilizer, improved seeds and the use of other best agronomic practices. The finding suggest that if maize production depends on rainfall then the use of other risk mitigating strategies to control the effects of the weather vagaries are essential.

In relation to gender, Onumah et al. (2010), found males to be more efficient in fish farming than their female counterparts in Southern Ghana but this study finds that gender is unrelated to technical inefficiency. In their study males are more efficient in maize production due their ability to focus on maize production more than the females because the economic activity of maize production is their primary role in the household unlike females who together work as maize farmers as well as house wives. Again the males are able to perform the labor intensive farm practices in addition to the use of hired of labour. But females mainly rely on hired labour and with scarcity and unreliable nature of hired labour results to inadequacies in the performance of the best farm practices to impede their efficiency. The results of the study also reveal that maize producers level of education does not explain the variation in technical inefficiency. But Khan & Ali (2013) study reveals that if producers are educated it enhances the application of the best farm practices in tomato production process. Nyagaka et al. (2010) also observed a positive influence of education on technical efficiency in their studies. Binam et al. (2008) and Onumah et al. (2010) in their studies on the production of cocoa and fish respectively obtained mixed results about the role of education to the production of the frontier output. Studies in crop production such as Ogundari (2008) and Alhassan (2012) has found extension contact with the farmers to influence technical inefficiency

Variables	Parameters	Estimate	Standard Errors
Constant	δ_0	-1.44**	0.791
Age^2	δ_1	-0.002***	0.001
Credit	δ_2	1.759***	0.712
Gender	δ_3	-0.247	0.272
Edu	δ_4	-0.060	0.109
Numvisit	δ_5	-0.014	0.045
Dumplough	δ_6	2.600***	0.604
BKdistrict	δ_7	-0.089	0.271
Nkdistrict	δ_8	-3.905***	0.952
Kintampo	δ_9	-1.935***	0.571
Wencdist	δ_{10}	-1.058**	0.488

Note: **, *** corresponds with 5% and 1% levels of significance, respectively.
Source: Authors computation, 2012

Table 6. Maximum likelihood estimates of the technical inefficiency model.

negatively. But this study finds that extension contact does not explain technical inefficiency. Solís et al., (2006) study indicates that soil conservation practices result to higher levels of technical efficiency among farmers but the land management practice mostly used by the maize farmers such as ploughing of the land affects technical inefficiency positively. The study further demonstrates that Nkoranza, Kintampo, and Wenchi Districts influence technical inefficiency negatively with the exception of Sunyani West District. The producers of maize in these districts are less technically inefficient than their counterparts in the Sunyani West District. Therefore farmers in the Nkoranza, Kintampo and Wenchi Districts apply the best farm practices on their farms more efficiently than those in Sunyani (Table 6). A related study of cocoa production in Ghana by Dzene (2010) confirms the results of this study that district variation affects producers‘ ability to achieve the frontier output.

Conclusions

The study which analyzed technical efficiency of maize production in the Brong-Ahafo Region of Ghana revealed that the input factors (seed, herbicide, labour, land and cost of intermediate inputs) scaled per hectare- are productive at decreasing returns to scale. Cost of intermediate inputs and seed cause the most significant changes to maize output. Again the study indicates that on average, 17% of maize output in the Brong-Ahafo Region is lost due to technical inefficiency. Farmer location and characteristics such as age-squred contribute to the achievement of the frontier output. Also the timely application of in-kind credit facility which is supported by the application of risk mitigating techniques is essential to produce maize efficiently. Based on these findings, the study recommends that older farmers, especially those with less experience in maize production should be supported to adopt best farm practices on their farms. Farmers in the Sunyani west municipality should be trained to adopt best farm practices. Ploughing of the land should be carried out with green manuring to achieve the optimum results. The delays in the provision of in-kind credit should be minimized to meet favorable weather conditions for optimum use.

Corresponding author:
Boahen Atta Oppong
Department of Agricultural Economics and Agribusiness, University of Ghana
P.O.BOX LG 68
Phone: 0249494109, Email: attakwameatoapoma@gmail.com

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Analysis of Factors Influencing Caterers of the Ghana School Feeding Programme to Purchase Rice from Local Farmers in the Tamale Metropolis, Tolon-Kumbungu and Karaga Districts

A. F. Shaibu, R. M. Al-hassan

Department of Agricultural Economics and Agribusiness, University of Ghana, Legon Accra Ghana

Abstract

The Ghana School Feeding Programme is the local version of the Home Grown School Feeding. Launched in 2005, the programme has three basic objectives; Poverty Reduction and Food Security, Reducing Hunger and Malnutrition and Boosting Domestic Food production in Ghana. Studies have shown that the programme have had tremendous impact on school enrolment, retention and malnutrition but the same cannot be said about its agricultural portfolio. Indications are that the programme has not succeeded in boosting domestic food production. Over the years no clear procurement procedures relating to the purchase of foodstuff have been followed. Linkage between the Ghana School Feeding Programme and local farmers is a subject matter that is under-researched. This study therefore seeks to assess the factors that influence Ghana School Feeding Programme caterers to buy rice from local farmers in the Tamale metropolis, Tolon-Kumbungu and Karaga districts of the northern of Ghana. The findings will be useful to policy makers and rice farmers in generally especially with regard to agricultural marketing opportunities created by the School Feeding Programme. Analysis of the Ghana School Feeding Programme's procurement of rice from local farmers was conducted using a probit regression model. The willingness of caterers to buy rice from the local farmer which is a binary choice is the dependent variable and the factors which are hypothesized to influence the decision of the caterer are the independent variables. The results show that majority of caterers buy rice from local millers and the market and very little from local farmers. The factors which had significant influence on the caterers to buy from the local rice farmer include, availability of storage facility, other jobs done by caterers, price of milled rice, easy location of rice farmers and delays in the payment of feeding bursaries. The Ghana School Feeding Programme Secretariat should employ caterers who are unemployed and do not have any other jobs doing. Also the provision of adequate storage facilities in schools and the early disbursement of feeding bursaries to caterers are essential in solving the problem of buying foodstuffs directly from farmers.

Key words

Access, Ghana School Feeding Programme, caterers, local rice, procurement.

Introduction

Ghana has a long history of school feeding programmes implemented by different development agencies, particularly in the north of the country. The two most important players in School feeding in the country had been the Catholic Relief Services and the World Food Programme (Fisher, 2007). The Ghana School Feeding Programme (GSFP) is basically intended to stimulate the local economy through creation of additional demand for local farm produce, and to improve food security. This objective aligns closely with the United Nations' Millennium Development Goals (MDGs) on hunger and poverty.

