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Papers in Economics and Informatics

http://online.agris.cz

ISSN 1804-1930
VII, 2015, 1

International scientific journal
Prague

Agris on-line Papers of Economics and Informatics

The international reviewed scientific journal issued by the Faculty of Economics and Management of the Czech University of Life Sciences Prague.

The journal publishes original scientific contributions from the area of economics and informatics with focus on agriculture and rural development.

Editorial office

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Publisher

Faculty of Economics and Management
Czech University of Life Sciences Prague
Kamýcká 129, 165 21 Praha 6 – Suchdol
Czech Republic
Reg. number: 60460709

ISSN 1804-1930

VII, 2015, 1

30th of March 2014

Prague

Agris on-line
Papers in Economics and Informatics

ISSN 1804-1930

VII, 2015, 1

Agris on-line Papers in Economics and Informatics

Volume VII Number 1, 2015

Content

Agris on-line Papers in Economics and Informatics

Volume VII Number 1, 2015

Technical Efficiency of Pineapple Production in Osun State, Nigeria

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Abstract

Pineapple is one of the most important fruits in Nigeria and it had been identified that the country has comparative advantage in its production. However, there is need for empirical studies on the technical efficiency of its production. This paper presents the analysis of technical efficiency of pineapple production in Osun state, Nigeria using stochastic frontier production function and resource use efficiency. Primary data was collected from 120 pineapple farmers using multi stage sampling technique. Results revealed that quantity of suckers and labour used in pineapple production was positive and significant at 5% while farm size was significant at 1%. The returns to scale indicated that a unit increase in all the specified production inputs will lead to a more than proportionate increase in pineapple yield by 2.1%. The mean technical efficiency of the pineapple farmers indicated that an average farmer could obtain about 93% of output from a given mix of inputs. The estimated gamma parameter revealed that 81.4% of the variation in output among the pineapple farmers was due to disparities in technical efficiency. Resource use efficiency indicated underutilization of suckers and overutilization of other specified production inputs. The study therefore recommends that farmers should cut down the use of resources that were over utilized and increase the quantity of suckers used in the production of the commodity for optimal productivity.

Keywords:

Pineapple productivity, technical efficiency, stochastic frontier, Osun state.

Introduction

In Nigeria, horticultural crops such as pineapple have a significant place. These crops not only contribute to the share of agriculture in national economy, but possess a great potential and comparative advantage to compete in the liberalized economy (Oguniyi, Oladejo, 2011). Pineapple has been identified as one of the horticultural crops with enormous potentials for nutritional and health benefits, foreign exchange earnings, industrial growth and development (Joy, 2010; Fawole, 2008; Fakayode et al., 2012). According to Ullah, (1980), the development of industrial uses of the crop will stimulate large scale production of the crops and enhance diversification of entrepreneurs to site processing plants in the rural areas which will improve the quality of life of the rural population and reduce the rate of rural-urban migration. Also the expansion of local industries for Pineapple can increase national income as well as provide higher incomes for farmers involved in its production (Fawole, 2008). In Nigeria, pineapple production is the main source of income for many farmers (Baruwa, 2013) hence they depend solely on it for their means of livelihood.

Among the top ten pineapple producing countries in the world, which include: Thailand, Costa Rica, Brazil, Philippines, Indonesia, India, Nigeria, China, Mexico and Colombia, Nigeria had the lowest productivity of 7.9 tons/ha when compared with the other nine top producers thereby, contributing a small share (6.1%) of the world pineapple production (FAOSTAT, 2012). An analysis of the trends in Nigeria's productivity growth on agricultural crops showed that technical inefficiency was mainly responsible for poor productivity performance (Adenikinju, 2005). The inefficiency problem was attributed to factors such as use of low input technologies, lack of knowledge of high input technologies and poor farm management skills, poor extension services, unavailability and high cost of inputs (Anyanwu, Obasi, 2010). The inefficient allocation of these resources by farmers had made Nigerian agriculture to remain at the traditional and rudimentary level (Michael, 2011). In addition, the productivity of these farmers was often affected by factors such as age, cropping patterns, years of farming experience and lack of access to credit which tend to impact negatively on productivity and efficiency (Obasi et al., 2013). This trend must

be reversed in order to enable Nigeria achieve its potentials and meet the goals of the Agricultural Transformation Agenda. One way peasant farmers (small scale pineapple producers) can achieve sustainable agricultural development is to raise the productivity of their farm by improving efficiency within the limits of the existing resource base and available technology (Amarasuruya et al., 2010).

Technical efficiency is a major component of productivity used in measuring farm performance (Lawal, 2007). It refers to the achievement of the maximum potential output from a given amounts of inputs, taking into account physical production relationships (Cesaro et al., 2009). Technical efficiency can be output, reflecting the maximum output that can be achieved from each input, or alternatively representing the minimum input used to produce a given level of output (Ogunniyi and Oladejo, 2011). Analysis of technical efficiency in agriculture has received particular attention in developing countries like Nigeria because of the importance of productivity growth in agriculture for overall economic development (Ogunlari, 2009). Gains in agricultural output through the improvement of efficiency levels are becoming particularly important nowadays since opportunities to increase farm production by bringing additional virgin land into cultivation or by increasing the utilization of the physical resources have been diminishing (Lawal, 2007). Furthermore, for individual farms, gains in efficiency are of great substance in periods of financial stress since efficient farms are more likely to generate higher incomes and thus, stand a better chance of surviving and prospering (Gil et al., 2007).

Previous studies on pineapple in Nigeria had been skewed towards market efficiency which includes those of Oladapo et al. (2007) who examined the market margin and spatial pricing efficiency of pineapple in Nigeria. Adesope et al. (2009) analyzed the Economics of group marketing of pineapple in selected markets of Osun state, Nigeria and Amao et al., (2011) analyzed the Economics of Pineapple marketing in Edo and Delta states, Nigeria. Empirical studies on the use of Stochastic frontier production function in determining efficiency in Horticultural crop production in Nigeria were also elaborated. Okon et. al., (2010) analyzed the technical efficiency and its determinants in Garden egg (Solanum spp) production in Uyo Metropolis, Akwa Ibom State, Nigeria, and Lawal, (2007) analyzed the efficiency of sweet orange production among small scale farmers in Osun State, Nigeria. However, no study had been documented for the technical efficiency of pineapple production in Nigeria to the best of author's knowledge. The study therefore examines the level of technical efficiency of pineapple production in Osun State, Nigeria in order to derive policy measures that will increase technical efficiency and thus productivity using a stochastic frontier production function.

Materials and methods

Study area

The study was conducted in Osun state, Nigeria. The state lies between latitude 7°30´N of the equator and longitude 4°30´E of the Greenwich meridian on a land area of about 9,251 km². Osun state shares boundaries with Kwara state in the North, Oyo state in the West, Ogun state in the South, Ondo and Ekiti states in the East (Osun State profile, 2004). The provisional 2006 population census result put the population of Osun state at 3,423,535 (NPC, 2006 Estimate), comprising mainly the Yoruba ethnic group. The people are predominantly peasant farmers cultivating mostly cash crops, food crops, fruits and vegetables as well as livestock production. According to Osun State Agricultural Development Programme (OSSADEP), the state is divided into three operational zones for administrative convenience - Ife/Ijesa, Iwo and Osogbo comprising of 30 local governments areas (Osun state, 2009).

The state has 2 distinct climatic seasons, namely the dry and wet season. The natural vegetation comprises moist evergreen and semi-evergreen forest and secondary forest, with mean annual rainfall ranging between 1400 to 2000 mm while mean annual temperature ranges between 25°C to 27°C thereby providing a conducive climate for growing most tropical crops like pineapple. Osun state was selected for the study because of its high volume of pineapple production in South west Nigeria. A multi-stage sampling technique was used in selecting respondents for the study. The first stage involved purposive selection of 3 local government areas that are prominent for pineapple production in Osun state which include Ayedaade, Ife East and Ife North, the second stage involved selection of 2 communities in each local government and finally a total of 120 pineapple farmers were randomly selected from the 6 communities based on probability proportionate to size.

Method of data analysis

Descriptive statistics was used to analyze the socioeconomic characteristics of the pineapple farmers while stochastic frontier production function (SFPF) was used to analyze the technical efficiency of the Pineapple farmers in the study area. The stochastic frontier production function independently proposed by Aigner et al. (1977) and Meeusen and Van Den Broeck (1977) assumes that maximum output may not be obtained from a given input or a set of inputs because of the inefficiency effects. The ideas of production function can be illustrated with a farm using *n* inputs: X_1, X_2,……, X_n, to produce output *Y*, efficient transformation of inputs into output is characterized by the production function *f*(X), which shows the maximum output obtainable from various inputs used in production. It can be written as:

$$Y_i = f(X_a; \beta) + \varepsilon_i \quad (1)$$

Where,
Y_i is the quantity of yield,
X_a is a vector of input quantities and,
β is a vector of parameters
ε i is an error term defined as:

$$\varepsilon_i = V_i - U_i \quad (2)$$

i = 1, 2, ... n farms

V_i is a symmetric component that accounts for pure random factors on production, which are outside the farmers' control such as weather, disease, topography, distribution of supplies, combined effects of unobserved inputs on production and U_i is a one-sided component, which captures the effects of inefficiency and hence measures the shortfall in output Y_i from its maximum value given by the stochastic frontier $f(X_a; \beta) + V_i$. The model is expressed as:

$$Y_i = \exp(X_i\beta + V_i - U_i) \quad (3)$$

The technical efficiency of production of the i-th farmer in the appropriate data set, given the levels of his inputs, is defined by:

$$TE_i = \exp(-U_i) \quad (4)$$

From equations (3) and (4), the two components V_i and U_i are assumed to be independent of each other, where V_i is the two-sided, normally distributed random error ($V_i \sim N(0, \sigma_v^2)$) and U_i is the one-sided efficiency component with a half normal distribution ($U_i \sim |N(0, \sigma_u^2)$). Y_i and X_i are as defined earlier. The *βs'* are unknown parameters to be estimated together with the variance parameters.

The variances of the parameters, symmetric V_i and one-sided U_i, are σ_v^2 respectively σ_u^2 and the overall model variance given as σ^2 are related thus:

$$\sigma^2 = \sigma_v^2 + \sigma_u^2 \quad (5)$$

The measures of total variation of output from the frontier, which can be attributed to technical efficiency, are lambda λ and gamma γ (Battese, Corra, 1977) while the variability measures derived by Jondrow et al., (1982) are presented by equations (4) and (5):

$$\lambda = \frac{\sigma_u}{\sigma_v} \quad (6)$$

$$\gamma = \frac{\sigma_u^2}{\sigma_v^2} \quad (7)$$

On the assumption that V_i and U_i are independent and normally distributed, the parameters σ^2, σ_v^2, σ_u^2, λ and γ can be estimated by method of maximum likelihood estimates (MLE), using the computer program FRONTIER Version 4.1 (Coelli, 1996).

The farm specific technical efficiency (TE) of the i-th farmer can be estimated using the expectation of U_i conditional on the random variable (*i*) as shown by Battese and Coelli (1995). The TE of an individual farmer is defined in terms of the ratio of the observed output to the corresponding frontier output given the available technology, that is:

$$TE_i = Y_i/Y_i^* = \exp(X_i\beta + V_i - U_i) = \exp(-U_i) \quad (8)$$
$$\exp(X_i\beta + V_i)$$

So that: O ≤ TE ≤ 1

Empirical stochastic frontier production function

This was assumed to be specified by the Cobb Douglas frontier production function which is defined by:

$$\ln Y_i = \ln\beta_o + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + V_i - U_i \quad (9)$$

Where subscript i refers to the observation of the i-th farmer, and

Y_i = pineapple yield (kg)
X_1 = quantity of sucker/ha (number)
X_2 = quantity of fertilizer used (kg/ha)

X_3 = total quantity of labour used (mandays)

X_4 = farm size under pineapple cultivation (ha)

β_i's = parameters estimated

ln's = natural logarithms

V_i = random errors which covers random effects on production outside the control of the decision unit

U_i = technical inefficiency effect which are the result of behaviour factors which could be controlled by an efficient management (Xu, Jeffrey, 1995) and are assumed to be 0 independent of V's.

In this study, the technical inefficiency was measured by the mode of the truncated normal distribution (U_i) as a function of socio-economic factors (Yao, Liu, 1998). Where U_i is defined by:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 \qquad (10)$$

Where: U_i = Technical inefficiency of the i-th farmer

Z_1 = gender (male =1; female = 0)

Z_2 = age of farmer (years)

Z_3 = years of education (years)

Z_4 = household size (number of persons)

Z_5 = years of farming experience (years)

These socioeconomic variables were included in the model to indicate the possible influence of the farmers' socioeconomic characteristics on the technical efficiencies of the farms (Adepoju, 2008). Correlation matrix was computed for the socioeconomic variables to test for multicolinearity among the variables. The efficiency of resource use was obtained from the estimated equation by comparing the marginal value product (MVP) with the marginal factor cost (MFC) of that input. The MVP of an input was obtained by:

$$MVP_{xi} = MPP_{xi} * P \qquad (11)$$

Where MPP_{xi} is the marginal physical product of input *xi* and P is the unit farm gate price of the output (q). The MFC for inputs was defined as:

$$MFC_{xi} = MPP_{xi} * r_{xi} \qquad (12)$$

Where r_{xi} is the unit price of input *xi*. Whenever $MVP_{xi} > MFC_{xi}$ there is under utilization of resource *xi*; $MVP_{xi} < MFC_{xi}$ there is over utilization of resource *xi* and $MVP_{xi} = MFC_{xi}$ there is optimum utilization of resource *xi*.

Results and discussion

1. Socio economic characteristics of the pineapple farmers

Results from Table 1 revealed that 88.3% of the respondents were males which implied that pineapple production in the study area was largely dominated by the males.

Socioeconomic variables	Frequency	Percentage
Gender		
Male	106	88.3
Female	14	11.7
Total	120	100.0
Age		
0-20	0	0
21-40	8	6.7
41-60	91	75.8
Above 60	21	17.5
Total	120	100.0
Years of formal education		
No formal education	22	18.3
1-5 years	11	9.2
6-10 years	53	44.2
11 years and above	34	28.3
Total	120	100.0
Household size		
1-5	80	66.7
6-10	36	30.0
11-15	4	3.3
Total	120	100
Farming experience		
1-5 years	5	4.2
6-10 years	16	13.3
11-15 years	70	58.3
Above 15 years	29	24.2
Total	120	100.0
Farm size		
0.1 - 1	110	91.7
1.1 - 5	10	8.3
Total	120	100.0

Source: Field survey, 2013

Table 1: Summary of the socioeconomic characteristics of the pineapple farmers in Osun state, Nigeria.

This conforms to the findings of Fawole (2008) and Baruwa (2013) that pineapple

production is male dominated. Majority of the farmers (75.8%) were within 41-60 years age group with mean of 54 years. This implied pineapple farmers in the study area were relatively old which can affect the rate of technology adoption, productivity and efficiency. Results further revealed that 66.7% of the farmers had household size of 1-5 persons with mean of 5 persons. The small household size of the respondents had a great implication on family labour supply as large household size has tendency to supply more family labour and vice versa and are capable of readjusting to sudden changes in labour supply at peak periods of labour demand (Oluyole et al, 2013). Most of the respondents (58.3%) had 11-15 years of experience in Pineapple production with mean of 13 years. This implied that most of the pineapple farmers had been into pineapple production over a long period of time which may necessitate the need to re-train farmers on improved techniques of production to increase output as farmers might still be attached to their regular old techniques of production. However farmers with more years of farming experience tend to be more efficient in production (Kudi et al, 2008). Results revealed, most of the pineapple farmers were producing on a small scale (0.1-1ha farm holdings) with an average farm size of 0.89 ha. The farmers used an average of 73 man days of labour/ha, 3765 pineapple suckers/ha and 463 kg of fertilizer/ha to produce an average pineapple yield of 21,658 kg/ha per production cycle (table 2).

2. Stochastic production frontier estimation

2.1. Production factors

Results from table 4 revealed that the coefficients of variables related to quantity of suckers (X_1) and total quantity of labour used (X_3) were positive and statistically significant at 5% while farm size (X_4) was significant at 1% implying that these variables were the factors affecting yield of pineapple farmers in Osun State and any increase in the value of these variables would increase pineapple production. This results conform to findings of Amarasuriya et al. (2010) in technical efficiency in intercropped pineapple production in Kurunegala District where the estimated maximum likelihood coefficients for land, plant density (which depends on the quantity of suckers used) and labour were positive and found to have significant impact on the technical efficiency of pineapple production in the study area. Okon et al. (2010) also reported in their study that quantity of planting materials, total quantity of labour used and farm size significantly affect technical efficiency of Garden egg farmers in Imo state. However the coefficient of fertilizer (X_2) was negative and not statistically significant which contradicts the findings of Amasuriya et al. (2010) that the coefficient with respect to the quantity of fertilizer used in pineapple production in kurunegala district, Sri lanka was positive and significant. Though it is widely known that the use of fertilizer improves crop production on farms but at some point, adding increasingly more fertilizer improves yield by less per unit of fertilizer and excessive quantities can even reduce yield.