Rice constitutes a major staple on GSFP menu. It is normally cooked 3 times a week for the pupils. USAID (2009) cites (JICA, 2007 ibid) and reported that Ghana's rice production estimates range from 200,000 to 300,000 MT of paddy or roughly 120,000 to 180,000 MT of milled rice, the bulk of which comes from the Upper East, Northern and Volta Regions, Rice is the second most important cereal next to maize in Ghana and is fast becoming a cash crop to many rice farmers (Asare, 2010).

According to Anderson et al. (2005), locally produced foods provide the most sustainable and often most nutritious source of food for people who consume it. Using locally-produced food provides both an inexpensive and nourishing meal, and stimulates the local economy by creating reliable markets for agricultural products. However the authors admit that when School Feeding Programmes (SFPs) are first initiated, it may be necessary for them to rely in part on non-local foods for the first six months to a year while local agricultural production responds to increased demand and output is sufficiently increased

Studies by two NGOs, SEND Ghana and ESCASARD/SNV, independently concluded that there has been limited impact of the Ghana School Feeding Programme on local farmers (SEND, 2008) and (ESCASARD/SNV 2009). The 2007 action plan target of purchasing 80% of foodstuffs from local farmers was not achieved (GSFP/ AOP 2010). With the exception of the Eastern region where more than 20% of food was bought from local farmers, in all the other regions in more than 50 percent of the schools, less than 20% of food was purchased locally. In 2009, the government of Ghana spent about 98% of GSFP budget on food items (GSFP/AOP 2010)

In Kenya and Nigeria key implementation strategies were adopted in their school feeding programmes[1] to boost the market of locally produced food. These strategies were Competitive tendering for food and transport with registered farmers and suppliers and, the food were purchased by cooks at local markets coordinated by local school meals committees (PCD 2009:2010)

[1] Eradicate Hunger in Kenya and the Osun State Home Grown School Feeding and Health Programme in Nigeria

Objective of paper: The main aim of the paper is to analyse the factors that influence Caterers of the Ghana School Feeding Programme to buy rice from local farmers in the Tamale metropolis, Tolon-Kumbungu and Karaga district of the Northern region of Ghana.

Methodology

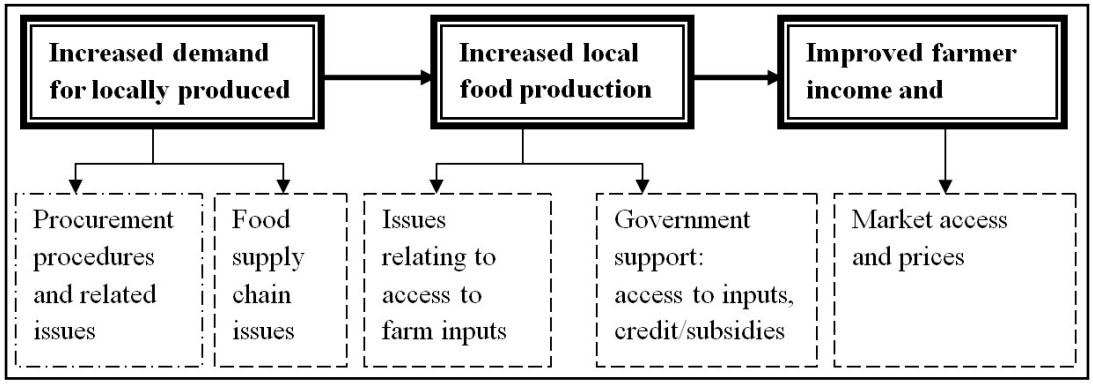
1. Theoretical and conceptual framework

Marketing is the most important aspect in the development process of an economy. This is due to the fact that development primarily means expansion in productive activities in the economy. However there cannot be continuous expansion in production unless the commodities produced are actually sold out and, selling depends on the proper marketing conditions (Prasad and Prasad, 1995).

Figure 1 illustrates the conceptual framework of the possible impacts of the Ghana School Feeding Programme on domestic food production. It shows that increased demand for local foodstuffs would lead to increased domestic food production which is intended to increase farmers' income and well being in the end. As indicated in the boxes with broken lines, increased domestic food production would involve food supply and procurement issues where individuals and groups are involved. Increased domestic food production means farmers would have to get more inputs which require the support of government especially in terms of access to credit and subsidies.

2. Method of analysis

The HGSP model which specifically illustrates the theory of change posits that by using a structured demand approach to make strategic



Source: Adapted from GSFP/AOP (2010)

Figure 1: Possible impacts of the GSFP on domestic food production.

use of public procurement, the local economy will be stimulated by the flow of direct benefits primarily to targeted groups and indirect benefits via multiplier and spill-over effects to local population more widely (Sumber and Sabates 2010). Maxwell (2007) argued that procurement of food locally for publically-funded school feeding framework is important for two reasons; there is growing recognition among stakeholders of the benefits of substituting domestically produced for imported commodities and secondly governments' demand for domestically produced commodities is predictable and seen to provide an opportunity to structure demand for a significant quantity of domestically produced food.

The paper adopted a supply chain model of assessment to determine how a structured demand could facilitate the procurement of rice from local farmers by making available information on prices and procurement costs from various sources in the supply chain. Based on the available sources of rice supply to the caterer, the Probit model was used to further determine the factors that influence GSFP caterers to buy rice from local farmers

3. The probit model

Following the works of Kuhar and Juvancic (2010), Kasteridis et al. (2007) the probit model was adopted in the analysis of factors influencing GSFP caterers to buy rice from local farmers.

Model specification

$$Pr\ (Y = 1/X) = \Phi\ (X\beta) \qquad (1)$$

Where *Pr* denotes probability and Φ is the Cumulative Distribution Function (CDF) of the standard normal distribution. The parameters β are typically estimated by maximum likelihood In their study on '*Determinants of purchasing behaviour for organic and integrated fruits and vegetables in Slovenia*' Kuhar and Juvancic (2010) used the probit model and following Greene (1997), the model was built around a latent dependent variable and was specified as:

$$y_i^* = \beta X_i + \varepsilon \qquad (2)$$

Where y_i^* is an unobserved frequency of quality and vegetables purchase, β□ is the vector of unknown parameters and *Xi* is a vector of explanatory variables (which may be continuous or discrete).

4. Empirical model specification

For the purpose of this study the probit model is restated as follows;

$$WLN = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \varepsilon \qquad (3)$$

Where; *WLN* is the dependent variable which is a binary choice (1 for caterer buys paddy rice from local farmer and 0 otherwise). β_0 is the intercept, the β_s are the regression coefficients of the independent variables $X_1\ X_2,\ldots\ldots X_7$, and ε is the error term.

The independent variables, which describe GSFP caterers' willingness to purchase paddy rice from local farmers, are described as follows;

- **Processing cost (X_1):** This a continuous variable measured in Ghana cedis. An estimated average processing cost for an 80kg of paddy rice was used and the cost build up was, transportation, boiling, milling and labour expenses. The a priori expectation for this variable is negative. As the processing cost of paddy rice increases, GSFP Caterers would be more willing to buy milled rice from middlemen to save cost rather than buy paddy rice from the farmers.
- **Distance from caterer/GSFP school to the local market and the mill (X_2):** This is a continuous variable indicating the distance in kilometres between the caterer or GSFP School and the local market on one hand and the milling site on the other. This variable has a positive or negative apriori expectation. It is expected that as the distance between the market place and the caterer or the school gets longer, there is the tendency for the caterer to buy paddy rice from the farmer who may be closer to a GSFP school in lieu of milled rice in order to save travel time and transportation cost. Similarly, the longer the distance between the local mill and the caterer/GSFP school, the less the probability of her willingness to buy paddy
- **Availability of Storage facility (X_3):** This is a dummy variable equal to 1 if a caterer has access to storage facility and 0 otherwise. As paddy rice is more bulky than milled rice, it is expected that if storage facilities are available the caterer will be more willing to buy paddy rice from the farmer than milled

rice from the local market since the caterer will have enough storage facility to store the bulky paddy rice, especially during the peak season when prices are low

- **Price of milled rice (X4):** This is continuous variable measured in Ghana cedis. This represents the average price for a 120kg of milled rice purchased from local millers. The study used the price of local millers because they constitute about 50% of the caterers □ sources of supply. From the caterers' point of view milled rice is a substitute to paddy rice and the effect of the price of milled rice has positive a priori expectation. As the price per 120kg of milled rice increases, relative to the price and processing cost per 160kg of paddy, the demand for paddy rice from the farmer would also rise.
- **Student population in GSFP School (X_5):** The population of school pupils in a GSFP school is hypothesized to influence caterers' willingness to buy rice from the farmer positively. As the number of pupils enrolled in the school increases the caterer would have more mouths to feed which implies that the demand for rice would be higher and the caterer would like to buy paddy rice in bulk at relatively cheaper price from the farmer than milled rice from local miller or the market. This variable was estimated using the total student population handled by each caterer
- **Other jobs done by caterer (X_6):** This is a dummy variable equal to 1 if a caterer is engaged in multiple jobs and 0 otherwise. Some of the caterers are engaged in other jobs some which are often full time regular employment. So it is expected that caterers will be less willing to buy paddy rice from the farmers because of the time involved in processing and milling. The caterers could use this additional time to do the other jobs if they buy milled rice from the local miller or the market.
- **Whether caterer easily locates the rice farmer (X_7):** This is also a dummy variable equal to 1 if caterer can easily locate the rice farmers and 0 otherwise. It is expected that if a caterer can easily locate the farmer, it will affect his or her willingness to buy rice from the farmer positively. From the conceptual framework, a greater proportion of the GSFP is being run in the rural areas where majority of rice farmers are located. Therefore if a caterer is living closer to the farmer, they are more likely to buy from the farmer than from the market. The GSFP also requires that caterers buy local foodstuff from the communities where the programmes are run.
- **Years of Formal Education (X_8):** This is a continuous variable measured in years. The years of formal education is expected to have a negative impact on caterers' willingness to buy rice from the farmer. As the level or years of education obtained by the caterer increases, they are less willing to buy paddy rice from the farmer. This is because from the survey data, there was a positive correlation between years of formal education and multiple jobs of caterers. Caterers who had more years of education were mostly doing other jobs in addition to the catering services. So it is expected that years of formal education will affect caterers' willingness negatively.

Variable	Definition	A priori Apriori Expectation
X_1	Ave Annual Processing cost of paddy rice in GH¢	-
X_2	Distance from milled rice supplier to school (km)	+
X_3	Availability of storage facility (Yes=1,No=0)	+
X_4	Price of milled rice per bag/120kg	+
X_5	Student population measured in numbers	+
X_6	Caterer doing other jobs (Yes=1, No=0)	-
X_7	Easy locating a rice farmer (Yes=1,No=0)	+
X_8	Delays in the release of bursaries to caterer (Yes=1, No= 0)	-
X_9	Caterers Years of formal education	-

Dependent Variable (WLN: Caterer buys paddy from Farmer (Yes = 1, No = 0)
Source: own processing

Table 1: Summary of variable definitions and a priori expectation.

5. The study area

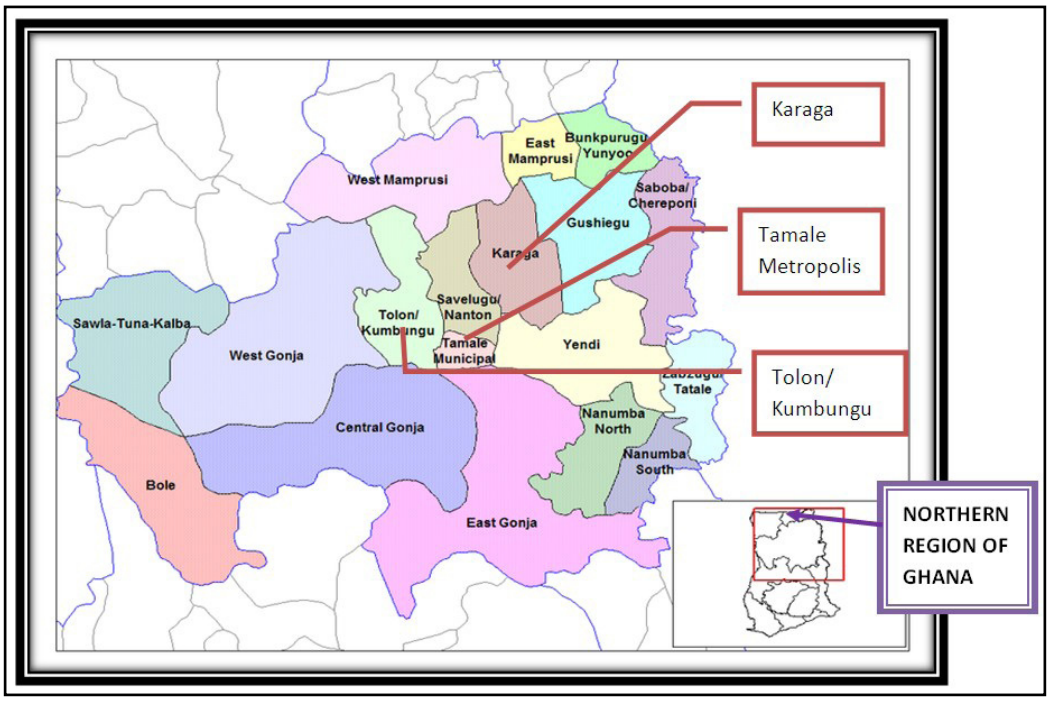
The study was conducted in the Tamale metropolis, Tolon-Kumbungu and Karaga districts of the Northern region of Ghana (Figure 2). The northern regions of Ghana (Upper East, Upper

West and Northern regions) are relatively poor and rural households, especially women and their young daughters, lack physical and economic access to food. This perhaps necessitated the introduction of school feeding and food aid programmes by the multinational organisations in the north in the 1950s (WFP 2007a).