2.2. Inefficiency factors

The estimated parameters of the inefficiency model in the stochastic frontier production function of pineapple farmers in Osun State were presented in table 4. Results revealed that the coefficients of parameter estimate related variables such as gender (Z_1), age (Z_2) and years of education (Z_3) were negative while Household size (Z_4)

Variable	Mean	Std. deviation	Min. value	Max.value
Yield	21,657.69	9,9824.33	8,372.86	88,696.8
Sucker	3764.53	190.08	3048	4572
Fertilizer	463.02	81.24	254	635
Labour	72.54	12.59	50.8	129.54
Farm size	0.89	0.31	0.2	2.4
Age	54.05	7.59	30	70
Education	7.49	3.87	2	17
Household size	5.03	2.22	1	19
Experience	13.29	4.09	2	30

Source: Field survey, 2013

Table 2: Summary statistics of yield and explanatory variables.

and farming experience (Z_5) were positive but not statistically significant on technical efficiency of pineapple farmers in the study area. This implied that these socioeconomic/inefficiency factors were less important in determining the technical efficiency of the pineapple farmers in the study area unlike the production factors. The results were consistent with the findings of Idris et al. (2013). He found that farmers' age, farming experience and education were not significantly related to technical efficiency of pineapple farmers in Samarahan, Malaysia. Amasuriya et al. (2010) also reported in his study on the technical efficiency in intercropped pineapple production in Kurunegala district, Sri lanka that education, age and number of family members (household size) did not have any significant impact on efficiency of the pineapple producers in the study area. Though the inefficiency variables were not significant, the sign of the inefficiency model of the stochastic frontier production function had important implications on technical efficiency. The positive coefficients for household size (Z_4) and farming experience (Z_5) indicated that these factors decrease the technical efficiency of the pineapple farmers while negative coefficients for gender (Z_1), age (Z_2) and years of education (Z_3) indicated these factors lead to increase in technical efficiency of pineapple farmers in the study area.

2.3. Correlation matrix

The correlation matrix for yield and socioeconomic variables was computed to verify whether the statistical insignificance of the socioeconomic variables on the technical efficiency of the pineapple farmers in the study area may be attributed to high multi-colinearity of the parameters. In using the correlation matrix to test for multicollinearity among variables, it is assumed that any pair of correlation coefficient that is more than 0.70 would pose serious multi-colinearity problems (Adeniyi, 2013). Thus, as shown in table 3, none of the variable pair of the correlation coefficient posed serious multi-colinearity problem that could be responsible for the insignificance of the parameters. However, table 3 showed in order of importance that household size > gender > years of experience > age > years of education were all positively correlated with yield in the study area.

2.3. Variance parameters

Table 4 revealed that the estimated sigma squared ($\sigma^2 = 4.38$) was statistically different from zero at 5% level of significance. This indicated a good fit of the model and the correctness of the specified distributional assumptions of the composite error term. The variance ratio (gamma = 0.81) which can be interpreted to mean the differences between actual (observed) and frontier output are dominated by technical inefficiency indicates that systematic influences that are unexplained by the production function are the dominant sources of random error (Okon et al., 2010). The results from table 4, revealed that about 81% of the variation in yield among Pineapple farmers in the study area was due to the differences in their technical efficiencies while 19% would be due to random effects.

2.4 Elasticity of production and returns to scale (RTS)

Results from table 4 revealed that a unit increase in the number of suckers used will correspond to a more than proportionate increase in pineapple yield by 1.3%. While a unit increase in the quantity of labour and farm size (ha) used will lead to a less than proportionate increase in pineapple yield by 0.50% and 0.50% respectively. A unit increase in the quantity of fertilizer used corresponds to a less than proportionate decrease in pineapple yield by 0.22%. The value of returns to scale, which is the summation of the elasticity of production of the variables involved in pineapple production was 2.1 (table 4). This implied increasing returns to scale, indicating that an increase in the use of all specified production inputs

Variables	Output	Gender	Age	Years of education	Household size	Years of experience
Output	1					
Gender	0.072	1				
Age	0.048	-0.148	1			
Years of education	0.015	0.091	-0.266	1		
Household size	0.147	-0.031	0.353	-0.110	1	
Years of experience	0.063	0.048	0.4548	-0.214	0.334	1

Source: Computed from survey data, 2013.

Table 3: Correlation matrix for yield and socio-economic characteristics of pineapple farmers.

Variables	Parameter	Coefficient	Standard error	T-ratio
Production function				
Constant term	$ß_0$	0.90811814	1.3993742	0.6489459
Number of suckers used (X_1)	$ß_1$	1.32686020	0.5378930	2.4667736**
Quantity of fertilizer used (X_2)	$ß_2$	-0.21939091	0.1554340	-1.4114727
Total quantity of labour used (X_3)	$ß_3$	0.50447788	0.2175497	2.3189092**
Farm size (X_4)	$ß_4$	0.50304837	0.09705917	5.1829043***
Inefficiency model				
Constant term	Z_0	0.51954112	0.42943420	1.2098271
Gender	Z_1	0.01062548	0.04856982	0.21876713
Age	Z_2	-0.04968262	0.17875332	-0.27793957
Years of education	Z_3	-0.01462249	0.01508117	-0.96958601
Household size	Z_4	0.023281710	0.04039317	0.57637744
Years of experience	Z_5	0.135570150	0.01446367	0.93731477
Variance parameters				
Sigma squared	σ^2	4.3796927	4.1158574	1.6401022**
Gamma		0.81362837	0.19528440	4.1663767***
Log likelihood function		90.715764		
LR test		13.608830		
No. of observations	120			

Note: *** = significant at 1%, ** = significant at 5% level of probability, * = significant at 10% level of probability

Source: Computer printout of FRONTIER 4.1c, using field survey data, 2013.

Table 4: Maximum likelihood parameter estimates of stochastic production frontier of pineapple producers in Osun State, Nigeria.

Inputs	MPP	MVP	Unit price of input (₦r_{xi})	MFC	Efficiency ratio
Sucker	1.3269	66.345	20	26.538	2.50
Fertilizer	-0.2194	-10.97	140	-30.716	0.34
Labour	0.5045	25.23	1500	756.75	0.03
Land	0.5030	25.15	4029	2,026.59	0.012

Source: Field survey, 2013

Table 5: Relative efficiency of input use.

would result in more than proportionate increase in the yield of pineapple.

2.5. Resource use efficiency

The result of the resource-use efficiency was given in table 5. The unit farm gate price of pineapple was N 50.00/kg. Result indicated that suckers were under-utilized as MVP > MFC while fertilizer, labour and land were over-utilized as MVP < MFC. This means that increase in the use of suckers will lead to further increase in output. Specifically for every amount spent on suckers, the returns from pineapple will increase by N 2.50. However for production inputs with MVP < MFC, there is need to cut down the level of resource use until the marginal value product and the marginal factor cost of each resource are at equilibrium in order to attain optimal allocation of the resources (i.e. MVP = MFC).

2.6. Technical efficiency estimates

Table 6 showed the frequency distribution of the pineapple farmers in the study area according to their Technical efficiencies in production. Results revealed, estimated technical efficiencies of the pineapple farmers ranged between 0.69 and 0.98 with a mean technical efficiency of 0.93. This implied that on the average, farmers are able to obtain 93% of potential yield from a given mix of production inputs.

Efficiency level	Frequency	Percentage
0.61-0.70	1	0.83
0.71-0.80	7	5.83
0.81-0.90	23	19.17
0.91-1.00	89	74.17
Total	120	100.0
Minimum value	0.69	0
Maximum value	0.98	6.7
Mean technical efficiency	0.93	75.8

Source: Field survey, 2013

Table 6: Frequency Distribution of Technical Efficiency of Pineapple farmers in Osun State, Nigeria.

In the short run, there is scope for increasing Pineapple yield by 7% through the adoption of the techniques and technology employed by the most technically efficient Pineapple farmer in the study area at no additional cost. The implications of the result is that an average Pineapple farmer in the study area could realize 6% cost savings {i.e. 1-(0.93/0.98)*100} to achieve the technical efficiency level of his most efficient counterpart while the most technically inefficient Pineapple farmer in the study area could realize 30% cost savings {i.e. 1-(0.69/0.98)*100}.

Conclusion

The study analyzed the technical efficiency of pineapple production in Osun state, Nigeria using stochastic frontier production function approach and resource use efficiency. Results indicated that production factors such as quantity of suckers, labour and farm size used in pineapple production were significant and more important in determining the technical efficiency of the pineapple farmers in the study area. The return to scale was 2.1. This indicated stage 1 of the productivity zone showing an inefficient allocation and utilization of resources. Resource use efficiency indicated underutilization of suckers and overutilization of labour, fertilizer and farm land used in pineapple production. Despite the fact that about 90% of the farmers in the study were technically efficient, there is scope for improving technical efficiciency and productivity through investments in research and development and adoption of techniques and technology at no additional cost. The study recommends that farmers should cut down the use of resources that were over utilized and increase the quantity of suckers used in the production of the commodity in order to attain optimal allocation and utilization of resources for enhanced productivity.

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Agris on-line Papers in Economics and Informatics

Volume VII Number 1, 2015

Web Interface for Education of Mentally Disabled Persons for Work in Horticulture

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Anotace

Předkládaný článek se zabývá tvorbou vhodného webového rozhraní pro vzdělávání osob s mentálním postižením pro práci v zahradnictví. Výzkum je založen na testování několika forem webové navigace skupinou mentálně postižených. Testování probíhalo po dobu sedmi týdnů v modelovém kurzu, který seznamoval účastníky s pracovními činnostmi v zahradnictví. Dílčím výzkumem bylo také identifikováno vhodné zařízení pro práci s webovou podobou modelového kurzu. Formulované výsledky byly na modelový kurz zpětně aplikovány a využity pro účely reálné podpory vzdělávání mentálně postižených pro práci v zahradnictví.

Klíčová slova

Přístupnost, webové rozhraní, mentální postižení, zahradnictví.

Abstract

This paper deals with the development of a suitable web interface for the education of persons with mental disabilities to work in horticulture. The research is based on the testing of several forms of web navigation by the group of mentally disabled persons. Testing was performed for seven weeks in a model course which acquainted the participants with working activities in horticulture. A partial research has also identified a suitable device and the form of control the web part of model course. Formulated results were retroactively applied to the model course and utilized for the purpose of a real support for education of mentally disabled persons for work in horticulture.

Key words

Accessibility, web interface, mental disability, horticulture.

Introduction

Integration in employment is perceived as a self-fulfillment of a person, which has a positive effect on self confidence. Training pathways and subsequent employment is a very important and significant milestone in the life of every human being. For the success in simple work activities in sheltered workshops or other customized workplaces people with mental disabilities need to get a number of usable skills and habits in the field of labor education. Everything what these people learn, increase their self-sufficiency, self-reliance and facilitate their surroundings of mutual coexistence. The problem of mentally disabled persons, unlike some of their unaffected peers, is excessive amount of free time that they cannot used effectively. The skills which they gather while working in the workshop, classroom, school, kitchen or on land, will help them alleviate this problem or remove it completely (Švarcová, 2006).

Entry to the open labor market is one of the most important expressions of the social emancipation of people with mental disabilities and also the culmination or the measure of success of previous educational work (Valenta, Műller, 2003).

Creating and implementing support programs for people with mental disabilities is beneficial also in terms of economy. Long-term care is more expensive than supported independence and meaningful work. Even low paid employment or part-time job gives a person with mental disability status of the adult who contributes to the society and this employment also efficiently stimulates and maintains its skills and habits

(Bartoňová, 2005; Černá, 2009).

People at medium and heavier level of mental disability are realized in the work under supervision - in sheltered workplaces. Other possibility is supported employment. The basic objective is to prepare people with severe disabilities for the performance of less demanding professions. These jobs are characterized by their monotony, and therefore are not sought. These include working as a kitchen helper or doing odd jobs in horticulture, etc. (Pipeková, 2010).

Tas and Tatnall (2010) reported that a significant number of people with mental handicap, learning difficulties, concentration disorder, or other special needs require help and support for their education. Mesiti et al. (2011) adds that the use of ICT and also Internet plays important role in the shaping of knowledge and skills of these people.

Assistive Technology used by mentally disabled persons

The term Assistive Technology (assistance aids) means tools that help to improve physical, sensory or mental functions of people who have these functions reduced for different reasons. Assistive Technology serves people with disabilities as a tool how to deal with their disability, and also help to ensure that those persons may live as well as a healthy population (Keblová, 2006).

Persons with mental disabilities benefit from the assistive technologies in particular to facilitate communication. These devices include:

- Communication tables;
- Large-scale buttons with voice output;
- Tabular communicators.

Besides the buttons and tabular communicators there could be used a special kind of software which is controlled mainly by the touch screen (Kantor, 2012).

The above mentioned findings show that the inclusion of people with mental retardation in the working collective is vital. Mentally disabled persons people with disabilities can realize themselves especially in simple and monotonous work activities. Therefore horticulture is one of the alternatives where they can succeed.

Materials and methods

Research for development of the web interface for education of mentally disabled persons for work in horticulture was regularly attended by eight participants. Research participants were people with varying levels of mental disability. In all cases, these people permanently live in nursing homes or centers for persons with disabilities, they are not currently employed anywhere and within therapeutic activities they work in sheltered workshops, etc. (Table1).

Down syndrome, also known as Down's disease (morbus Down) is the most common form of mental retardation. People with this syndrome constitute about 10% of the population of all persons with mental disabilities. Due to the fact that the disorder is widespread and its diagnosis is relatively easy, its symptoms are well known to all professionals working with people with mental retardation. (Švarcová, 2006).

Perinatal encephalopathy, also called cerebral palsy is the name for a whole group of nerve disorders, either congenital or acquired early. Perinatal encephalopathy is the cause of various handicaps at a later age children - motor disorders,

	Age	Level of mental retardation (oligophrenia)	Kind of disorder	Associated disability
participant A	60	mild	Perinatal encephalopathy	moderate visual impairment
participant B	47	moderate	Perinatal encephalopathy	-
participant C	48	moderate	Down Syndrome	-
participant D	52	mild	Down Syndrome	-
participant E	62	mild	Perinatal encephalopathy	-
participant F	53	moderate	Down Syndrome	-
participant G	37	moderate to severe	Perinatal encephalopathy	lower extremity motor function
participant H	49	severe to profound	Perinatal encephalopathy	motor disorder

Source: authors‘ own research

Table 1: List of research participants.

epilepsy, impaired intellectual functioning, sense organ disorders, character defects (Švarcová, 2006).

Education of persons with mental disabilities

Švarcová (2006) states that one of the most commonly used methods of education for children and adults with severe mental disability is so called Social reading. It is usually understood as cognition, interpretation and appropriate response to visual signs and symbols, pictograms, words and groups of words that frequently appear in the environment or in a broader context. To direct learning in a real situation should precede, and also follow after, the learning of these symbols in a controlled environment, eg. in the classroom or at home. Both stages should be accompanied by, using text, pictures or pictograms.

As examples of of this kind of teaching Švarcová (2006) presents a deep-seated and in society widely used kind of pictograms, which are traffic signs and traffic symbols. For their adoption it is necessary to acquaint students with symbols not only in class, but they must also learn the real environment where are those symbols are being used. Otherwise, people can better understand the importance of symbols in a real situation only after their experiencing in the preparation.

Pictograms are nonverbal information, perceivable formations created by drawing, writing, printing or other procedures. Commonly used in public places, buildings, for instructions and warnings. Their aim is to enable people quick orientation wherever the text messages might be an obstacle to understanding, eg. in transport or in hospitals. Each pictogram represents and depicts a factual significance (Gerlichová cited Kantor, 2012).

Špinar (2004) complements that for users with learning or concentration disabilities is a visual content in the form of eg. images or pictograms very important. These objects are able to focus their attention and illustrate the importance of content much better than dozens of lines of text. For this reason it is appropriate to use illustrative images, pictograms, visual bullets, photos, etc. However, to comply with the rules for visually impaired persons, it is necessary to describe each image carrying importance information by html "alt" atribute.

Existing experience confirms that this form of teaching and presentation of materials can actually lead to the improvement in education of people with mental disability and their better inclusion in the society in general and in particular in the field of horticulture (Benda, 2011).

From the above-described recommendations result a requirement for practicality and simplicity in the development of a web interface and also the web content. All textual information must be supplemented by visual content and in particular for Web interface and navigation. Across the interface it is appropriate to define a clear system of pictures and pictograms, accompanied by their clear text identification or label, which will be held throughout all the Web.