In Tamale metropolis it is estimated that about 60% of the people are engaged in agriculture. The major crops cultivated include maize, rice, sorghum, millet, cowpea, groundnuts, soya bean, yam and cassava. Farmers in the Metropolis and rural Tamale in particular are smallholder subsistence food producers with few income earning opportunities due to low productivity. The farmers lack off-farm employment and are vulnerable to natural calamities such as unreliable rainfall and bush fires (MoFA, 2010). Total land holders in the metropolis in 2006 were 33,614 of which 23,018 holders representing 68% were producing rice (Seidu 2008). Low agricultural productivity and marketing of agricultural produce are the most prominent challenges in the agricultural sector in the metropolis. In the Northern region, Tamale Metropolis has the highest number of pupils enrolled in schools under the programme with an estimated 13.5% of the 50,597 pupils benefitting in the entire region as at (GSFP stats, 2011).

Tolon/Kumbungu district is one of the districts created by the erstwhile Provisional National Defence Council (PNDC) Law 207 in 1988 with Tolon as its Capital. The district was carved out of the then West Dagomba District Council (WDDC). It covers an area of about 2,741 square kilometres and forms about 3.9% of the total land size of the northern region. The district shares borders with the West Mamprusi District to the north, West Gonja to the west and south and with the Savelugu-Nanton District and Tamale Metropolis to the east. In 2010 output of rice from the district was 39,360 metric tons representing 21.2% of total output from the northern region and second to Tamale metropolis in that particular year. The average yield was 3.20 metric ton per hectare. Other major crops produced in the district include cassava (55,000 metric tons), yam (40,920 metric tons), maize (26,190 metric tons) and groundnuts (17,542 metric tons) (MoFA, 2011).

Karaga district was carved out of the then Gushegu/ Karaga District and officially inaugurated in August, 2004.The district is located in the North-Eastern part of the Northern Region. It has a total area



Source; http://ghana-net.com/Documents/776px-Northern_Ghana_districts.bmp

Figure 2: Map showing the study area and the districts.

of 2,958 Kilometres square. It shares boundaries with four districts; West and East Mamprusi to the North, Savelugu/Nanton to the West and Gushegu to the Southeast. Major traditional crops cultivated in the district include maize, sorghum, millet, soya bean, groundnuts, cowpeas, cassava, rice and yam. According to MoFA (2011), rice constitutes the second largest crop after Soya Bean in the district where the area put under cultivation for crop rose from 2000 hectars in 2006 to 4120 hectars in 2010 showing more than 50% increase in area cultivated within the period. In terms of output there has been a tremendous increase in rice output from 6000 metric tons in 2006 to 50,238 metric tons in 2010 with an average of 3.2012 metric ton per hectare in that year.

6. Sampling procedure

A purposive sampling technique was employed in this study with a sample size of 150 comprising 100 rice farmers and 50 GSFP caterers. Sixty (60) farmers were sampled from Tamale metropolis and 20 farmers each from Tolon-Kumbungu and Karaga districts. The farmers were selected based on proximity to GSFP schools with at least one rice farmer selected randomly from the community where a GSFP school was located while the sampling of caterers was based on number of pupils being fed in the schools with preference given those with large enrolment since the demand for rice by the GSFP caterers was conceptually identified as 'derived demand'; more numbers implied more mouths to feed and hence higher demand for foodstuffs.

Results and discussions

1. Characteristics of rice farmers

Table 2 indicates that rice farming is dominated by male across the three districts. Even though there are some female farmers in the northern region, the purposive sampling technique used, could not capture female rice farmers in the sampling frame. On the whole majority of the sampled farmers have household sizes between 2 and 10, while farmers with household sizes between 31 and above are in the minority.

Almost all the farmers are aged between 26 and 59 years, an indication that the farmers include both young and adults. Also 93% of the respondents have up to 6 years of formal education which is an indication of high illiteracy rate among the farmers. Over half of the farmers do not belong to any FBO and this could be a challenge in linking farmers to the GSFP because it could be easier dealing with groups than individual farmers. Also majority of the farmers grow rice as the only crop.

2. Characteristics of GSFP caterers

Table 3 shows the socio economic characteristics of GSFP caterers. In sharp contrast to the gender of rice farmers, the caterers are females. Inferring from the statistics, majority of GSFP caterers are engaged in other forms of employment and from the survey data, some of them are regular public service employees especially those in Tamale metropolis with very few number engaged in the catering services only. Majority of the caterers are also adults suggesting that they could cope with the physical requirement of the catering activities and be able to do effective bargaining in procurement. Heckler et. al. (1989) have shown that adults transfer such skills to teenagers in the family setting and this has been identified as the primary socialization agent for each new generation. That socialization process includes the development of a large set of skills and knowledge relevant to acting as consumers or buyers in a complex marketplace. Unlike the farmers the caterers have undergone more years of formal education. About 72% of them have obtained formal education from 7 and up to 15 years (from Junior High School to Tertiary level). This could be the reason for majority of them being in regular full time employment.

3. Analysis of GSFP caterers Procurement of rice

Table 4 below illustrates price and cost analysis based on 2011 estimates. The table virtually illustrates the cost benefit analysis of the GSFP caterers' procurement from the various sources of supply. From the survey data the average annual[2] consumption of paddy rice from farmers in the study districts in 2011 was 56,858.1kg. Total milled rice consumed was 142,144kg and out of this figure, 68 percent came from local millers and the rest from retailers. Comparing the prices and quantity levels, the procurement costs from the various sources have been estimated and the overall cost by the GSFP stood at GH¢ 209,167.60 (at farm gate, local miller and retailers prices). However if the GSFP caterers were to buy all the rice from the farmer the total expenditure would have been GH¢167,163.66 and

[2] An average of 195 school days in each academic year

Characteristic		Tamale Metro	Tolon-Kumbungu	Karaga	Total
Gender	Male	60	20	20	100
	Female*	0	0	0	0
	Total	**60**	**20**	**20**	**100**
Age (Years)	20-40	36	11	7	54
	41-60	20	9	13	42
	61and above	4	0	0	4
	Total	**60**	**20**	**20**	**100**
Education	0	57	15	19	91
(Years)	1- 6	0	2	0	2
	7-14	3	3	1	7
	15 and above	0	0	0	0
	Total	**60**	**20**	**20**	**100**
Household size	0 ≤10	49	8	14	71
	11 ≤20	5	10	5	20
	21≤30	4	2	1	7
	31 and above	2	0	0	2
	Total	**60**	**20**	**20**	**100**
FBO Member	Yes	27	15	6	48
	No	33	5	14	52
	Total	**60**	**20**	**20**	**100**
Crops grown	Rice (only)	39	10	17	66
	Rice (major)	9	7	1	17
	Rice (minor)	12	3	2	17
	Total	**60**	**20**	**20**	**100**

* Female rice farmers were excluded in the sampling frame because of the purposive nature of the sampling technique used. Rice farmers who lived in a GSFP community were those selected.