Results and discussion

On the basis of the acquired information there has been web interface for a model course prepared. This course substantively aims to prepare mentally disabled workers for work in horticulture.

Within the model horticultural course there was introduced unequivocal system of pictograms factually associated with individual horticultural activities. This system is not used only in the model course posted on the Web, but it is also referred to places associated with individual horticultural actions on the fields in the real garden.

On the principle of information visualization, and also because of the frequent repetition of the operations, study materials are created in the form of video-demonstrations. These demonstrations are further modified by post-production. Part of the postproduction of video materials describing the various horticulture activities is also enrichment of selected set of pictograms. In terms of materiality and simplicity there were illustrative pictograms selected in form of black and white images.

For a period of seven weeks of practical and theoretical training, research participants were gradually introduced to various video-demonstrations and also they were familiar with used pictograms in terrain. To verify the accuracy of assumptions, research participants were gradually invited to a web page to press correct navigation pictogram to launch the right movie describing the selected activity. Within four testing sessions there were presented four different websites with different forms of simple navigation:

- text horizontal navigation;
- text vertical navigation;
- picture navigation using applied pictograms;
- picture navigation using applied pictograms and short textual description.

Research participants were measured by time required to start the specified video-demonstration by pressing the navigation element by a finger on the capacitive touch screen device Shuttle PC. This device has been identified as the most suitable based on the associated research, which is mentioned bellow.

Testing of appropriate device for controlling the web page

During the first session with the participants it has been found that the use of a standard keyboard and mouse is unsuitable for them. For this reason we created a simple web page with two images that participants had to point and click.

Research participants tested desktop PC with the controls in the form of a standard keyboard and mouse as the first. Despite the relatively large size of presented images, mouse control was found to be unsuitable. Just a few participants were able to click on the desired image and the time required for navigation was unreasonably long.

To operate a website, to click on a desired image, using only the keyboard it was necessary to add of the attribute "accesskey" to the web source code. This attribute allows control by pressing ALT or CTRL + key associated with the attribute value. Description of the images has been extended by a number that represented it for a navigation.

The necessity of pressing two keys at once and remembering or re-tracing the required number again led to a disproportionate load and stress of participants. This form of navigation had to be described as substandard. Significant improvements in accuracy and speed of control has not been detected using a special keyboard "BigKeys" and very large trackball. For most participants, these were completely new devices and for the most of participants it would have required a long period of training to manage them.

Currently smart devices with a touch screen are very popular. Based on data of the StatCounter (2015) mobile devices with touch screen (phones and tablets) form more than 38% of platforms using Internet.

The latest research data about the use of this kind of communication technologies by agricultural enterprises in the Czech Republic (carried out by the Department of Information Technologies, 1 August, 2014 Faculty of Economics and Management, Czech University of Life Sciences Prague) show that 43 % of respondents use smart mobile devices for various purposes. Even though only a part of these users utilize their devices for the access to the Web statistics shows an incessant increase in this respect, too (Stočes et al., 2015).

Assuming the possibility of using mobile devices to browse the created web and even the model course also in the terrain, there has been gradually tested three different devices with touch screen:

- Tablet ASUS (resistive touch screen);
- iPad2 (capacitive touch screen);
- PC Shuttle X 5020XA Plus (capacitive touch screen).

Using a device with a touch screen has proved to be very suitable. Navigation of web become more intuitive for participants. Using the touch pen (stylus) in case of resistive ASUS tablet touch screen has once again led to delays in navigation. On the contrary pressing it by a finger were performed by participants quite naturally and with a high accuracy. In addition, this form of navigation could be used by all participants in the research.

An effective control of devices by participants reached especially if the device was placed on solid surface and they have not to hold it with the other hand. Possible need of so called multi-point or multi-touch control of device proved to be also inconvenient. Once the content of the web page was not been customized to the resolution of a device display and participants were forced to use both vertical and horizontal scroll bar, this situation caused delays in navigation and loss of concentration again. When there was an iPad2 used in this case, it was necessary to use multi-touch to zoom the web page. This feature could effectively handle none of the participants.

From the made examinations implies that the website must be able to adapt the resolution of the device used by the user. If not this state makes difficulties to navigate and use the web page by all users. Lestari et al. (2014) notices, that this condition may cause hidden critical links, hidden components, as well some hidden important information that should have been presented to users without needing them to do horizontal scrolling thus decreasing the deliverable effect of certain values from website. Moreover, it can decrease website experience for website users at all.

The appropriate solution is to use responsive

design. As Marcotte (2011) stated, under this designation it is understood the design of websites that automatically adjusts the width of the display device. It is a modern approach to creating websites and also a compromise between the fixed design, so the design with a fixed width content, and a fluid design with variable width content.

After the application of responsive design principles and the location of the device on a solid surface, participants were able to click on the images pretty fast and virtually flawlessly pass. Participants selected PS Schuttle device as the most applicable especially for the optimal dimensions of a diagonal size of the screen and robustness.

According to the conducted research and in comparison with scientific publications (van de Ven and de Haan, 2003; Lee and Forshay cited Denaes, 2012; Huguenin, 2000) can be mentioned touch screen as the most suitable technology for controlling web page by persons with mental disabilities. Lee and Forshay (in Denaes, 2012) specifically states: "Touch screen computers seem to be the best option for this population because their movements do not need to be as precise as with the computer mouse. Besides, the touch screen is also known to improve the motivation and the attention span of the participants."

Selection of appropriate web interface

As already mentioned, four kinds of web interface was therefore tested by research participants using the PC Shuttle device with touch screen on a web page created by the principles of responsive design. Participants were measured by time required to start the specified video-demonstration by pressing the correct navigation element represented by pictogram by a finger.

To the each participant there was defined an objective to find concrete horticulture activity and display correct material. The timer was started after setting of an objective and it was stopped after the participant displayed the required material. The measured time of each participant is presented in table 2.

Values are rounded to whole seconds using a mathematical rounding. For the final evaluation there were selected only those participants who attended all the measurements and the health status allowed them to independent browsing of presented web interfaces. Only the results of five participants were included in the overall assessment at the end. During the measurement, there were only two wrongly or incorrectly displayed materials. These measurements were not included in the results and participants were able to start again.

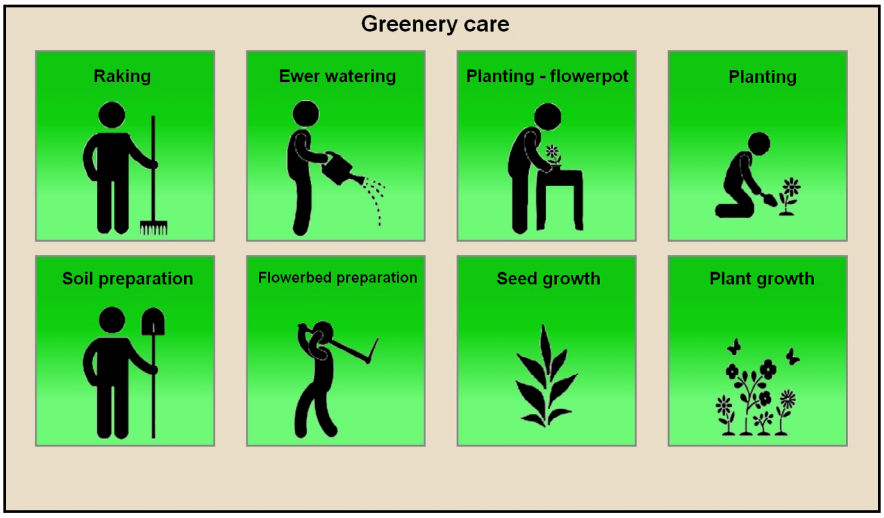
During the observation of the each participant it was found that with a purely textual navigation most of them read the whole navigation first and then returning back to the required item by re-reading the entire navigation from left to the right. Noticeable are the differences between horizontal and vertical arrangement of the navigation. The vertical arrangement of individual items caused slower reading and worse overall orientation in navigation.

When using image navigation represented only by pictograms there was groping whether the pictogram truly represents the desired horticultural operation. By combining this type

	Text horizontal navigation	**Text vertical navigation**	**Picture navigation using applied pictograms**	**Picture navigation using applied pictograms and short textual description**
participant A	12	15	12	7
participant B	-	-	-	-
participant C	10	12	9	5
participant D	8	11	8	4
participant E	6	6	4	3
participant F	-	-	-	-
participant G	9	11	7	3
participant H	-	-	-	-
Arithmetic mean	*9*	*11*	*7*	*4*
Median	*9*	*11*	*8*	*4*

Source: authors‘ own research

Table 2: Measured values of time needed to reach the objective in whole seconds.



Source: authors‘ own research

Figure 1: final form of the web interface of the model course.

of navigation with text description all participants demonstrated the best results. Correct orientation in the web navigation consisted of the finding of learned pictogram and verifying the correctness also in a text label. In this case all participants pressed correct navigation pictogram without hesitation. All participants correctly identified pictogram as a navigation item and pressed it.

Performed observations and measured values show that the most appropriate form of web interface in the form of navigation is the use of pictograms with the text label (Figure 1).

Conclusion

The performed research shows that for the correct development of a web interface, there must be several factors considered. The first is the education of mentally disabled persons, which is based on a continuous exchange of information highlighted by pictograms. The second is the suitable form of control the web navigation by proper device. According to the conducted research and in comparison with scientific publications can mentioned the touch screen as the most suitable technology for controlling the web page. An effective control of devices by participants reached especially if the device was placed on solid surface and they have not to hold it with the other hand, zoom or scroll the content, or use the multi-touch. Because of the simple operation and control, the web page must adapt its content to the width of used device. For this reason it is also necessary to apply principles of responsive design during the creation of the web page. After the application of mentioned factors, performed observations and measured values presented that the most appropriate form of web interface for persons with mental disabilities is the use of simple pictograms with the text label.

Aknowledgement

The knowledge and data presented in the present paper were obtained as a result of the Grant No. 20151007 of the CULS Prague Internal Grant Agency titled "Innovative approaches to the use of ICT in education for mitigation of social exclusion" and the Grant No. 20151039 of the FEM CULS Prague Internal Grant Agency titled "Utilization of open data in the agrarian sector".

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Agris on-line Papers in Economics and Informatics

Volume VII Number 1, 2015

Several Comments on Creation and Use of PSE Indicator within Measuring of Financial Transfers to Agricultural Producers

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Anotace

Článek je věnován problematice indikátoru PSE. Cílem je vymezit pozici EU v rámci vybraných zemí OECD (zemí srovnatelné ekonomické úrovně). V této souvislosti je hodnocena nejen vývojová tendence tohoto indikátoru, ale především je věnována pozornost struktuře PSE. Dále článek analyzuje problematiku PSE ve vazbě na příjmy zemědělských producentů a zisk zemědělských hospodářství, protože souvislost mezi těmito kategoriemi je pokládána za významnou. Metodika odpovídá stanoveným cílům (horizontální a vertikální analýza, komparace). Závěry jsou prezentovány se smyslu: hodnocení vývojových trendů PSE, struktury PSE, vhodnosti metodiky stanovení indikátorů, analýzy vztahu PSE, příjmů a zisku.

Klíčová slova

Zemědělství, finanční transfery, odhad produkčních podpor, příjmy a zisk zemědělských hospodářství, Evropská unie

Abstract

The paper deals with problems of a PSE indicator. The aim is to delimit the EU position in the framework of selected OECD countries (countries of a comparable economic level). In this connection not only development tendency of this indicator is evaluated, but above all the attention is paid to the PSE structure. Further, the paper analyzes problems of the PSE in relation to incomes of agricultural producers and a profit of agricultural farms because the connection between these categories is considered significant. The methodology corresponds with set aims (a horizontal and vertical analysis, a comparison). Conclusions are presented in the sense: evaluation of development trends of the PSE, the PSE structure, suitability of the methodology of determination of indicators, analyses of the relation of the PSE, incomes and a profit.

Key words

Agriculture, financial transfers, estimation of production supports, incomes and profit of agricultural farms, European Union.

Introduction

An extent of supports flowing in agriculture has been already a subject of discussion hold at professional theoretical as well as practical level for a long time. At the same time, the amount of farmers´ supports is still more often criticized even by the laic public. In evaluation of agrarian support it is always necessary to starts from the fact that their level is the result of political (resp. agrarian-political) decisions and tools. The decisions are made at the levels of national governments, eventually of institutions of integrated units, as in case of the European Union (further only the EU), and change in dependence on aims of agrarian policy and on domestic and foreign economic and political environment.

The adopted measures in area of supports can be and they are of various character. For example in Europe measures are known in the historical context supporting overcoming of lack of foods (after the World War II) and vice versa solving food surpluses (e.g. the CAP reform from 1992); at this time measures for support of food safety, measures leading to maintenance or improvement of quality of the environment ("agri-environmental" measures), measures for maintenance of settlement in the country and supporting development of so called rural regions, measures supporting development

of entrepreneurial farmer activities, and many others including support of agrarian markets. Various supporting tools are used by both the advanced world countries (more significant farmer support), and countries less developed or developing (less significant support). In the advanced world the provision of supports in agriculture already from the beginning of their existence has one common and long-term aim – maintenance and growth of agricultural incomes. According to Anderson and Martin (2006) this aim is in fact the most important aim. It is possible to absolutely agree with this statement. Also other authors put brains to relation of financial transfers and farmer incomes in the area of support of commodity market, support and protection of agrarian markets, and differences among states, e.g. Tagermann (Tagermann, Koester 1977, Tangermann 2004), Bielik (Bielik, Juríček, Kunová 2007), Färber, (Färber, Seidel 2002) an others.

Measures which in practice have a form of agrarian-political tools are oriented in areas which influence incomes of agricultural producers in a substantial way. To illustrate this point we can name e.g.:

- institutional interventions in market environment of agrarian products (by means of set price system, e.g. by existence of intervention prices),
- subsidisation of inputs in agriculture,
- protective import barriers, which enable domestic producers to sell for higher prices than importers would offer (these are disadvantaged by treshold prices including customs duty and other costs). Domestic producers are in this way preferred to the interest of domestic consumers, i. e. purchase for as lowest prices as possible.
- on the contrary a support of domestic export (export subsidies),
- a support of use of services for agriculture,
- tax relieves as a part of agricultural supports (This advantage which moreover makes monitoring of supports more difficult, is pointed out by Wilhelm (2009),
- and others.

Because all mechanisms and tools of granting of agricultural supports differ in particular states, objectively there is need of a methodological approach which would enable to monitor the agricultural support rate in comparable way in various states and systems. In this area, OECD is active; so called indicators of agricultural support started to be monitored here in selected states from 1980´s. These indicators have passed several changes during its existence; nevertheless, their sense is still maintained.

1. to measure what economic effect of support they bring to farmers,
2. what is the rate of re-distribution of public means in favour of farmers
3. to serve as a basis for monitoring of impacts of agrarian policy
4. to be information which could enable an objective dialogue between farmers and national governments as well as among governmental organizations (resp. institutions of integrated units as the EU is) and supranational institutions (WTO, FAO, MMF, World bank)

At present states in the area of supports are compared by the help of four basic indicators and others which are derived from these basic ones. The basic indicators are:

- Producer Support Estimate (PSE) which monitors support in relation to farmers´ income,
- Consumer Support Estimate (CSE) which takes into account agrarian political transfers for consumers of agricultural commodities,
- General Services Support Estimate (GSSE) expressing support to services for agriculture (including research, education etc.),
- Total Support Estimate (TSE) expressing a rate of re-distribution of public means in favour of agriculture.

WTO brings other question. This approach divides supports flowing in agriculture according to their character into groups (box). So it distinguishes "Amber box" (support relating to the production), "Blue box" (supports connected with limitation of production), "Development box" (developing supports), "Green box" (supports deforming market in a minimal rate). „Aggregate Measure of Support – AMS approximates the most to the PSE indicators in this category. AMS includes supports tied to commodity (e.g. a support of market prices) in relation to the value of production. Effland (2001) dealt with problems of comparison of AOCD and WTO system. She states that in case of PSE and AMS the starting points and aim are moreover the same. However, methodology

and support structure are different. The PSE includes more kinds of supports than AMS and refers the supports to farmers´ incomes. AMS works with a narrower extent of supports and gives these in connection with the production value (OECD left this approach). On dates 1995 – 2007 of USA agriculture it documents significant quantitative differences between values of both the monitored indicators.

Materials and methods

Aim of the paper is to determine EU position within selected OECD countries (countries of a comparable economic level) by the help of indicator PSE. The EU will be in this connection compared not only by a development tendency of this indicator, but above all attention will be paid the PSE structure. The PES structure has a high predicative ability about agri-political orientation of supports flowing in agriculture and not big attention has been paid to it yet. Further the paper deals with problems of PSE in relation to incomes of agricultural producers.

The methodological side results from chosen aims. A starting point for analysis of PSE construction will be the existing methodology of OECD. Quantitative data will be analyzed by the help of horizontal and vertical analysis with subsequent comparison.

At present the PSE is monitored at two levels, at the level of agricultural commodities, and at the level of agricultural farms. The paper orientates on problems of monitoring of PSE at the farm level in national or supranational dimension (EU, OECD). The level of supports of producers is in this case monitored partially by the basic indicator PSE and partially by indicators derived from it: Percentage Producer Support Estimate (% PSE), Producer Nominal Assistance Coefficient (NAC) and Producer Nominal Protection Coefficient (NPC). NAC and NPC are considered moreover equivalent.

PSE is defined as: The annual monetary value of gross transfers from consumers and taxpayers to agricultural producers, measured at the farm gate level, arising from policy measures that support agriculture, regardless of their nature, objectives or impact on farm production or income. (OECD, 2013)

From the quantification point of view it is based on value of state budget contribution (in the EU also on contributions from the EU budget), i.e. on a value incurred by re-distribution of public means and other transfers advantaging agricultural producers.

$$PSEc = MPSc + BOTc, \quad (1)$$

where

PSEc = PSE of concrete country

MPSc = market price support

BOTc = other transfers

c = marks a concrete country

Indicator %PSE is defined *as a share of gross farm receipts (including support)*.

$$\%PSE = \frac{PSEc}{GFRc} . 100, \quad (2)$$

where

PSEc = PSE of concrete country

GFRc = Gross Farm Receipts

$$GFRc = VPc + BOTc, \quad (3)$$

where

VPc = Value of Production

BOTc = Budgetary and Other Transfers

$$NACc = \frac{GFRc}{VPc - MPSc}, \quad (4)$$

where *MPSc* = budgetary transfers

Producer Nominal Protection Coefficient (NPC): *The ratio between the Price received by producer (Including Payments per tonne of current output) and the border Price (measured at the farm gate)*

$$NPCc = \frac{VPc + POc}{VPc - TPCc - TPTc}, \quad (5)$$

where

TPc = Transfers to Producers from consumers

TPTc = Transfers to Producers from Taxpayers

Results an discussion

Analysis of PSE development and structure

PSE in historical context

Indicators of agricultural support have passed several changes in its history. The OECD Ministerial Council Decision 1982 on deepening of trade liberalization and reduction of protectionism brought a pressure on concerned countries in order

to reduce mainly such a rate of farmers support which leads to deformation of agrarian markets. By reason of comparison and check of support rate the already above mentioned indicators were introduced.

Considering the PSE – its second revision (see the table 1) is actual at present. Adjustments referred mainly to the indicator structure, it means, types of transfers were implemented or removed according to character of agri-political measures. However, changes happened also in the indicator construction and terminology.

The first form of PSE indicator (1987–1999) included substantially less transfers than today. In the PSE construction supports of market prices, direct payments, supports of reduction of inputs and services were taken into account. This structure corresponds with effort to catch rate of protectionism in particular countries (or supranational units), above all in the area of agrarian markets. Among others, Corden (1973) focused on deformation of agrarian markets in the 1960´s invoked thanks to protective measures in the area of foreign trade with agricultural commodities (import limitation, customs tariffs, export subventions). He warned of the fact that it is necessary to look at the protectionism as at a financial transfer. His approach was applied later in empirical measurement of agricultural support by Joslin (1975, 1998). The indicator was in this period called Producer Subsidy Equivalent (PSE) and was defined as "the payments that would be required to compensate farmers for the loss of income resulting from the removal of a given policy measure" (OECD 1987).

A sense of the given indicator clearly results from this definition – i.e. to monitor supports to agricultural enterprises as a compensation of income decrease which follows from agri-political interventions. The first EPS revision happens in 1998/1999. From the fundamental changes it is possible to mention the following:

- the indicator got a name Producer Support Estimate. This name reflected better the reality, it is not possible always and everywhere to catch up all support in full extent, however, it is dealt with their "estimation",
- from the structure general services were excluded and an individual GSSE indicator arose,
- the number of included supports increased by other areas with the aim to separate supports tied to production from the others.
- monitoring of supports tied to area/animals in actual and historical dimension started,
- the volume of supports no longer referred to the production value, but to so called gross farms receipts. Gross receipts do not represent real incomes of farmers, however, they are methodically determined as a sum of PSE from which supports of market prices and production values are excluded.

A subject of discussion a question became, whether to include also relieves in the support (tax, social, etc.), and if so, in what way. Solution of this problem was complicated by various systems of monitoring of relieves used in particular countries.

A result of the second revision (2007) is the current

1986		Revision 1997-9		Revision 2007	
A	Market price support	A	Market price support	A	Support based on commodity output (market price and payments based on output)
B	Direct payments	B	Payments based on output	B	Payments based on input use
C	Reduction in input costs	C	Payments based on area planted/animals number	C	Payments based on current A/An/R/I production required
D	General services	D	Payments based on historical entitlements	D	Payments based on non current A/An/R/I production required
E	Other	E	Payments based on input use	E	Payments based on non current A/An/R/I production non required
		F	Payments based on input constraints	F	Payments based on non-commodity criteria
		G	Miscellaneous	G	Miscellaneous

Note: A-Area, An-Animals Number, R-Receipts, I-Income
Source: The PSE Manual, OECD 2008

Table 1: PSE structure in historical context.

form of PSE. Six principles is taken in to account in the indicator construction which can be in introduce in a simplified form:

1. principle: includes criterion of clearly determined receiver. It is an agriculture enterprise (as a producer) whether its owner is an individual farmer or a group of owners.
2. principle: financial transfers accounting traceable,
3. principle: transfers resulting from general political measures, although they can influence agriculture, are not monitored,
4. principle: transfers are defined as "gross" (gross incomes). Producers´ costs (including taxes) are not included because they would change fundamentally the transfers to "net" incomes.
5. principle: supports refer to primary producers. Supports from tax payers are delimited by state budgets; in supports from consumers the consumer is understood as a buyer of agricultural commodities at the first level (processor, trade),
6. principle: political measure are divided according to implementation criterion for supports provided per production base (a unit of output, area, farm animal), support of production and sale, and others.

At present the structure of used indicator PSE is created by several groups: payments supporting commodity outputs (support of market prices, support of sale), payments supporting input use (variable/fixed) and support of services, payments provided for state of areas, animals and revenues with requirement of production (on current) and without the requirement of production (on non current) for the actual or historical state, and further various payments for no-commodity outputs and other supports. All above mentioned groups have either a direct or indirect relation to producers´ incomes, however, an influence on incomes are shown by all.

PSE development in selected countries

If we would like to obtain real information about the PSE development, it is necessary to start from the fact that two fundamental changes happened in this indicator´s construction: in 1997 and 2007. There were not only changes in ranking the particular kinds of transfers, but also the comparative base the production value was replaced by producers´ incomes. Therefore, it is not possible to monitor the period from origin of PSE (1986) to the present as a continuous time series. Therefore, 27 years of PSE existence was divided into 3 sections-periods which correspond with time validity the appropriate methodology (the 1st period 1986-1996, the 2nd period: 1997-2006, the 3rd period: 2007-present). At the same time it is not possible to compare (from a view-point of maintenance of principle of comparability) absolute values of PSE. For the comparison the variant of %PSE indicator was used.

In comparison of data in particular periods (see the table 2) in which the support of agricultural producers was measured by the help of %PSE it is possible to state that in all periods in the monitored countries there is an obvious decreasing tendency of representation of financial transfers in production value and incomes. We can obtain the orientation comparison from basic index (see the table 3). From its value it is obvious that the approach to reduction of supports differs from particular countries. More significant decrease of financial transfers in agriculture happens paradoxically in countries where their value is traditionally low (the USA, Australia with the exception of the 2nd period). On the contrary, where the PSE value is high a more significant decrease would be presumed, only very slow decrease in the PSE happens and in the 3rd period the PSE even grows (Norway, Switzerland, Japan). The reason for these facts can be among others also an approach of national governments to agricultural producers and agrarian lobbyism. Objectively the %PSE is influenced by development of volume of financial transfers and development of production value, resp. of gross incomes creating the comparative base. A standard situation leading to decrease in the %PSE is, if the base grows (production value, gross incomes) and also financial transfers grow, but slower (OECD, EU). In the monitored periods also other variants appear leading to development of %PSE. For example the %PSE decreased when the base grew and the value of financial transfers decreased (Australia, the USA), or the value of base decreased, but the value of financial transfers decreased faster (Japan). The %PSE increased when financial transfers grew faster than the base (Norway), or when the dimension of base decreased, but financial transfers grew (Switzerland).

From the mention it is obvious how different the approaches of agrarian policies to this sensitive

1. period (1986-97) - % Producer Subsidy Equivalent												
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
OECD	37.6	38.3	35.2	31.6	31.8	34.9	33.2	34.2	33.8	31.1	29.6	28.2
EU	38.6	41.6	37.4	29.3	32.9	38.3	34.5	36.7	35.6	34.8	33.8	32.2
Norway	69.6	71.9	69.6	65.7	71.3	72.9	70.3	69.4	70	64.3	66.3	38.3
Switzerland	74.5	76.8	77.2	65.1	71.1	72.5	63.9	70.2	71.9	64.2	68.6	69.1
USA	24.1	23.1	18.4	21.3	16.7	17.1	16.9	17.9	14.1	10.1	13.3	13.7
Australia	12.9	9.1	8.3	7.5	8	8.8	9.9	9.2	9	6.5	6.3	4.6
Japan	65.1	64.6	62.2	56.8	51.6	51.7	56.9	57.5	62.7	62.2	58	54.3
2. period (1998-2006) - %Producer Support Estimate												
	1998	1999	2000	2001	2002	2003	2004	2005	2006			
OECD	32.1	35.2	32.2	28.8	30.5	29.2	30.1	28.5	26.4			
EU	35.2	38.2	32.7	30.2	33.8	33.7	32.6	30.4	29			
Norway	70.8	71.2	66.5	65.3	73.7	71.1	66.3	65.8	64.1			
Switzerland	71.6	75.3	69.8	67.3	70.6	69.1	69.2	66.1	65.3			
USA	21.6	25.5	23.3	22.1	18.5	15.1	16.3	15.3	11.2			
Australia	4.9	3.9	3.3	4.7	3.7	3.4	3.6	3.6	4.5			
Japan	58.2	59.9	59.7	56.3	57.2	57.5	55.9	53.8	51.6			
3. period (2007-2011) - %Producer Support Estimate												
	2007	2008	2009	2010	2011	2012						
OECD	22	21	22.7	19.9	18.8	18.6						
EU	23.5	22	23.3	19.8	17.5	19						
Norway	55.6	59.4	61.2	60.1	57.7	63.1						
Switzerland	48.8	56	60.3	53.5	54.4	56.7						
USA	10	8.8	10.6	7.7	7.7	7.12						
Australia	5.1	4.4	3.1	2.7	3	2.3						
Japan	46.7	48.3	48.9	53.3	51.6	55.9						

Source: Monitoring and evaluation: Reference Tables. OECD.STATExtracts-Complete databases available via OECD´s iLibrary

Table 2: Development of %PSE in the period 1986-2011.

	1. period	2. period	3. period
OECD	0.75	0.82	0.85
EU	0.83	0.82	0.81
Norway	0.99	0.91	1.14
Switzerland	0.93	0.91	1.16
USA	0.57	0.52	0.71
Australia	0.36	0.92	0.46
Japan	0.83	0.89	1.2

Source: author

Table 3: Development of % PSE in all time periods, measured with basic index (base = starting year of the time series).

area are and how deceptive is to make unambiguous conclusion in the sense that the general interest is decrease of financial transfers flowing to support agricultural producers. Concerning the EU as a whole, a continuous decrease in the %PSE happens in all time periods, even if not so significant.

PSE structure

PSE structure changed in historical context (see the table 1).To the original supports included in PSE also other kinds of supports were added and on the contrary some general services were

excluded from PSE and they are an individual indicator at present. Ranking of particular kinds of supports is the methodological matter, however, also agri-political. If supports really exists, it is possible to discuss justification of their existence, nevertheless it is not possible to infirm their role and to decide within PSE which supports should be ranked and what should not because all has an impact on producers´ incomes.

Rather it is possible to thing about supports which are not included in the PSE and what incomes they also influence. It is dealt for example with inclusion of financial transfers flowing in agriculture from relieves on social security, relieves on fuels, transfers which are results of general political decisions concerning also agriculture etc. The problems of tax relieves for farmers were investigated by Wilhelm (2009), who monitors not only tax advantages (relieves) but also on the other hand he deals with the fact that some inputs in agriculture are tax-disadvantaged (e.g. taxes on pesticides, fertilizers). These transfers are applied in various countries in varying degrees; they are not included in the present methodology, and their quantification is difficult. Nevertheless, they exist and influence the producers´ incomes. the PSE is really an estimation serving above all for comparison, not a real value. The table 4 stating the present PSE structure in selected countries including the EU as a whole offers interesting results.

The support tied to the commodity market (category A) represents at average of monitored OECD countries the most significant item (47.6 %). Within this average there are significant differences. Norway and Switzerland show traditionally high values, on the contrary a small market support is in the USA, and zero support in Australia. In the EU as a whole, the support of commodity market represents only a fifth of all supports in the framework of the PSE. A strong interest of the Common Agricultural Policy (CAP) shows itself in decrease of deformation of agrarian market. Within the support of commodity market generally support of market prices is supported; a support of sale is not significant.

Also supports tied to inputs (category B) show big differences in the monitored countries. While in the USA and Australia they represents 30 – 40 % of all supports in PSE, in Norway and Switzerland they are minimal. Nor in the EU the value c. 14 % represents a significant financial means. Interesting is not only the representation of supports to PSE inputs, but also their internal structure. In the USA and Australia the emphasis is put on support of services for producers, in Norway and Switzerland supports of variable inputs prevail (In Australia they are zero). In the EU and Australia an emphasis is put also on support of fixed capital.

The categories C, D, E are represented by all forms of supports tied to the area, animals, receipts and incomes. Their sum creates an important part

	OECD (%)		EU(%)		USA (%)		Australia (%)		Norway (%)		Switzerland (%)	
PSE	**100**		**100**		**100**		**100**		**100**		**100**	
A	**47.6**	100	**20.9**	100	**11.9**	100	**0**	0	**51.6**	100	**44.6**	100
A 1		94		96		85		0		86		88
A 2		6		4		15		0		14		12
B	**12.4**	100	**13.9**	100	**32.5**	100	**38.3**	100	**5**	100	**1.6**	100
B 1		38		37		33		0		55		88
B 2		38		52		19		55		38		11
B 3		24		11		48		45		7		1
C	**14.4**		**17.3**		**26.8**		**23.6**		**30.9**		**23.5**	
D	**23.1**		**45.5**		**19.6**		**37**		**0**		**21.4**	
E	**2**		**2.1**		**9**		**1.1**		**0.2**		**3.5**	
F+G	**0.5**		**0.3**		**0.2**		**0**		**12.3**		**5.4**	

A-support based on commodity output, A1-market price support, a2-payment based on output, B - Payment based on input use, B1- Payment based on variable input use, B2- Payment based on fixed capital formative, B3-Payment based on farm services, C-Payment based on current A/An/R/I Production required, D-Payment based on non-current A/AN/R/I production non required, E-Payment based on non commodity criteria, F+G-miscellaneous payments
Source: author

Table 4: PSE structure in selected countries (=), 2012.

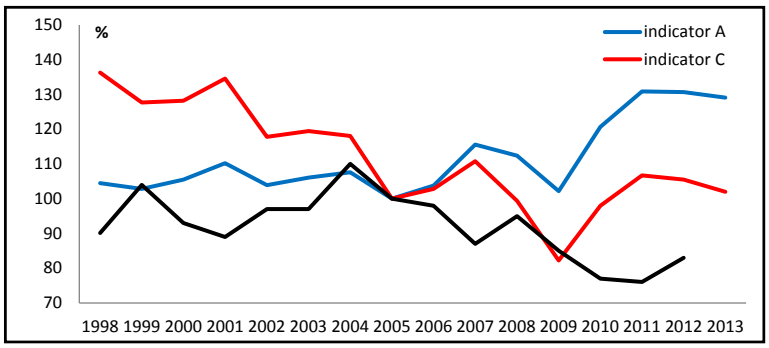
of the PSE moving in an interval of values from 48.8 % (Switzerland) to 64.9 % (EU).