Source; from survey data - December 2011

Table 2: Characteristics of rice farmers – categorical (% of farmers).

Characteristic		Tamale Metro	Tolon-Kumbungu	Karaga	Total
Gender	Male	0	0	0	0
	Female	30	10	10	50
	Total	**30**	**10**	**10**	**50**
Income Sources	Catering Only	8	2	1	11
	Catering Major	14	4	5	23
	Catering Minor	8	4	4	16
	Total	**30**	**10**	**10**	**50**
Age (Years)	18 ≤25	0	1	2	3
	26 - 40	17	8	8	33
	41 and above	13	1	0	14
	Total	**30**	**10**	**10**	**50**
Education(Yrs)	0	2	0	9	11
	1 - 6	3	0	0	3
	7- 14	23	9	1	33
	15 and above	2	1	0	3
	Total	**30**	**10**	**10**	**50**

Source: from survey data December

Table 3: Characteristics of GSFP caterers- categorical.

Source	Price (GH¢)	GSFP Consumption (Kg)	Procurement Cost (GH¢)	
			Others sources	From Farmer
Farmer: per bag (80kg)	50.50**	56,858.10	47,525.80	47,525.80
Local miller per 60kg* milled	65.00	96,230.00	104,249.17	80,993.58
Retailer (per 60kg milled)	75.00	45,914.00	57,392.63	38,644.28
Total		199,002.10	209,167.60	167,163.66

*Conversion ratio (80kg paddy = 60kg milled)

** Including processing cost of (GH¢) 5.50

Source: from survey data December 2011

Table 4: Comparative analysis of caterers' sources of rice supplies in 2011.

Explanatory Variable	**Coefficient**	**Std Err**	**Prob**	**Marginal effects**
Constant	-12.896	6.531	0.048	-
Processing cost	-0.002	0.004	0.629	-
Distance from market	0.048	0.152	0.752	-
Storage facility	2.416**	1.053	0.022	0.927
Price of milled rice	0.082**	0.036	0.024	0.044
Pupils population	0.008**	0.004	0.020	0.004
Other Jobs	-2.376***	0.690	0.001	-0.986
Easy farmer Location	3.040*	1.587	0.055	0.918
Delays in GSFP bursar	-0.105*	0.063	0.097	-0.424
Yrs of Education	-0.407	0.743	0.593	-
Dependent Variable;	Caterer buys from farmer or not (1= Yes, 0 = No) (N= 50)			
Log likelihood	-9.132116			
Wald chi2 (8 df)	29.22		*** significant at 1%	
Prob	0.0003		**significant at 5%	
Pseudo R^2	0.7353		*significant at 10%	

Source: from survey data December 2011

Table 5: Results of factors influencing GSFP caterers to buy rice from local farmers.

government would have saved GH¢ 42.003.94 (about 20% of the total procurement cost from other sources).

4. Factors influencing GSFP Caterers to buy rice from local farmers

Table 5 presents the estimated results from the Probit model showing GSFP caterers' willingness to buy rice from local farmers. The LR statistic of 29.22 and a p-value of 0.0003 were reported suggesting that the whole model is statistically significant at 1 percent. The Pseudo R-square value of 0.7353 implies about 74% of the variation in the dependent variable is explained by variations in the explanatory variables. All the estimated coefficients had the expected sign. However the estimated coefficients that were not statistically significant include processing cost of paddy rice, distance between the caterer and market and, the years of caterers' formal education. The negative signs for other jobs done by caterers and delays in feeding bursaries variables support the hypothesis that the probability that a caterer will choose to buy paddy rice from the farmer would decrease if the caterer has other jobs or if there are more delays in the release of feeding bursaries. If caterers have other jobs, they would not want to add rice processing to their income generating portfolios hence the desire to buy paddy rice from the farmer will decrease. On the other hand delays in the release of feeding bursaries to the caterers do not allow them to purchase from the farmer especially during rice harvesting season and more so as a result of some farmers

unwillingness to sell on credit. The coefficients with the positive signs support the hypothesis that the probability of a GSFP caterer choice to buy local rice from the farmer increases as price of milled rice which is a substitute to paddy rice increases or as more storage facilities are available to the caterer, or as the number pupils handled by the caterer increases, or if there is a high probability of a caterer locating the rice farmer easily.

The marginal effect for the 'other jobs' variable suggest caterers who have other jobs are about 1% less likely to buy paddy rice from farmers. This is possible because the caterer may not have enough time to process and mill the paddy rice relative to another caterer who is doing the catering as the only job. Similarly, a caterer who has a storage facility is also 1% more likely to buy paddy from farmers while a cedi increase in the price of milled rice increases the probability of caterers' choice to paddy rice from the farmer or farm gate by 0.044%

Conclusion

1. Conclusions

Rice farmers across the study districts do not have direct access to the Ghana School Feeding Programme as about 88% of GSFP caterers buy milled rice from local millers and other sources than paddy rice from local rice. This is largely due to the fact that 29 out of the 50 caterers have other jobs aside the catering services and therefore do not want to add rice processing to their income generation portfolios. Another factor that hinders farmers' accessibility to the GSFP market is delays in the release of feeding bursaries to caterers.

Factors that encourage the GSFP caterers to buy local rice from the farmers include, larger number of pupils being fed by the caterer, persistent increases in the price of milled rice, the existence of storage facilities in the GSFP schools and easy location of rice farmers. These point to a need to facilitate increasing economies of scale for caterers; large numbers of pupils, storage for stocking, and proximity of farmers.

2. Policy recommendations

The recommendations are direct measures that can be executed to strengthen the relation between farmers and caterers, increase local purchase and make the situation for the market relation between these two groups more favourably .

In order to facilitate easy farmers' access to GSFP market, the GSFP secretariat and government for that matter should contract caterers on permanent basis focusing on those who can spend their time and energy to buy local foodstuffs including paddy rice directly from farmers. The disbursement of feeding bursaries should also be timely such that it coincides with the harvesting or peak period when prices of foodstuffs including rice are generally low. In this regard, it may also be possible for the government to assist caterers to obtain loans from banks in order to meet their demand schedules.

Government should support rice farmers by creating the necessary environment to make accessibility to the GSFP market more easily. This can be done by enlisting all farmers in the GSFP communities across the country and their detail submitted to caterers. A procurement manual detailing the procurement process which focuses on buying foodstuffs from farmers should also be initiated and a monitoring system developed to check compliance. The target farmers can be supported with credit facilities, fertilizer subsidy and other inputs to help increase their output and yield.

The GSFP Supply chain can be shortened if caterers buy rice directly from the farmers. This can be possible if government in collaboration with the Ghana Education Service provides adequate storage facilities in all GSFP schools. With this, caterers will not have much problem stocking paddy rice which they can buy from farmers. The list of all rice farmers in GSFP communities will assist caterers to locate farmers easily. From the literature caterers are assisted by cooks to provide food for the pupils. It is therefore possible for a caterer to handle more than a school so as to increase the number of pupils under her control.

Corresponding author:
Abdul-Fatawu Shaibu, MPhil Candidate
Department of Agricultural Economics and Agribusiness, P. O. Box LG 25 University of Ghana, Legon Accra Ghana
E-mail: fatash73@yahoo.ca

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Mobile Access to Information in the Agrarian Sector

P. Šimek, M. Stočes, J. Vaněk

Faculty of Economics and Management, Czech University of Life Sciences in Prague, Czech Republic

Anotace

Příspěvek se zabývá analýzou možností zpřístupnění webové aplikace agrárního WWW portálu Agris pro mobilní zařízení různých platforem. Hlavními požadavky na mobilní verzi aplikace jsou možnost fungovat offline, implementace všech základních modulů (články, ceny, avíza) a konzervativní vzhled. Na základě analýzy možností zpřístupnění obsahu agrárního WWW portálu Agris pro mobilní zařízení byl navržen koncept, kdy bude vyvinuta nativní mobilní aplikace pro platformu Android, hybridní mobilní aplikace pro platformy Android, iOS a Windows Phone 8 a optimalizovaný validní webový výstup pro mobilní webové prohlížeče (responsive layout). Nativní a hybridní aplikace umožní uživateli pracovat v online i offline režimu, přístup pomocí webového prohlížeče bude vyžadovat trvalé připojení. Uvedené řešení mobilních verzí serverové aplikace agrárního WWW portálu Agris představuje obecné řešení problematiky mobilního přístupu k informačním zdrojům, kdy venkovské regiony jsou nedostatečně pokryty vysokorychlostním bezdrátovým připojením k internetu, avšak v kontrastu s velkým rozšířením moderních mobilních zařízení.

Klíčová slova

Mobilní aplikace, mobilní web, Android, iOS, Windows Phone, Agris, responsive design.

Abstract

The paper treats the analysis of possibilities how to make web applications of the agrarian web portal Agris accessible to mobile devices of various platforms. The principal requirements for the mobile version of the application are: a possibility to be functional off-line, the implementation of all basic modules (papers, prices, warnings) and a conservative design. On the basis of the agrarian web portal Agris analysis we postulated a concept when a native mobile application for the Android platform, a hybrid mobile application for the Android, iOS and Windows Phone 8 platforms and an optimal valid web output for mobile web browsers (responsive layout) will be developed. Native and hybrid applications will allow users to work both in online and off-line modes. The access via a web browser will require a permanent connection. The proposed solution of mobile versions of the agrarian web portal Agris represents a universal solution of problems with mobile access to information sources when rural areas are not adequately covered with a high-speed wireless connection to the Internet, in contrast to a large extension of modern mobile devices.

Key words

Mobile applications, mobile web, Android, iOS, Windows Phone, Agris, responsive design.

Introduction

Our contemporary society has been characterized not only by a permanently growing number of information sources but also by an access to these sources from various client devices and platforms. An enormous growth has been recorded especially in the area of single-purpose or multi-purpose mobile devices. There exists an inexhaustible number of mobile devices using several platforms from which users connect to the server sources of information. The most frequently used platforms are Android a iOS even though they are rather different.

The significant aspect of the regional development is accessibility and transferability of the information and service development based on the network technologies and the net economy (Jarolímek and Ulman, 2014). The situation seems to be the same in the area of agriculture, forestry, water supply

and distribution, countryside, food industry etc. For the obtaining of information more and more users employ smart mobile phones or tablets made by a lot of producers. From the users' point of view there is one major obstacle – the data connectivity. As soon as users leave with their device the high-capacity wireless connection (either with a partial or full mobility), their work with a mobile application is often spoilt by time-consuming data downloading.

Although the Digital agenda Strategy Europe 2000 emphasized (among other things) the importance of a wideband connection installation in the form of both a fixed connection and wireless networks (European Commission, 2010), the current situation is substantially different, especially in the Czech Republic. In rural areas users can often rely on the GPRS (General Packet Radio Service) or EDGE (Enhanced Data rate for GSM Evolution) connections only. Even under ideal conditions these connections allow only 80 kbps (kilobit per second) or 236 kbps respectively.

For the creators and operators of web or server applications there emerges a problem how to (under these conditions) provide for their customers a cheap, fast and effective mobile access. A server application cannot effectively provide its content and cannot function as a purposeful source of information unless there is a native client application provided for the mobile platform. This native client application must be adapted to the platform or to the intelligent responsive design (layout) of the web output, or perhaps to both. The orientation of native applications to concrete platforms puts serious obstacles in the path of the utilisation of different development environments, technologies and API which inevitably leads to waste of time and effort including higher expenditure on maintenance (Xanthopoulos and Xinogalos, 2013). Therefore there is a dilemma if to produce costly but (thanks to the optimization) fast native applications with a difficult implementation of data synchronization (Miravet at al., 2014), or if to produce a response output of the content itself which can also become more expensive (taking into account users' habits). Nevertheless, in the web access there are usually a lot of compromises, in comparison with native applications (Harrington at al., 2013). The whole process of the development of web applications, which use the native functions of a mobile device, should be based on the architectural MVC model (Model View Controller) (Francese at al., 2013).

For the applications aimed at a user interface it is appropriate to use jQuery Mobile, for intermediate and the most complicated applications it might be more appropriate to use Sencha Touch (Heitkötter at al., 2013). As a certain compromise might also serve the utilization of a hybrid framework which – thanks to the utilization of a nucleus for the processing of web technologies – shows certain qualities of a web access.

One of the options of development can be the utilization of cross-platform tools in the frame of one code base. For the development of business applications a hybrid framework might be the best (Vitols at al., 2013), nevertheless it might not be suitable always or in all cases (Klima and Selinger, 2013). The utilization of hybrid frameworks for the development and maintenance of applications across various platforms also bears some safety risks (Singh, 2013). It is necessary to eliminate safety threats of mobile applications as much as possible but this work is not easy at all.

According to Heitkötter two frameworks (PhoneGap, Titanium Mobile) can cover the gap between the development of web and mobile applications (Heitkötter at al., 2012). There is another possible approach – the utilization

T-Mobile O2 Vodafone

Source: T-Mobile, O2 and Vodafone

Figure 1: Maps showing the coverage of the Czech Republic with the mobile high-speed Internet.

of PIM (Platform Independent Model) in MDD (Model Driven Development) (Choi at al., 2009).