Relation of PSE, incomes and profit of agricultural producers

It would be easy to adopt an idea that the financial transfers (PSE) increase agricultural incomes and profit of agricultural farms. On the EU example it is possible to demonstrate that this statement would be simplifying. The PSE contributes, as a subsidiary financial tool, to producers´ incomes, it cannot be denied; however, it does not mean that it is decisive factor in their creation. Especially it is true in the profit. Financial transfers in favour of producers are a significant item (without their existence incomes and profit would reach lower values), but besides them they are also other factors which have a relevant influence both in the area of inputs and the outputs. In the graph 1, development of absolute PSE values, agricultural incomes (indicator A) and profit (indicator C) are monitored by the help of basic index in the EU in the period 1998 – 2013. It is obvious that the monitored indicators do not always develop in the same way, and there are considerable differences in particular years. For example the PSE decreased, however, producers´ incomes and profit increased (2000, 2001, 2006, 2007, 2010, 2011). But vice versa, the PSE grew, however, incomes and profit decrease (1999, 2002, 2004, 2008, 2012). Only in 3 years (2003, 2005, 2009) the development of all indicators agreed.

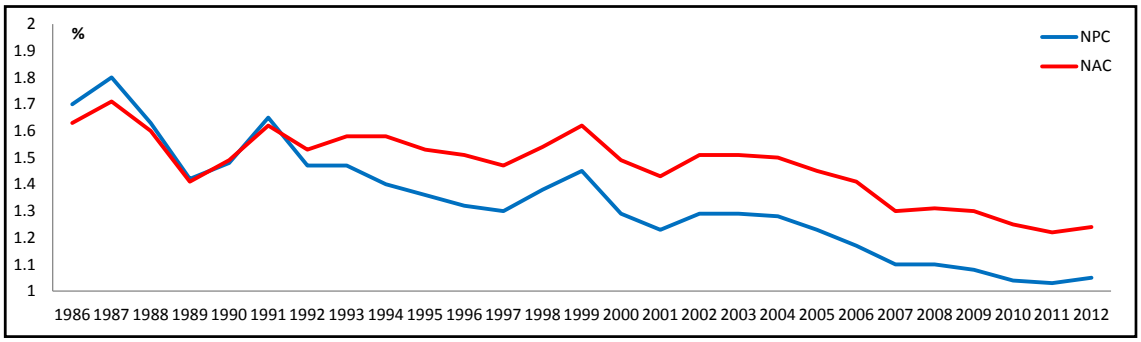
Producer Nominal Assistance Coefficient, Producer Nominal Protection Coefficient

NAC and NPC are indicators which in principle quantify differences between gross incomes, resp. the production value in price relations (including transfers) of the given country and gross incomes, resp. the production values, if they are expressed in world prices. They try to express a rate of protectionism for the given country, resp. given integration unit (the EU). From the graph 2 it is obvious that the development of indicators NAC and NPC is in fact identical in the EU. This fact leads sometimes to conclusions that VAC and NPC are equivalent in fact. Looking at the mentioned graphs it is clear that the development tendency is the same; however, values which characterize NAC and NPC are absolutely different. It is interesting that in the first period (1986 – 1997) the values



Source: own processing

Graph 1: Relation between PSE, EU agricultural incomes (A), gross incomes (OECD), and profit (C) in the EU, 1998 - 2012, (2005 = 100)



Source: own processing

Graphs 2: Development of NAC and NPC in development periods 1986-2012.

NAC and NPC moves relatively close together; in other time periods the values move apart more significantly. Therefore, it is not possible to evaluate these indicators as identical quite unambiguously.

Discussion

Results of analyses of concrete data of the PSE (see the summary) are very significant for agri-political measures. However, no less important is also what methodology led to the monitoring and calculations of the PSE. To this topic it is possible for all the questions discuss the following:

- above all it should be decided what all the PSE is about to express. At present, the PSE is understood as estimated financial transfer in favour to farmers from tax payers and consumers. As it is seen from the PSE genesis, kinds of financial transfers included in PSE changed with the effort to include as biggest number of transfers as possible, nevertheless it is obvious that all kinds of transfers cannot be caught up in accounting, so it is dealt only with transfers which can be caught up in accounting (the principle 2). As the first methodological step it is possible to consider a decision making whether:
  a) the methodology will be led by an effort to catch as biggest number of supports as possible or
  b) the methodology will refer only to significant kinds of supports.
- if the variant a) will be chosen, than it is necessary so that the most supports as possible were caught up in accounting in order that they could be qualified. Even in this case it will be always dealt with an estimation and not exact numbers. The more meaningful seem to be the variant b). For example at present when there is a world-wide pressure on reduction of supports deforming agrarian markets it would be suitable to categorize financial transfers in areas – agrarian market, production base, incomes and others. This categorization is easy regarding the internal PSE structure (see the table 4); however, the aggregated indicators do not enable this resolution. The commodity indicators are much more transparent. If particular categories of transfers show disproportions, than it would be very easy to react with agri-food tool.
- also it is possible to discuss the base with which the indicator PSE is compared. At present, this base is so called "gross incomes" (a value of production including support of market prices + the PSE cleaned from the support of market prices). It is obvious that not all financial transfers are tied to production; therefore it is possible to discuss why the construction of "gross incomes" is chosen just in this way. According to the 4th principle, deductions of costs and taxes co-creating "profit" are not included. It is possible to agree with that, nevertheless, all incomes originating from agricultural activity should be taken into account. In this case the biggest progress is the EU methodology quantifying agricultural incomes by the help of the general agricultural account.

Conclusion

The results summary concerns concrete findings on base of the PSE quantification. The methodological side was discussed above (see the Discussion).

Countries with high rate of support of agricultural producers (measured by the PSE) do not show more significant activities for its reduction; vice versa it grows in recent years (Norway, Switzerland, Japan). Countries with a traditionally low PSE value are more willing to decrease of the indicator (the USA, Australia). These different approaches are a result of national agrarian policies, including influence of agricultural lobby.

In the framework of the PSE, particular categories of transfer have various representations. The commodity market (A) is supported the strongest in the framework of the monitored countries in Norway and Switzerland, however, also the average value of OECD (48 %) document that it is in most countries. From the found out values it is possible to judge a significant fact that in countries where transfers in the commodity markets are decreased, these "saved" means are poured into categories of supports tied to the area, animals, and also revenues and incomes (C, D, E). It is interesting that countries which significantly support their farmers in the market areas have a minimal input support (Norway 5 %, Switzerland 1.6 %). The opposite are countries where market support is relatively low (the USA) or none (Australia). There these transfers represent 30 – 40 %PSE. The average value of OECD (12 %) also indicates the fact that

countries included in the monitoring mostly do not prefer the input support. It is worth noting also the fact that a desirable support of fixed capital inputs in agriculture is realized by Australia (55 %) and the EU (52 %). On the contrary variable inputs are supported in Norway (55 %) and Switzerland (88 %).

The EU development tendency of %PSE corresponds with strategic aims of the CAP – to decrease a share of supports in the production value (gross incomes). The decrease of indicator is not strong, but it is continuous (see the table 3). In the PSE structure in the EU as a unit it is obvious a tendency to decrease a share of support of agrarian market and to reduce thereby their deformations. According to the last published data the share of market support is 21 % (96 % is created by market price support, 4 % by sale support). Also input support is not a dominant item. On the contrary, transfers tied to production base (an area, a number of animals) as well as results (revenues, incomes) create 64 % PSE in the EU. This is an illustrative case when there are shifts among categories within PSE.

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Volume VII Number 1, 2015

Geomatic Concepts in Agriculture Thesauri

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Anotace

Zemědělské tezaury (například AGROVOC nebo NAL Agriculture Thesaurus) jsou velmi velké a robustní systémy formalizovaných znalostí. Jsou zaměřeny především na informace z oblasti zemědělství, nicméně i ony používají fragmenty informací a znalostí z dalších oblastí. A tak zahrnují i základní pojmy z oboru geomatiky. I přesto, že geomatické pojmy nejsou hlavní složkou výše uvedených tezaurů, hrají velmi důležitou roli v procesu detailního popisu zemědělských a dalších pojmů obsažených v tezaurech (zejména v procesu jejich měření, pozorování nebo mapování).

Tato studie posuzuje geomantické koncepty uvedené v AGROVOC a NAL tezaurech z hlediska geomatiky (ale s ohledem na metodiku vývoje a údržby tezaurů). Zaměřuje se na hodnocení podskupiny pojmů souvisejících s geomatikou a příbuzných vědeckých disciplín, jako je kartografie, fotogrammetrie, GIS a dálkový průzkum Země. Autoři studovali definice pojmů, jejich hierarchie, vztahy a i odkazy na další informační zdroje. Výsledkem je krátký seznam doporučení, jak zlepšit a obohatit výše uvedené tezaury z hlediska konceptů geomatické domény, což může vést ke zlepšení kvality tezaurů a jejich informační hodnoty.

Klíčová slova

Geomatika, tezaurus, sémantika, zemědělství, koncept.

Abstract

The agriculture thesauri (e.g. AGROVOC or NAL Agriculture Thesaurus) represent very large and robust systems of formalized knowledge. They are primarily focused on information related to agriculture. But they also use fragments of geomatic information and knowledge in a form of concepts and their terms. These concepts include general terms of all parts of geomatics as well as data instances (such as particular methods). Even though these concepts are not the main component of above-mentioned thesauri, the concepts from geomatic domain play very important role in a process of detail description of agricultural and other concepts (including processes of their measurement, observation or mapping) contained in thesauri.

This paper assess geomatic concepts in AGROVOC and NAL Agriculture Thesaurus from the view of geomatics (but with a respect to methodologies of thesauri development and maintenance). It means evaluation of the subset of concepts related to geomatics and close scientific disciplines such as cartography, photogrammetry, GIS science or remote sensing. Authors look into definitions of concepts, their hierarchy, relations and links to other information resources. As the result there is a short list of recommendations how to improve and enrich the above-mentioned thesauri from the view of concepts from geomatic domain. It can enhance the quality of thesauri and their information value.

The paper introduces the fundamental terminology (terms thesaurus, geomatics and concept) and related researches. Then a description of mapping of concepts in particular tools follows. The results of mapping are summarized in the part focused on the most frequent imperfections. The last section (with the exception of the final conclusion) presents the set of recommendations concerning usage of concepts from geomatic domain in agricultural thesauri.

Key words

Geomatics, thesaurus, semantics, agriculture, concept.

Introduction

Thesauri belong to very powerful semantic tools. They provide lot of information classified to groups based on broader and narrower term relations. The agriculture thesauri such as AGROVOC, CABI or NAL (National Agricultural Library's) Agriculture Thesaurus represent very large and robust systems of formalized knowledge from agriculture domain. They are primarily focused on information related to agriculture. But they also use fragment of geomatic information and knowledge in a form of geographic concepts. These concepts includes general terms connected not only to geomatics (e.g. "border", "Earth", "accuracy") as well as specific geomatic concepts (such as "remote sensing", "spatial data" or "photogrammetry"). Even though these concepts are not the main component of above-mentioned thesauri, the concepts from geomatic domain play a very important role in a process of detail description of agricultural and other concepts (including processes of their measurement, observation or mapping) contained in thesauri.

This paper assess geomatic concepts (concepts related to geomatics and close scientific disciplines such as cartography, photogrammetry, GIS science or remote sensing) in AGROVOC and NAL Agriculture Thesaurus semantically. Authors look into definitions of concepts, their hierarchy, relations and links to other information resources. As the result of research there is a list of recommendations how to improve and enrich above-mentioned thesauri from the view of concepts from geomatic domain. It can enhance the quality of thesauri and their information value.

The paper introduces the essential terminology (terms: thesaurus, geomatics, semantics and concept) and related researches focused on comparison of concepts and their evaluation. Than a description of methodology based on semantic factoring, similarity quantification and formal conceptual analyses follows. The results of evaluation are summarized in the part focused on the most frequent imperfections. The last section (with the exception of the final conclusion) presents the set of recommendations concerning using concepts from geomatic domain in agricultural thesauri.

Materials and methods

This paper deals with several terms that could not be frequently used in the agriculture domain. Therefore authors consider to publish their definition and explanation necessary.

Geomatics – scientific and technical interdisciplinary branch focused on collecting, distributing, storing, analysing, processing and presenting of geographical data or geographical information – is the young discipline of science dealing with spatial data and spatial technologies. Just the orientation to "spatial" is very important to the relation between geomatics and agriculture. Geomatics provides a large portfolio of data, technologies (including Global Navigation Satellite System), analyses and map outputs, which are essential in many sectors of agriculture such as precision farming, satellite farming, site specific crop management, sustainable agriculture or landscape and rural development.

Thesaurus is a lists of terms or concepts (notice: Terms and concepts represent different entities in the ontological and semantics theory, but for purposes of this article they will be used as equivalent words, because each term will be represented by concept), which is based on similarity of meaning of particular terms. It usually contains a hierarchical structure of terms or concepts (using the principle of broader and narrower concepts) and relations to synonyms and sometimes antonyms. Thesauri also provide an explicit explanation or definitions of terms similarly to dictionaries. More detail information on thesauri is available for example in the article Approaches To Thesaurus Production (Michiels, Noel, 1982) or Thesaurus Maintenance, Alignment and Publication as Linked Data: The AGROOVOC Use Case (Caracciolo et al., 2011).

In the article the two essential agriculture thesauri are compared. AGROVOC – multilingual agricultural thesaurus is managed by Food and Agriculture Organization (FAO) of the United Nations (UN). It consists of over 32 000 concepts available in 21 languages. AGROVOC is based on the SKOS (Simple Knowledge Organization System) standard (Bechhofer, Miles, 2009). AGROVOC is very open. It means not only providing of Linked Data, but above all a huge number of publication (e.g. Soergel et al., 2006, Sini et al., 2008 or Caracciolo et al., 2013) describing development and research of the thesaurus.

The National Agricultural Library's Agricultural Thesaurus – online vocabulary tools of agricultural terms is produced by National Agricultural Library, United States Department of Agriculture, and the Inter-American Institute for Cooperation

on Agriculture as well as other Latin American agricultural institutions. It contains about 98 000 terms in English and Spanish. The thesaurus uses SKOS standard. This thesaurus is also available as Linked Data. More information on NAL is published in document Alonso (2007).

Semantics as a research of meaning and its studying belongs among key tasks of contemporary sciences connected with information technologies, including geomatics. Particular studies are focused on a development of semantics models (Huang et al., 2010, Zhang, Xu, 2011, Wang et al., 2011, Zhang et al., 2014), collecting of semantic data and information (Hazman et al., 2009, Pazienza et al., 2012), linking of semantic data resources (Severino, 2007, Lauser, 2008, Lopez-Pellicer et al., 2010), semantic similarity (Bae et al., 2014, Batet et al., 2014, Jiang et al., 2014) or development of semantic data resources in various domains (An, Zhao, 2007, Ping, Yong, 2009, Li et al., 2013, Gimenez et al., 2013). Majority of above mentioned document, which are connected to geographic domain, constitutes the main theoretical background of this article as well.

The methodology of comparison of selected geomatic concepts in agriculture thesauri is composed of two basic steps – selection of suitable concepts and their processing. The selection of concepts is based on personal experience of authors as well as on domain dictionaries such as online Terminological dictionary of surveying and cadastre or International GIS Dictionary (McDonnell, Kemp, 1995). The final set contains 34 concepts: “accuracy”, “border”, “cartography”, “coordinate”, “dimension“, „Earth“, „feature“, „generalization“, „geodesy“, „geography“, „geoinformatics“, „geomatics“, „GIS“, „GNSS“, „GPS“, „imagery“, „landscape“, „map“, „map projection“, „mapping“, „metadata“, „morphology“, „photogrammetry“, „projection“, „raster data“, „remote sensing“, „scale“, „spatial data“, „surface“, „surveying“, „thematic map“, „topography“, „vector“ and „vector data”. The set includes common terms (e.g. “border”, “feature”), technologies (e.g. “GPS”, “GNSS”), sciences (e.g. “cartography”, “geodesy”) and specific geomatic concepts (e.g. “spatial data”, “map projection”).

Selected terms were processed by both descriptive and quantitative methods to test their occurrence in thesauri, similarity and position in the hierarchy of thesauri. To the comparison there are used descriptive methods of graphical scheme of hierarchies (based on broader and narrower concepts, which are the key components of SKOS standard) and other relations such as related concepts (similarly to Severino, 2007). Concepts were also processed by quantitative methods focused on computation of similarity using Formal Concepts Analysis (Wille, 1992), which is described with use of mathematical structures in Kavouras, Kokla (2007). The tested concepts are decomposed into primitives, which are in this case based on definitions (and other explicit descriptions) published in both thesauri. Based on the occurrence of primitive concepts the similarity according Tversky (1997).