Modern information sources in the agrarian sector have to react flexibly to current tendencies in technology and to users' demands. In order to keep their quality level they have to offer at least an optimum output for the browsers of mobile devices, or perhaps both a native and a hybrid mobile application.

Materials and methods

One of the most frequently visited information sources of the agrarian sector in the Czech Republic is the agrarian WWW portal Agris. The main aim of the agrarian WWW portal Agris is to create a unified on-line information space on the Internet for the area of the agrarian sector (agriculture, food industry, forestry, water supply and distribution) and rural areas. The task group of users consists of enterprises' managers, managers from state and local administration, students, all consumers of food and inhabitants of rural areas. The development and implementation of the current version of the agrarian sector web application took place from 2010 to 2011. It was created with the use of the most modern trends as a flexible and robust web application (Šimek at al., 2011) serving in full to users accessing primarily from personal computers. For the efficient identification of individual papers, their administration, sorting and distribution, the individual papers are described by metadata in the DC (Dublin Core) and VOA3R Metadata AP (Virtual Open Access Agriculture and Aquaculture Repository Metadata Application Profile) format which was especially developed for the description of agricultural data and information (Šimek at al., 2013).

From the long-term outputs of the Google Analytics application follows that more and more users access the agrarian portal from mobile devices (ca. 10% of almost 30 thousand visitors a month), first of all from the Android and iOS platforms. Therefore it is necessary to make for them an effective access to the content of the portal with the utmost reduction of time needed for downloading of the content itself into mobile devices.

Ensuing from the analysis and design of the optimum access from mobile devices, the requirements on the mobile application of the agrarian WWW portal Agris are as follow:

- possibility to be functional off-line (the batch downloading of new papers for the extra off-line work with papers);
- the implementation of all basic modules of web application
  - papers – the display of news information
  - prices – the possibility of going through the prices of agrictulural commoditites and graph generation
  - warnings;
- „A conservative design" based on a web application.

When analysing the used methods of mobile applications' development, the following parametres for individual kinds of mobile access were chosen:

Native application

In the case of a native mobile application there is the need of development for each platform separately - using various tools and technologies including the creation of updates. With the increasing number of platforms the length of needed time grows, too; and so do the costs of mobile applications' generation and maintenance. Nevertheless there is the advantage of an optimum result in the form of stable and fast mobile applications with a possibility to work off-line.

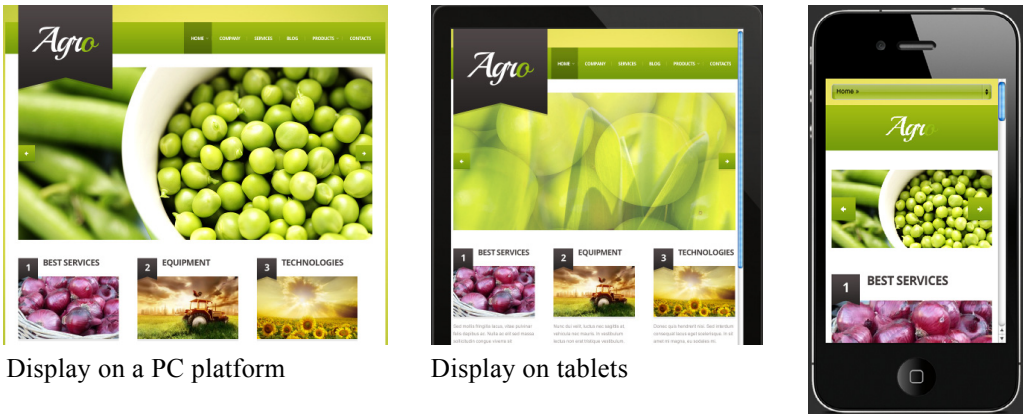
Hybrid application

The advantages of hybrid applications lie in the fast development, fast updates and relatively easy extension of application. The opposite could be a non-optimum result.

Web mobile application

The major advantage of the mobile web application is an easy and very fast implementation with the help of an intelligent distribution of cascading style sheets for a web browser. Even though the result could be an effective responsive design of classic web application, users mostly use the permanent Internet connection for their work with a mobile application.

The above described three approaches to the creationof a mobile application and web will be consequently applied to the agrarian WWW portal Agris. Nevertheless the whole issue is of general nature because the coverage of rural regions with the high-speed wireless Internet connection is insufficient which is in contrast to the wide spread of modern mobile devices. Even though users have at their disposal a tool for working with information sources, they



Display on a PC platform

Display on tablets

Display on smartphones

Source: TemplateMonster.com

Figure 2: An example of a responsive design.

don't have at their disposal transmission capacity for the access to the information source. The whole issue could be efficiently solved by a native or hybrid application, or perhaps by a mobile web, with the possibility to work in an off-line mode.

Results and discussion

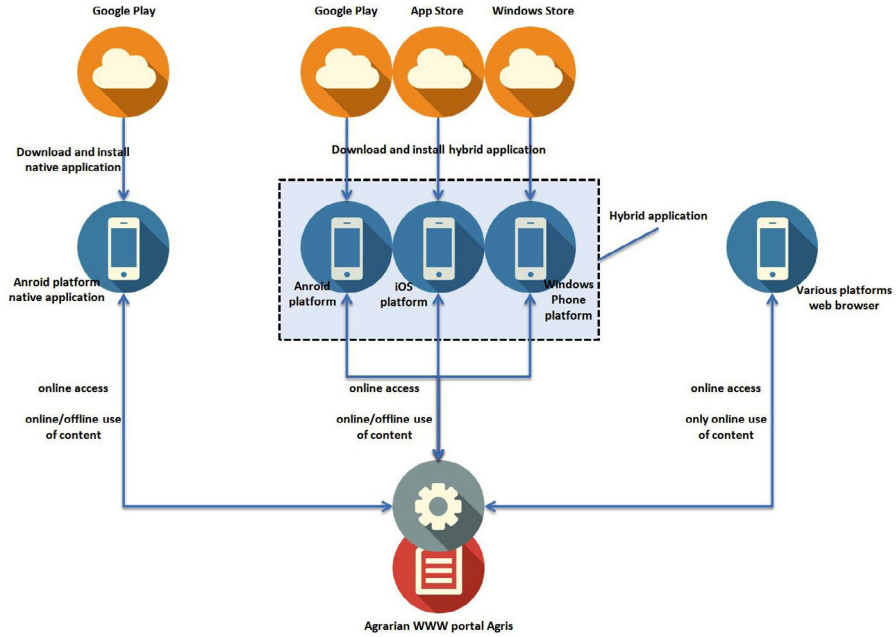
After a detailed analysis of rather very conservative users' preferences of the agrarian WWW portal Agris and after the analysis of possibilities of the creation of mobile access to the content of the agrarian WWW portal we moved to the creation of following types of mobile access:

1. native application for the Android platform;
2. hybrid application for platforms:
   a. iOS
   b. Android
   c. Windows Phone 8;
3. layout for mobile devices (a responsive layout).