Results nad discussion

In total 34 concepts connected to geomatics mentioned in previous parts of this article were compared. The both thesauri contain 21 of the set of tested concepts (61,76%, Table 1). It is result better than average, but it is necessary to mention two additional facts:

1. There are only 14 concepts (41.18%, Table 1) which are found in both thesauri simultaneously – “cartography”, “dimension”, “geodesy”, “geography”, “geomatics”, “gis”, “gps”, “imagery”, “landscape”, “mapping”, “photogrammetry”, “remote sensing”, “scale” and “topography”.
2. None of thesauri contain such a fundamental geomatic concepts such as “map”, “coordinate” or “border”. Moreover these concepts are quite general and overlap to other thematic domains, including agriculture.

A scant occurrence of concepts is not sufficient from the view of semantics. Users have to have more detail explicit information available to realize context and meaning of concepts. Thesauri allow to add descriptions or definitions to each concepts. But as it is evident from following table (Table 1), taking advantage of explicit descriptive information is not sufficient.

The following results are based on comparison of 2 concepts (“cartography” and “photogrammetry”) defined in both thesauri. These concepts are processed by methods described in the part Methodology.

Authors deal with two pairs of definitions:

“cartography”

- AGROVOC: The art and science of the production of maps. This includes

Thesaurus	Number of concept	Number of defined or described concepts
AGROVOC	21	9 (42.86% from concepts contained in AGROVOC; 26.47% from all tested concepts)
NAL	21	11 (52.38% from concepts contained in AGROVOC; 14.29% from all tested concepts)
AGROVOC & NAL	14	2 (42.86% from concepts contained in AGROVOC; 5.88% from all tested concepts)

Source: own processing

Table 1: Overview of concepts and their description in thesauri.

the construction of projections, design, compilation, drafting and reproduction.

- NAL: The art, science and technology of mapmaking.

"photogrammetry"

- AGROVOC: The science of obtaining reliable measurements from photographs.
- NAL: The science of deducing precise measurements from photographs.

All definitions are decomposed to single terms:

"cartography"

- AGROVOC (10): art, science, production, map, construction, projection, design, compilation, drafting, reproduction.
- NAL (4): art, science, technology, mapmaking.

AGROVOC & NAL (2): art, science.

"photogrammetry"

- AGROVOC (5): science, obtaining, reliable, measurement, photography.
- NAL (5): science, deducing, precise, measurement, photography.
- AGROVOC & NAL (3): science, measurement, photography.

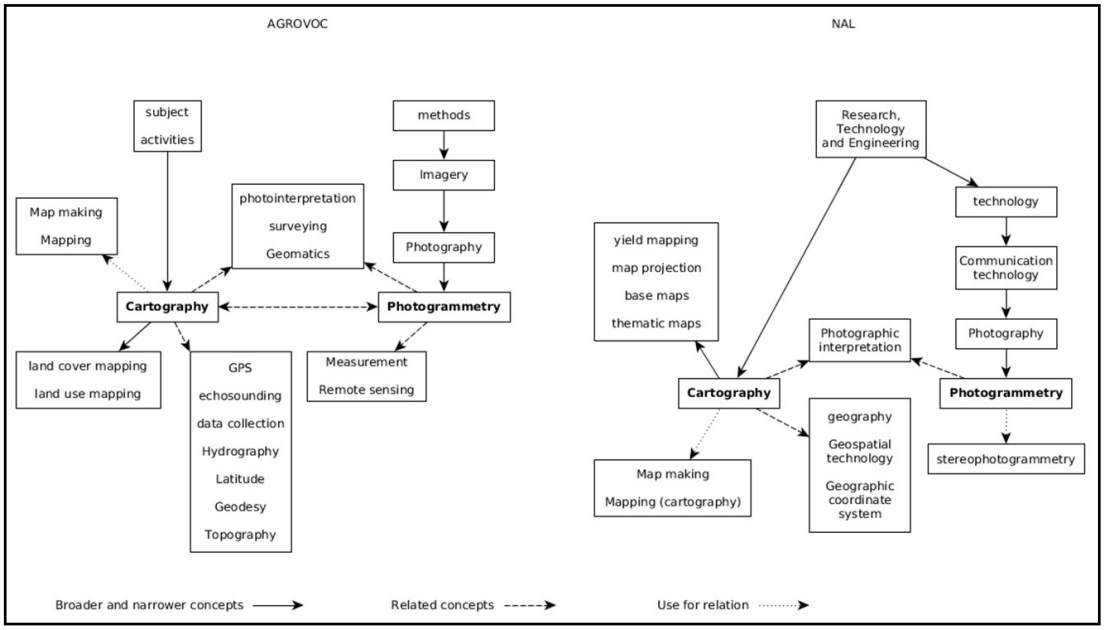
Decomposed terms of particular definition are processed by statistic computation of similarity, which is expressed as a percentage (0% means completely different concepts, 100% same concepts). As it is evident from definitions and their decomposition the similarity of concept "photogrammetry" is higher (42.86%) than the similarity of concept "cartography" (16.67%). Taking into consideration specificity of tested concepts both values are insufficient.

Previous results point to a speculation that both pairs of concepts are composed from more or less independent concepts (even though concepts express the same entity). This guess is supported by the Formal Concept Analyses, which is connected with semantic factoring of definitions. Its results show that concepts have several common terms, but they are not interconnected by any relation of subordination or superiority.

Testing of various relations (broader and narrower concepts, related concepts and relation Used for) have to find other types of connections of evaluated concepts. Following scheme (Figure 1) presents a comparison of hierarchies and relations of both concepts in each thesaurus.

From the Figure 1 it is evident, that similarly to definitions the classification of concepts and relations are quite different in the AGROVOC and NAL Agriculture Thesaurus. There are following heterogeneities, which are characteristic not only for tested concepts (this opinion is based on the detail research of the AGROVOC that is not published now).

- Even though both concepts represents branches of science or technical activities, their classification into broader concepts is totally different, especially in case of AGROVOC. But also independent position of the concept "cartography" in NAL is not correct. This difference is important in case of concept "Photography". In both thesauri it is the nearest broader concept to "photogrammetry", but AGROVOC classifies this concept to methods and NAL to technologies.
- The development of narrower concepts seems to be non-systematic. It is evident from the sets of narrower concepts to the "cartography" in both thesauri. NAL deals with small subset of key cartographic



Source: own processing

Figure 1: Relations of concepts in the NAL thesaurus.

concepts and AGROVOC use relations to two (relatively marginal) types of mappings.

- The last group of heterogeneities comes from the related concepts. Even though cartography and photogrammetry are very similar scientific disciplines, according to the tested thesauri they have only one join related concept – "photointerpretation" or "Photographic interpretation" (thesauri deals with two different concept, but in this case they can be considered to be equivalent). Moreover only AGROVOC contains the relation between "cartography" and "photogrammetry". Relation to other related concepts are similarly to narrower concepts very non-systematic and in many cases not correct (e.g. very weak relation between "cartography" and "echosounding").

Conclusion

This article describes analyses of concepts connected to geomatics and their implementation in two the most important agricultural thesauri (AGROVOC and NAL Agricultural Thesaurus). The results could be summarized into following points:

1. Occurrence of geomatic concepts in agricultural thesauri is slightly above-average, but there is a lack of common concepts.
2. Explicit specification of geomatic concepts in agricultural thesauri is very poor.
3. The similarity between definitions is very poor. Even though both concepts are very specific and well (but not uniformly) defined.
4. There are two pairs of interconnected definitions without any relations of subordination or superiority.
5. Both tools contain some errors, but NAL looks more consistent.
6. Inconsistency in hierarchies even though both thesauri are focused on the same topic and use same rules, principles and standards. For example thesauri contain quite specific concepts such as "thematic map" or "GPS", but not concepts "map" or "GNSS" which should their broader concepts logically.

Results of the limited research described in this article show that

- ...it is necessary to stop a spontaneous and subjective development and modification of semantic tools. They have to be created in very close cooperation of domain experts with use of standardized (recommended) methods.
- ...users as well as developers have to become

aware that universal concepts do not exist, because they are context-dependent. These contexts proceed from many aspects such as language convention, culture, domain, education etc. Users need to feel context or they need to be able to find it in a semantic tool. Tools have to provide context by explicit semantic description and relations.

The future steps of this research will be focused on evaluation of other types of geographic concept and semantic tools. It should lead into a creation of recommendations for users and administrator of semantic tools and a development of a more efficient and correct way of storing of geographic concepts with use of more detailed relations and multiple representation.

The high quality of implementation of geographic concept is very important from a view of general communication or sharing information. It is crucial in many processes such as various types of agriculture connected to geoinformation technologies, implementation of INSPIRE directive in Europe (details see in Řezník, 2013) and other standardization activities or educational activities that need to handle well described information (details see in Janečka et al., 2011).

Acknowledgements

This contribution was supported by:

- the European Regional Development Fund (ERDF), project „NTIS - New Technologies for Information Society“, European Centre of Excellence, CZ.1.05/1.1.00/02.0090
- the project EXLIZ – CZ.1.07/2.3.00/30.0013, which is co-financed by the European Social Fund and the state budget of the Czech Republic.

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Agris on-line Papers in Economics and Informatics

Volume VII Number 1, 2015

Social Media for Organic Products Promotion

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Anotace

Cílem článku je představit nová sociální média jako jeden z efektivních marketingových nástrojů pro ekologicky hospodařící zemědělce. Výzkum zahrnuje aplikaci praktických doporučení navržených Lohrem (2013). Pro jejich ověření na úspěšně zavedené koncepci pracující s přesně definovanou cílovou skupinou byla zvolena data z Facebooku Provozně ekonomické fakulty České zemědělské univerzity v Praze. Jako jeden z klíčových indikátorů úspěchu je zkoumán dosah publikovaných příspěvků. Pro jeho zvýšení doporučujeme publikovat kratší příspěvky a zábavný obsah (jako jsou fotky). Zvlášť analyzujeme vliv her a soutěží na loajalitu fanoušků a doporučujeme jejich využívání pro lepší kontakt s uživateli.

Výsledky souběžně provedené studie využití Facebooku k propagaci bioproduktů ukázaly, že mít mnoho fanoušků na stránkách Facebooku nutně neznamená, že budou také aktivní. Distribuce aktivit odpovídá tzv. „dlouhému chvostu“, čímž s využitím teorie sociální výměny podle Emersona (2003) implikujeme, že potenciál sociálních médií farmářských stránek je v dnešní době stále vysoký a na své využití teprve čeká. Sociální média mohou složit farmářům jako marketingový nástroj, ale zatím nejsou plně využívána. Jedním z důvodů může být neobeznámenost zemědělců s možnostmi, které se nabízí, nebo nezkušenost s novým druhem nástroje

Klíčová slova

Sociální média, výrobkový marketing, bio produkty, Facebook, příspěvek.

Abstract

The aim of the article is to introduce new social media as one of effective marketing tools for organic farmers. The research includes an application of recommendations proposed by Lohr (2013). In order to verify them on successfully implemented concept working with precisely defined target group the data from Facebook of the Faculty of Economics and Management of the Czech University of Life Sciences Prague were chosen. As one of the key indicators of success the reach of the published posts is examined. For its increasing we recommend to publish short posts and amusing content (such as photos). We analyse separately the influence of games and competitions on the loyalty of fans and recommend using them for better communication with users.

The results of mutually done analysis of utilization of Facebook to promote organic products showed that having a lot of fans at Facebook does not necessary mean that they are active as well. The distribution of activities corresponds to the so-called “long tail”, which implies, using the theory of social capital exchange according to Emerson (2003) that the potential of social media for farmers’ pages is nowadays still high and still waits for its utilization. Social media can serve to farmers as a marketing tool, but are not fully utilized yet. One reason might be that farmers are not familiar with possibilities or lack of experiences with this new tool.

Key words

Social media, product marketing , organic products, Facebook, post.

Introduction

Social media refers to the interactions among people in which they create, share, and/or exchange information and ideas utilising social exchange theory (see Emerson, 2003) in virtual communities

and networks such as Facebook, Twitter, LinkedIn, Instagram, etc. Social Media environment is still changing and social networks vary in the presentation of advertisements and information. "Social media is changing the business landscape and redefining how businesses communicate across their channels of distribution and with their customers." (Rapp et al., 2013)

A new form of communication with customers which enabled to serves the niches has emerged. The fact that the internet enabled selling to wider range of demanders led Anderson (2006) to develop the theory of "Long tail". He defines it as the „end of the demand curve". According to it the development resulted in the "fragmentation" of the market and wider choice of the customer. The ability to serve small markets or decentralized customers is one of the advantages of social media. According to Kánská et al. (2012) "Social media have become an integral part of marketing strategies and cost structures of many companies all over the world."

Organic products had the characteristics of the niche. However, "there has been a general increase in demand for 'organic' or 'biodynamic' produce (Jensen and Baggesen, 2014). It resulted to the situation described by Sage and Goldberger (2014). "Over time, if this niche proves profitable, it will attract more producers, thereby changing the face of the niche from a potential monopoly toward a competitive market" (Sage and Goldberger, (2014). The organic producers face increasing competition on the market. Because of the "Long tail" theory, social media can serve as a powerful marketing tool to organic farmers to promote their products.

However, social media considerably differ from other media. "They are rather resemble dynamic, interconnected, egalitarian and interactive organisms beyond the control of any organization (Peters et al., 2013). Their administration is in many cases beyond the current experiences of companies' management. Farmers are not familiar with possibilities which are provided and if so, it is too far from their daily routine. Also the research of Sturiale and Scuderi (2013) highlighted "the need for new managerial capacities: on one side that of creating consistent contexts that users appreciate and may well integrate the offer; on the other side that of managing the evolution of knowledge and competence systems deriving from external sources." Therefore, the aim of our research is to present and verify the suggestions how the Facebook can be utilized as a marketing tool for organic farmers.

Facebook as a marketing tool

"Facebook is a service on which users can find and add friends and contacts, send messages to friends, and update personal profiles. However, social networks are a qualitatively different type of product than text, pictures, and videos; there is a shift from the individual to the collective, as social networks leverage the power of relationships and the collective wisdom of man." (Berthon, 2012) There are around 1.3 billion Facebook users and 54.2 million Facebook pages created. The number of users is still increasing, e.g. between 2002 and 2013 increased by 22%. In 2010, companies spent about $62 billion on advertisements on social network sites (Gregurec, et al., 2011), which shows the growing importance of social media as a marketing channel (Hofmann et al., 2013).

Among the key indicators of success in social media presentation belong number of users involved in communication and total reach of published contributions. Peters et al. (2013) suggested nine guidelines in their study that may prove valuable for designing appropriate social media metrics and constructing a sensible social media dashboard. In Facebook environment number of shares, likes and comments are usually observed.

Social media communication, also known as user-generated, "now represents a prevalent source of information; it has changed the tools and strategies companies use to communicate, highlighting that information control now lies with the customer." (Michaelidou et al., 2011)

The communication between organic farmer and customer should be elaborated at three levels (Sturiale and Scuderi, 2013): (1) connection: build up trustworthy relations besides the mere possibility to find out market niches or communities to develop products and services; (2) conversation: provide tools and interaction models to create a shared "sense" that goes behind the brand name, that allows companies to enter their market of reference; (3) construction: offer consumers platforms and structures to develop products with members' contributions.

Erdogmus and Cicek (2012) proposed several tactics for the practitioners, how to create content at Facebook pages to build brand loyalty. The results show that that the company should offer advantageous campaigns, relevant and popular contents. Besides, this content

should appear on various platforms and offers applications on social media. (Erdogmus, Cicek, 2012) Interestingly, customers prefer to share music, technological-related, and funny contents on social media platforms. This finding are in line with the recommendations of the "Social Media in Business" (SMIB) methodology proposed by Lohr (2013).

Materials and methods

The aim of the paper is to introduce new social media as one of effective marketing tools for organic farmers applying recommendations proposed by Lohr (2013) in his so-called SMIB (social media in business) methodology. The guidelines for organic armers are given how to utilize the social media, particularly Facebook, as a marketing tool. The question is how to build effective communication with customers and other stakeholders which would help to promote the products of organic farming.

Analyzed sample is firstly described in terms of the structure and activity of the users and then following statements are explored:

1. Text of the messages for publication in social media is suitable to create short.
2. The company should utilize amusing and creative approaches in social media to better achieve set objectives.
3. The company should utilize applications, games or other elements of virtual reality to increase the involvement of their fans.

For verification of the first statement a Pearson correlation coefficient and ordered multinomial regression model (supposing logistic distribution of the error term) was estimated by maximum likelihood. As explained variable (y_i) was chosen the category of reach: 1 - 0 to 2000 reached users (there were 83 cases in this category), 2 - 2001 to 4000 reached (there was 146 posts in this interval), 3 - over 4001 reached people (136 posts). Explanatory variables were related to the posts' type. Testing several variables revealed that only two of them were statistically significant: x_{1i} – **the length of the post** (number of characters including the spaces) and x_{2i} and x_{3i} – **day when it was posted** (dummy variable taking the value of 1 if the status was published on Saturday or Sunday and value of 0 otherwise).