This proposed concept will cover the greater part of mobile devices' users who access the agrarian WWW portal Agris (Figure 3).

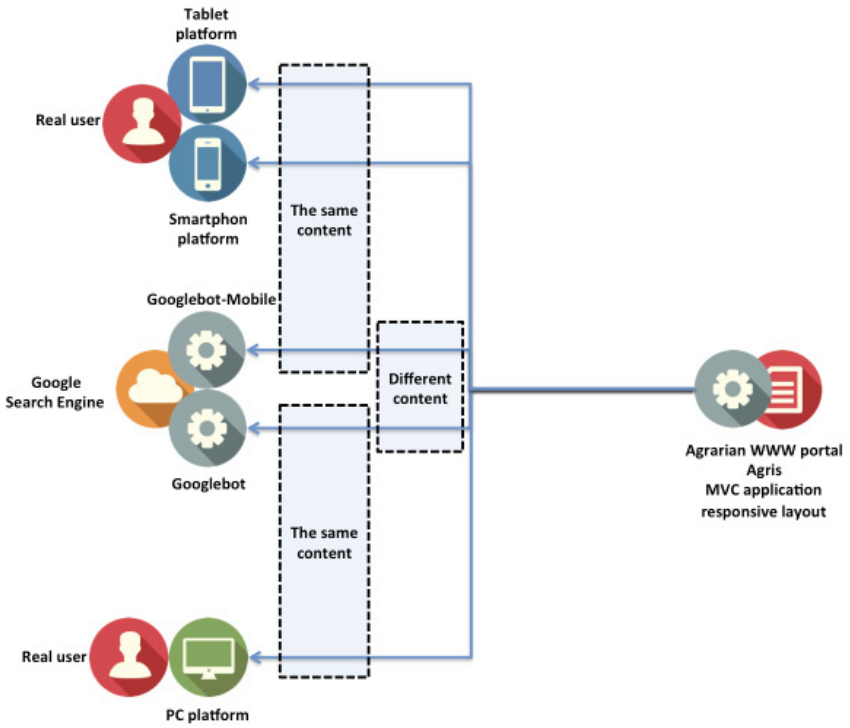
The final native application for the Android platform will be distributed via Google Play and the web interface of the agrarian WWW portal Agris. This way users can easily access the application and they can install it ito their mobile devices. The installed application will make for them accessible the content of the agrarian WWW portal in a user-friendly form. In the case of a high-quality and high-speed connection to the Internet they can work with the application in the online mode. Nevertheless, they can download the most up-to-date or chosen content into their application and consequently work in off-line mode, outside the high-speed connection: for example in the open ground, in plants etc. The final application was proposed so it would be easily sustainable. The sustainability is defined as the ability of the software product to be modified. The modifications include error corrections, improvements, adjustments owing to changes in the environment (individual OS versions), changes of requirements and changes of functional specification.

The hybrid application will be created with the help of PhoneGap platform. Thanks to this environment it is possible to create mobile applications which work on various mobile devices and platforms. The user interface of the emergent hybrid application is being developed with the use of web technologies such as HTML5 (HyperText Markup Language), CSS3 (Cascading Styles Sheets) and JavaScript. The developmental tools Phone Gap then transform the final files of HTML code, CSS and JavaScript into installation packages which are different for each platform. In the case of the agrarian WWW portal Agris the hybrid applications for Android, iOS and Windows Phone 8 platforms will be distributed via Google Play, App Store, Windows Store and the web interface of the agrarian portal. Users will be able to work with the portal content in both the online mode



Source: authors' own research
Icons source: IconArchive, Icons author : Pelfusion, http://pelfusion.com/

Figure 3: The proposed concept of the distribution of the agrarian WWW portal Agris content to various mobile platforms.



Source: authors' own research
Icons source: IconArchive, Icons author : Pelfusion, http://pelfusion.com/

Figure 4: The distribution of the content for mobile platforms with the help of the responsive layout technology.

and off-line mode. The final applications are not only sustainable but transferable as well. By the transfer we mean the application transfer (export) from one environment (of a different operational system) into another one.

For the access from mobile web browsers the layout of the agrarian WWW portal Agris was redesigned in such a way that it is automatically formatted for the user depending on the display dimension and the differentiation of the final mobile unit. The big advantage is that the implementation of the responsive layout is fast and thanks to the existing architecture of the agrarian WWW portal Agris rather undemanding. For an optimum output users need a random web browser which is able to process valid HTML and CSS code. A disadvantage might be the need of permanent connectivity to the Internet which means that users can work with the content online only. The version for desktops and mobiles is run on one URL address but the content and format are fully adapted to the employed user agent.

The whole agrarian web portal is configurated in order not to be considered as masked (by for example a full-text Google browser) because that would lead to the elimination from search results. The main condition is for the same content to be submitted to the mobile Google robot (Googlebot-Mobile) and to the mobile browser used by the real user (Figure 4).

Conclusion

The innovation of the agrarian portal functionalities occurs thanks to the identification of users' habits while using the most utilized mobile Android and iOS platforms and thanks to the identification of the possibilities of the agrarian WW portal Agris. Thus, this innovation fills an information gap in the area of the mobile access to an important information source from the agrarian sector. The whole concept of the future solution is described in detail in figure 3: to cover all three possible ways of access from mobile devices we moved to:

- the creation of a native application for Android platform;
- the creation of hybrid applications for Android, iOS and Windows Phone platforms;
- the creation of an intelligent responsive layout of the agrarian portal web application where (depending on end devices) relevant cascading style sheets are used for the formatting of the final design with an optimum layout of control elements.

Native and hybrid applications will allow users to work in off-line mode, too. And in this mode they will be able to download the chosen content of the agrrian WWW portal Agris into their devices.

Even though the web access from a mobile web browser will allow users to work with the agrarian portal application in an optimum form including displays, control elements and functionalities, it will be possible in online mode only. Users are completely dependent on their connection to the Internet. This drawback will be eliminated after the implementation of a full coverage with wireless high-speed connection (for example LTE – Long Term Evolution) by mobile operators and a complete offer of mobile devices supporting such a connection. This proposed solution of mobile versions of the agrarian web portal Agris represents a universal solution of problems with mobile access to information sources when rural areas are not adequately covered with a high-speed wireless connection to the Internet, in contrast to a large extension of modern mobile devices.

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Corresponding author:
Ing. Pavel Šimek, PhD.
Department of Information Technologies, Faculty of Economics and Management,
Czech University of Life Sciences Prague, Kamýcká 129, 165 21 Prague 6, Czech Republic
Phone: +420 2 2438 2050, E-mail: simek@pef.czu.cz

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