Logistic regression examines the log-odds (a ratio of expected number of successes to each failure) (1). Its interpretation is in terms of the odds ratio (OR). It measure the odds that the category of reach will be higher than the basic one (0 to 2000 reached users) given the length of the post and time.

$$\ln\left(\frac{p(y_i|\mathbf{x}_i)}{1-p(y_i|\mathbf{x}_{,t})}\right)=\beta_0+\mathbf{x}_i^T\boldsymbol{\beta}, \qquad (1)$$

where p is the probability and x_{it} is a matrix of k (k = 1, ... 3) explanatory variables. To incorporate unobserved heterogeneity into a model a farm-specific parameter is added. This β_{0i} constant can be treated as fixed (y_{it} is assumed to be independent) or random (y_{it} is assumed to be conditionally independent given β_{0i}).

The second statement is related to the post content. We analysed what type of publication (text / photo / link / share or video) had the highest reach. Further examination considered the optimal number of posts per time period in order to achieve high reach.

The third statement was verified on the game – Christmas competition held on FEM Facebook in December 2014. The loyalty of the users to the game was examined.

In order to verify the SMIB recommendations on successfully implemented conception working with precisely defined target group the data from Facebook of the Faculty of Economics and Management of the Czech University of Life Sciences Prague were chosen. We observed them for time period 1-11/2013. We omitted the values from December as there was a change in methodology of reach calculation in December 2013.

The statistics about the number of posts (in general any published text/photo/video/share of the post published at Facebook timeline page), fans (Facebook users which marked the page as "Like") and activity (any comment to the post or share of the post, or any "Like" of the post) were gathered. The dataset is sufficiently large as there is regular activity on the Facebook page (**https://www.facebook.com/pef.czu.cz**).

There are around 15 thousand students registered at the university, hence, there is quite high number of fans – 7392 as of 23 December 2013. Fans of Facebook pages consist of 62% of women and 38% of men. This is opposite to the structure of the whole Facebook, which is used by 46% of women and 54% of men. Not surprisingly, the majority of active users is between 18–24 years old (41% women, 25% men) and between 25–34 years, which corresponds to the students'

age structure.

The activity of users on FEM Facebook sites has the long tail distribution – i. e. small number of users creates the majority of activities, while the majority of users are active only rarely or not at all. From the total number of fans only 1587 (21.47%) were active. Active in this case mean that the user ever wrote any comment or "liked" any post or picture of the faculty page. In total those 1587 fans performed 4051 activities. This suggests that on average one active fan has made 2.55 activities. However, the distribution is different - 1 975 users performed only 1 activity, while the majority of activities (over twenty) were done by 16 people. In other words only 1% of people create 20% of activities. The median of activity is ensured by 204 people. Among the five most active people belong also 3 page's administrators. Regarding the gender structure, active users slightly differs from the fans of the Facebook page – all men are active, while the percentage of women is lower.

An analysis of utilization of the Facebook to promote organic products in the Czech Republic is done next. The Facebook pages were reviewed on 23rd December 2013 according to the keywords related to the organic farming:

- farmářské trhy - **farmers' market**,
- bioprodukty - **bio products**,
- ekologické zemědělství - **organic farming**,
- biopotraviny - **organic products**.

As it will be shown, the dataset is still not sufficiently wide and hence the possibilities of the Facebook are not yet exploited.

Results and discussion

Firstly, three recommendations of SMIB methodology are verified.

1. Text of the messages for publication in social media should be short

The shortest post (excluding 4 photos with no post at all) was photo "Léto 2013" with 9 characters. The longest information about transport situation near the university during floods situation contained 1083 characters. Informational posts naturally contain more characters than mere comments to the photo. We analyzed the relation between the post length and reach. However, there was no correlation found between the length of the post and post reach. Pearson correlation coefficient was almost zero (-0.0125) and statistically insignificant ($p = 0.812$). The relation between number of "like" of the posts of FEM CULS pages between 09/2011 and 06/2013 and the post length was examined already by Lohr (2013). He supposed that at the long messages the reader looses attention and the level of their interest decreases with the length of the message. He proved this by a linear function with slightly negative slope. The longer was the post, the lower number of likes it received. We had different data – for period of 01/2013 to 11/2013 and therefore the results are different. The slope coefficient is positive. The relation expressed by linear function (post reach = 3115 + 1.2785 post length) shows that the longer is the post, the higher is the reach.

This calls for detailed examination and taking into account also other factors. Original logistic regression model contained following explanatory variables: hour and minute of the post publication, dummy variable for a day in a week, dummy for AM / PM, dummy for exclamation mark contained in the status and question mark contained in a status and the number of posts' characters. However, only **post length** (x_1) and **Saturday** (x_2) and **Sunday** (x_3) turned up to be statistically significant (see Table 1).

The explanatory power of the model is relatively high (in 40.5% cases the model correctly categorize into reach category based on the fact, if the post was published on Saturday or Sunday and had particular length). LR test follows the chi-square distribution with degrees of freedom equal to the number of regressors. If the null hypothesis is true, the chances of obtaining a chi-square value of as much as 48.6125 or grater is practically zero. This suggests that collectively all regressors have strong influence on the probability that the post will fall into particular **category of reach**.

The coefficients are ordered log-odds (i.e. logit). If the post length is increased by one character, the log-odds of being in a higher category of reach (in comparison to the base interval from 0 - 2000) increases by 0.0012. The odds interpretation of the coefficients is as follows: When the post is published on Saturday, the odd in favour to reach higher number of users decreases. On the other hand, if it is published on Sunday, the odds in favour to reach more users increase.

Logit model confirmed the results from the correlation analysis. The odds of higher reach mildly increase if the status is longer. This finding is not in line with our expectations. We supposed that during longer reading, the reader might lose attention. For example Yoshimura (2006)

Number of correctly predicted cases = 147 (40.5%) Prob > Chi-square =0.0000

Likelihood ratio (LR) test: Chi-square(3) = 48.6125

Variable	Coefficient (log-odds)	Std. error	Z-value	P-value	P>|z|	Coeffient (odds)
x_1 – post length	0.0012	0.0007	1.8110	0.0701	*	1.0012
x_2 – Saturday	-0.5518	0.2685	-2.0550	0.0398	**	0.5759
x_3 – Sunday	0.6135	0.3517	1.7440	0.0811	*	1.8469
cut1	-0.9970	0.2032	-4.9070	9.24e-07	***	
cut2	0.7987	0.1994	4.0060	6.17e-05	***	
Log likelihood		-383.2103		Akaike criterion		776.4206
Schwarz criterion		795.8926		Hannan - Quinn criterion		784.1607

Note: * the coefficient is statistically significance at 0.1 level, ** at 0.05, and *** at 0.01 level
Source: own calculations in SW Gretl

Table 1: Results of the ordered logit model.

stated that the attention of the readers is limited. Because the algorithm of the reach calculation is unknown, it is not possible to determine the exact reason. A detailed content analysis is needed. In our case longer posts were related to the flood situation in Prague in June. Some students had to go to school to pass the state bachelor or master exams. Therefore, the information about the situation (transport possibilities, exam schedule etc.) were for the readers so important that they paid more attention to them (commented them or shared them). Hence, the reach was higher. This is in line with the finding of Yoshimura (2006) that in case of longer tests "adults tend to prioritize meaning over language form". We may conclude that despite that shorter posts are preferred, longer posts can be used in extraordinary situations without worrying about the decrease of the post reach.

2. The company should utilize amusing and creative approaches in social media to better achieve set objectives

Unlike traditional media, social networks comprise various types of media – written, photos or videos. Hence, another question is related to the post content. The company should utilize amusing and creative approaches to better achieve objectives. We tested what type of publication had the highest reach. There were 363 posts, photos, links, shares or videos published at the Facebook pages in 2013. The majority were photos (131), than links (106). There were only 86 original posts created. Two photos, one link and one share were financially supported, in other cases only organic reach can be considered. In absolute terms, the highest reach had photos (374 721), while the posts were seen by 365 917 users. On the other hand, the average reach was higher in case of posts (5 082), while photos were surprisingly not that successful (3071). The average reach of photos was even lower when we considered organic reach (not paid) only.

However, we have to account for extremes (more than 3 standard deviations from an average). There were extreme values of reach recorded in June. This was due to the crisis situation (floods in Prague), when the communication from the side of users and administrators was more intense and frequent. Another surpassing situation was in September at the beginning of the academic year during timetable assignment. Also the last post of the year should not be included into analysis as it was paid. The results are displayed in Table 2.

	Nr. of posts	Organic reach	Average reach
Post	72	5032.2778	5082.1806
Photo	119	2746.6639	2907.0672
Link	93	2608.6774	2864.8602
Share	35	3028.8571	3206.9714
Video	2	3301.0000	3328.5000
Total	321	3253.5701	3418.0405

Source: own calculations

Table 2. Reach of the posts without 12/2013 and extremes.

We find that the average reach was the highest in case of the text posts. This is not in line with results of Hofmann et al. (2013). They examined the communication of local governments on the social network sites and measured the success of the communication in terms of the frequency and polarity of citizens' comments on government posts. They concluded that „in particular, multimedia features like photos and videos contribute to the success of communication" (Hofmann et al., 2013). This is for obvious reason – as Pereira et al. (2014) stated – the Facebook users cannot

keep up with everything. Their qualitative research (interviews in focus group) revealed that "some content such as videos, fun posts, and events attract attention and stand out from the 'noise'.

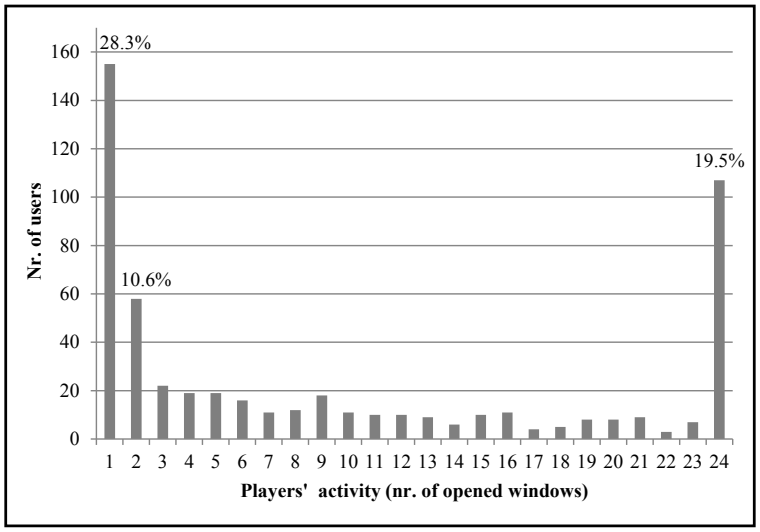
Our contradictory results would require detailed examination of the causes. One of them could be the motivation of the Facebook's users. Smock et al. (2011) suggested in their study that „measuring overall social media use instead of specific feature use obfuscates granular patterns regarding use: who is using what tool to what end". It is possible that for university students are more relevant the text posts with information value (e. g. exam dates) that mere illustrative photos or leaflets. Other possibility is that there were too many photos in comparison with other post types. They were published too often and students stopped to pay attention to them.

In general it might be assumed that the attention of the users slacken when there are too many posts. Therefore, we further examine the number of posts in relation to the reach. The highest total reach was in June, but on average (recalculated at one post) the highest reach was in August. There were only 11 posts published, but they were seen by 67 654 users. There were 41 posts (mainly photos – 21), but the total reach (88 725) per one was not that remarkable. One post was seen (on average by 3636 fans). 25% of the posts had less than 2120 views, which points out on the fact that few posts were seen by a lot of users. Our findings imply that the less number of posts per time period, the higher is their reach. Or in other words publishing too much does not necessary mean that the statuses will have desirable reach. For example Parsons (2011) analysed 70 Facebook pages of global companies and found out that they "post on average 24 times within a month which implies that consumers receive a message in their news feeds from companies that they like every few days. Companies need to be conscious of not bombarding users with messages." More precisely, it matters to publish the "right" (i.e. relevant) things and the "right" (not too much, not too few) number of them per time period.

3. The company should utilize applications, games or other elements of virtual reality to increase the involvement of their fans

The amusing content can be an application, game serving for the purpose of the competition. We analysed the data from Christmas competition which took place in December 2013. Its principle was easy – "open windows" in virtual Advent calendar. After opening (by click) one window another could have been open up to 5 hours. This competition sought to build loyalty of the users – players. They had less than 24 days to open all windows (so the results could have been announced before the Christmas holiday). The Facebook application attracted 548 users (out of 7392 fans) who could win 165 rewards. The majority of users opened only 1 window and lost the interest in future game. The competition also attracted people even in extraordinary hours (e.g. between 3 and 4 AM where the users were more active than usually). The distribution of the player´s activity is displayed at Graph 1.

The loyalty of users – players decreased overtime.



Source: own calculations

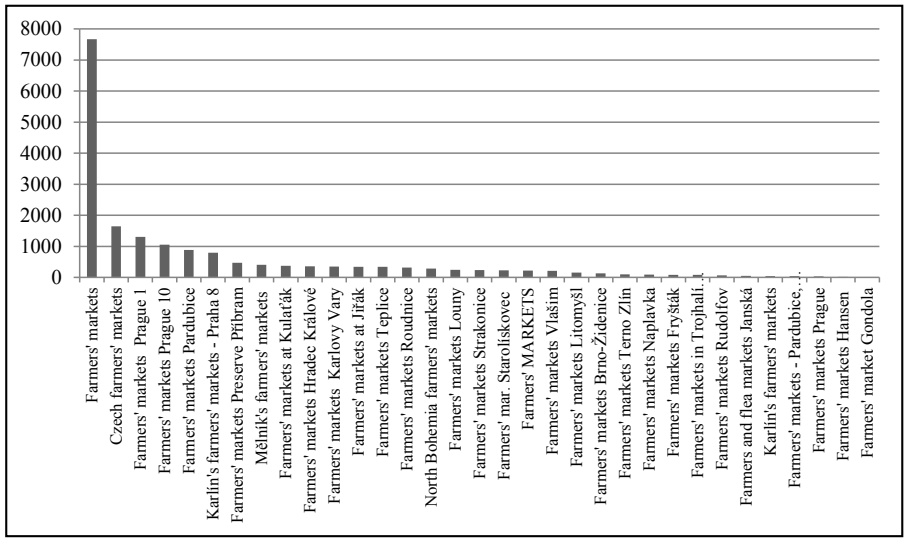
Graph 1. Players´ activity during competition.

Half of them opened maximally six windows, three quarters managed maximally 19. But almost 20% made it to the very end which is quite high conversion number. Therefore, we suggest running competitions with easy rules and longer duration which require longer-term attention of the players to build their loyalty.

The added value of the Christmas competition was that it enabled also personal contact with the users. Won rewards were picked up by the users personally at the university. The organizers had change to talk to users personally and build further relation with them.

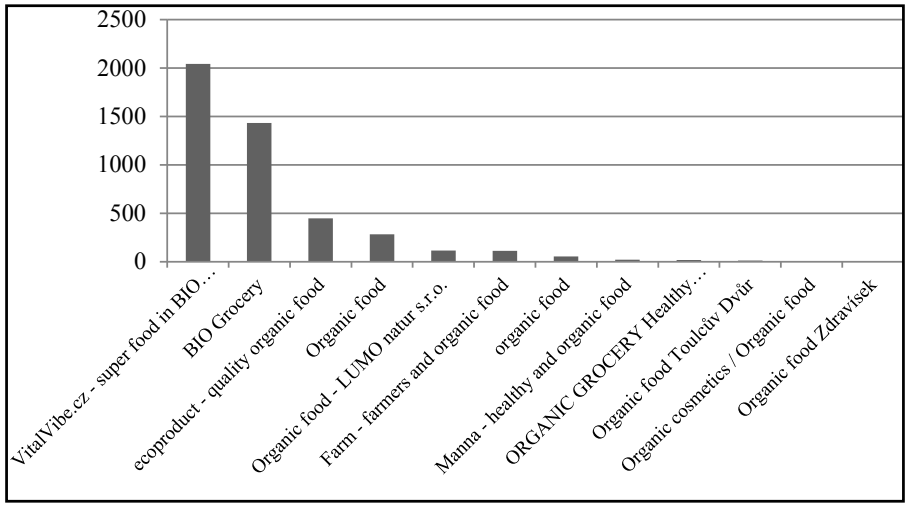
An analysis of utilization of the Facebook to promote organic products is done searching for a keyword **farmers' market**. In general, the number of fans differs according to the localization of farmers market (see Graph 2). The distribution follows "long tail" – one Facebook page had 41% of all fans, while the share of others is negligible. The survey revealed that Facebook is utilized mainly in big cities by organizers of farmers' market to promote those events. The most fans had non-profit organization "Farmářské trhy" (na Kulaťáku - part of Prague).

There can be found communities, groups (both open and closed) and events related to the farmers market on Facebook. However, the number of likes



Source: own research at Facebook

Graph 2: The number of fans of Facebook pages – key word: farmers' market.



Source: own research at Facebook

Graph 3: The number of fans of Facebook pages – key word: organic products.

or participation at the events is very modest and imply that Facebook as a marketing tool has its reserves.

Keywords **bio products** showed only one closed group, one community and one interest. Ecological farming refers only to the study programmes at the Czech University of Life Sciences. Key words **organic products** revealed few pages of bio products' shops, one community, one place, one group and even one person. (It might be assumed that the shop owner did not know how to create a Facebook page.) Hence, we may conclude that the Facebook is not fully utilize (or even appropriately utilized) for marketing purposes. The distribution of pages' fans can be seen at Graph 3.

Conclusion

The aim of the article was to introduce new social media as effective marketing tool for the organic farmers and producers. We presented and verified three suggestions of the Social Media in Business methodology proposed by Lohr (2013) on the data of already successfully working conception of FEM CULS for the time period of 1-11/2013. First suggestion that **text of the messages for publication in social media should be short** was not proved by our data. Content of the posts revealed that the longest were posted during floods in Prague in June. It is supposed the same effect can be reached during any crisis communication – at the field of the organic farmers it can be any type of quality crisis, such as plant diseases or communication hoaxes. We may conclude that despite that shorter posts are preferred to achieve higher reach, longer posts have its justification in extraordinary situations and their length does not imply the decrease of the post reach.

The statement that **the company should utilize amusing and creative approaches in social media to better achieve set objectives** was verified on the various types of media´s reach (text post, photos, links, shares and videos). Our data revealed contradictory results. The highest reach had text posts (probably connected with higher information value for the students). Another reason might be that there were too many photos published at once. It is efficient to use a balanced mix of media formats. For organic farmers it can be used for educative purposes and also for brand building. Therefore, in conjunction with our data based research, we suggest publishing the relevant content in reasonable time period (not more than one post per day on average).

Third suggestion that **the company should utilize applications, games or other elements of virtual reality to increase the involvement of their fans** was verified on the Christmas competition. The data showed that game (Facebook application) with easy rules and longer duration attracted considerable number of fans from which one fifth completed the game. For that reason, we recommend to the organic farmers or producers holding the competitions to build users loyalty.

The researched in the area of utilization of Facebook to promote organic products showed that this social medium is still not fully utilized yet. The distribution of the fans of Facebook pages follows "long tail" – one Facebook page promoting organic markets had 41% of all fans, while the share of the other pages was negligible. This implies using the theory of social capital exchange according to Emerson (2003) that the potential of social media for farmers' pages is nowadays still high and still waits for its utilization. This might be due to various reasons such as availability of the (broadband) internet connection, age structure of the internet users and farmers, or the lack of knowledge about the possibilities and social media communication skills. We showed that social media are a promising tool which can be used by organic farmers to promote their products.

Today, with the last changes of Facebook rules applied, it is now allowed to hold competitions out of the separated Facebook applications and organic farmers with not enough budgets are able to organize those activities directly on Facebook page timeline. This can lead to increasing of popularity and activity on Facebook page and it can produce higher post reach and brand building effect. As we showed in our article, the methods of using of social media are developed and organic farmers should exploit them.

A challenge for future research is to perform detailed content analysis of the posts in relation to their reach. This will shed better light on more effective social media usage by the organic farmers or producers.

Acknowledgements

The knowledge and data presented in the present paper were obtained as a result of the Grant No. 20151053 of the FEM CULS Prague Internal Grant Agency titled „Development and use of information and communication technologies in rural regions".

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Agris on-line Papers in Economics and Informatics

Volume VII Number 1, 2015

Towards Farm-Oriented Open Data in Europe: the Scope and Pilots of the European Project "FOODIE"

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Anotace

Rozdílné skupiny osob zainteresovaných v zemědělských aktivitách musí nakládat se značně heterogenními zdroji informací, ať už jde o ekonomická či environmentální rozhodnutí. Typickými úlohami, kde se kombinují rozdílná data, mohou být například definice pravidel (pro dotace, standardizace a regulace, národní strategie pro rozvoj venkova, změny klimatu), vývoj udržitelného zemědělství, načasování a ohodnocení sklizně či detekce poškození porostů. Evropský projekt nazvaný "Farm-Oriented Open Data in Europe" se zkratkou "FOODIE", financovaný v letech 2014 až 2017, si klade za cíl adresovat tyto požadavky. Tento článek se věnuje zaměření projektu s bližším uvedením pilotních testů. Detailněji je následně popsán český pilotní test skládající se ze tří scénářů: zvýšení efektivity dopravy v zemědělství, telematika zemědělských strojů a správa monitoringu variability plodiny na konkrétním místě.

Klíčová slova

Otevřená data; zemědělství; zemědělství s cloudovým řešením; telematika; strategické plánování; faremní informační systémy.

Abstract

The different groups of stakeholders involved in the agricultural activities have to manage many different and heterogeneous sources of information that need to be combined in order to make economically and environmentally sound decisions, which include (among others) the definition of policies (subsidies, standardisation and regulation, national strategies for rural development, climate change), development of sustainable agriculture, harvest timing and yield estimation, crop damages detection, etc. The European project called "Farm-Oriented Open Data in Europe" with abbreviation "FOODIE", funded between years 2014 and 2017 addresses the above mentioned issues. This paper describes the scope of the project with emphasis on its pilots. The Czech pilot is then analysed in detail including its three scenarios: Improving efficiency of transport in agriculture, Telematics of farm machinery and Monitoring of in-field variability for site specific crop management.

Key words

Open data; agriculture; farming on cloud; telematics; strategic planning; farm management information systems.

Introduction

The agriculture sector is a unique sector due to its strategic importance around the world. It is crucial for both citizens (consumers) and economy (regional and global) which, ideally, should make the whole sector a network of interacting organizations. Rural areas are of particular importance with respect to the agri-food sector and should be specifically addressed within this scope. The different groups of stakeholders involved in the agricultural activities have to manage many different and heterogeneous sources of information that need to be combined in order to make economically and environmentally sound decisions, which include (among others) the definition of policies (subsidies, standardisation and regulation, national strategies for rural development, climate change), development

of sustainable agriculture, crop recollection timing and pricing, plagues detection, etc.

In this context, future agriculture knowledge management systems have to support not only direct profitability of agriculture or environment protection, but also activities of individuals and groups allowing effective collaboration among groups in agri-food industry, consumers, public administrations and wider stakeholders communities, especially in rural domain.

The European project called "Farm-Oriented Open Data in Europe" (FOODIE), funded between years 2014 and 2017 addresses the above mentioned issues. After presenting the state-of-the-art and methodology in this paper, the pilots of the project are discussed separately depending on the country where the pilot is conducted. The Czech pilot is then analysed in detail including its three scenarios: Improving efficiency of transport in agriculture, Telematics of farm machinery and Monitoring of in-field variability for site specific crop management. At the end, benefits, opportunities and future development are mentioned.

An in-depth review of the different aspects is needed in order to design and implement the aforementioned service platform proposed by the FOODIE project. Such review must be considered to be in line with current initiatives and policies relevant in the environmental and agricultural domains as well as commonly and widely used standards, technologies, service oriented architectures and systems developed in other projects, together with the numerous data sources repositories available at local, national and European level that will enable the provision of new and added value agricultural services for the different stakeholders of the platform.

First of all, we have been inspired by the existing international and European initiatives that aim at facilitating the exchange and access to a wealth of heterogeneous data sets related to the environmental and agricultural domains. We have also included references to the main European policies that are directly involved in the agriculture sector, such as Common Agricultural Policy or Water Framework Directive and that have to be taken into account in the decision making process of the stakeholders. In this sense, call for global data collection for agricultural monitoring is analysed by Sachs et al. (2010). Principles of common agricultural policy are provided by Donald et al. (2002). Influence of Water Framework Directive on agriculture is discussed by Bateman et al. (2006). See Řezník (2013) for information on Infrastructure for spatial data in Europe (INSPIRE) including the application schemas for agriculture and aquaculture. European nitrate directive and its influence on the farm performance were described by Ondersteijn (2002).

To sum up, the FOODIE project has a lot of similarities with the above mentioned initiatives. Data model and searching including metadata originates from INSPIRE. Parts of global initiatives called GEOSS (Global Earth Observation System of Systems) and COPERNICUS could be used and integrated as a part of FOODIE hub. It is important for the FOODIE implementation to establish link with GODAN (Global Open Data for Agriculture and Nutrition) initiative, which is trying to define world Wide standards for Agriculture Open Data and CGIAR (Consultative Group on International Agricultural Research), which is active in global scale on simmer area as FOODIE.

As the second, we have paid the attention to the standards commonly used in the geospatial and environmental domains to encode, visualize and access to the datasets, e.g. sensor information. We would also like to stress the specific standards used in the agriculture domain for exchanging information, such as agroXML and SoilML, as well as the standards necessary for semantic tagging and publishing the datasets contained in FOODIE platform.

As the third, the results from relevant projects provide us an overview of the different architectural approaches followed by various projects in the environmental and agricultural domain which represent the basis for designing FOODIE architecture and specifying its building blocks. For instance, an architecture for soil data that may be re-used for FOODIE purposes is advertised by Douglas et al. (2008), Bröring et al. (2011), Feiden et al. (2011) and Kubíček et al. (2013). In addition, we also had a look at the results obtained by some projects in the areas of Big Data and Future Internet which are interesting from the point of view of the agriculture due the large volumes of data that can be generated over the time, e.g. sensor data from the in-situ sensors deployed on the farms, satellite imagery, its management, visualization and integration as well as in terms of new agriculture services that could be built/offered in the scope of the Future Internet architectures and paradigms respectively. Big Data represent in agriculture especially the biological data as described by Howe et al. (2008). Future

Internet, as described Moreno-Vozmediano et al. (2013), significantly changes the generally accepted principles of internet usage for agricultural purposes that were recommended by Thysen (2000).

As the fourth, the data and knowledge sources compile an exhaustive list of openly available datasets and vocabularies that can be used in the scope of the project in order to improve the semantic tagging and publication of datasets within the platform repositories as well as by enabling the provision of improved tools and advisory services for the different stakeholders (by integrating and fusing these external data with the datasets stored in the FOODIE platform). Spatial data harmonization of these openly available databases are depicted by Čerba et al. (2012). See Šimek et al. (2013) who described the usage of AGROVOC for the data descriptions in the agrarian sector.

As the fifth, the existing technologies and software solutions focuses on the different available alternatives – many of the coming directly from the open source geospatial community that can be used as building blocks of the FOODIE service platform hub.

Finally, we have also included the analysis of the different sensors and communication protocols used to communicate with/among them and which will be of relevance for deciding which the best option in each pilot is.

The aim of this paper is to introduce a software cloud platform developed by the FOODIE project, which is designed to manage farm data for good agricultural practices and decision support of agronomists. The main part of the Czech research aims at the implementation of INSPIRE methodology and optimization of data model to the specific conditions of the Czech agricultural sector. The results should lead to optimization of intensive cropland management in various pedo-climatic conditions of the Czech Republic in order to ensure the production of food with high quality while respecting the environmental limits of the farmland.

Materials and methods

Request for data management in agriculture increases with the usage of Farm management Information Systems (FMIS) and adoption of precision farming techniques – site specific crop management. Is often argued that, in the cases of precision agriculture, physical inputs, such as fertilizers, pesticides, seeds and other, are substituted by information and knowledge (Bongiovanni, Lowenberg-Deboer 2004). McBratney et al. (2005) identified the development of proper decision-support systems for implementing precision decisions as a major block in adoption of site specific farming. In the cases of data analyses and decision support programmes, it is recommended to focus on:

- the development of protocols and standards for the key data layers (yield maps and other);
- robust methods for data analysis, integration and delineation of management zones;
- innovative designs for the implementation of whole-of-field experimentation based;
- easy-to use software to facilitate the use and adoption of the above by farmers, their consultants and researchers.

An example of development of a model data-flows for decision support in precision agriculture is provided by Nash et al. (2009).

Communication and cooperation in adoption of precision agriculture depends on the farm size, as investigated by Kutter et al. (2011) from the farm survey made by qualitative experts in four European countries – Germany, Czech Republic, Denmark and Greece. Small farms were mainly connected to their local agricultural consultants, while large farms rely more on professional consulting. Services for strategic and tactic planning provided by consulting organization for farm enterprises, represented by MJM Litovel, are the topic of the Czech pilot study in FOODIE project.

In the first part (Scenario A), transport services of MJM are being optimized to supply the application of agrochemicals on the client fields and to support the product purchase using advanced planning and network analysis. In this case, precision agriculture provides tools to monitor the food production chain and manage both the quantity and quality of agricultural production (Gebbers, Adamchuk 2010).

Scenario B aims at tracking the agriculture machinery and evaluation of its movement within the fields. The use of guidance systems based on the satellite navigation can increase the steering accuracy and driving performance within large -scale fields (Holpp et al. 2013). Optimization of machinery passes in fields could help with soil condition improvement and also energy savings (Kroulík et al. 2011).

The third part of the strategic planning in the Czech pilot (Scenario C) is focused on the crop monitoring by remote sensing and agro-meteorological monitoring. Technologies of remote sensing are widely used in precision agriculture for crop monitoring and delineation of soil units (Moran et al. 1997). Satellite imaging offers periodic monitoring of crop vigour and seasonal changes, but with low spatial resolution, periodic revisit time defined by orbit constellation and dependency on atmosphere conditions. For this reason, aerial survey carried out in required vegetation stage provide more reliable input data for site specific crop treatment. The challenge for the future is to combine the remote sensing techniques with the real-time on-the-go measurements and to develop precision farming approaches that provide customized management of farm inputs for individual plants (Mulla 2013).

Results and discussion

FOODIE concepts and objectives are realized by means of the resulting service platform hub, which is demonstrated in three different pilots' scenarios across Europe, providing each of them a set of common and specific requirements:

- **Pilot 1: Precision Viticulture (Spain)** focuses on the appropriate management of the inherent variability of crops, an increase in economic benefits and a reduction of environmental impact.
- **Pilot 2: Open Data for Strategic and Tactical Planning (Czech Republic)** aims at improving future management of agricultural companies (farms) by introducing new tools and management methods, which follows the cost optimization path and reduction of environmental burden, improving the energy balance while maintaining the production level.
- **Pilot 3: Technology allows integration of logistics via service providers and farm management including traceability (Germany).** This pilot focuses on integrating the German machinery cooperatives systems with existing farm management and logistic systems as well as to develop and enlarge existing cooperation and business models with the different chain partners to create win-win situations for all of them with the help of IT solutions.

Description of Pilot 2 in Czech Republic

The arable land of the Czech Republic in areas with high intensity of crop production has specific traits. Large areas of cultivated fields with combination of higher variability of topographical and geological factors result in visible heterogeneity of soil conditions and crop yield. More than 54 % of agriculture land in the Czech Republic is managed by farms with a size of over 1'000 ha (Ministry of Agriculture, 2010). Based on a statistical evaluation of the Land Parcel Information System (LPIS), over 40 % of arable land lies in fields with an area larger than 20 ha. Crop management in these conditions requires advanced decision making. Therefore, there are increasingly applied approaches of site specific crop management.

Site specific management, known as precision agriculture, takes into consideration the spatial variability within fields and optimizes production inputs, thus fulfilling the objectives of sustainable agriculture (Corwin and Plant, 2005). The aim of precision agriculture is an optimization of production inputs (fertilizers, pesticides, fuel, etc.) based on the local crop requirements and plants requirements. Crop management in this way should lead to the effective use of agrochemicals and avoid of environmental risks.

The Czech pilot is represented by one agricultural supply company MJM Litovel (hereinafter MJM) and two corporate farms - Farm Vajglov and Farm Tršice. MJM offers various products for farming industry in the Czech Republic, such as fertilizers, plant protection products, animal feed, seeds, and a large selection of grower equipment. Furthermore, they provide services for farmers, especially for precision agriculture under their proprietary system PREFARM® for efficient use of fertilizers, increased revenues, and stable production quality.

The first farm, Tršice, is located in the most productive region of the Czech Republic, in the Central Moravia. The farm itself is focused on the intensive crop production in arable land (cereals, oil crops and other) and the production of hops. The second Farm, Vajglov, is located in the North Moravia region in the marginal mountain area. Most of the acreage of the farm belongs to the Less Favourable Area (LFA), where is reflected the lower productivity of the land by supporting agricultural land use and preservation of sustainable agriculture in these areas. The farm is focused on livestock production (grazing beef

cattle); agricultural land is therefore used in form of permanent grassland and is under organic farming regime. Basic data on both farms are listed in Table 1.

	Farm Tršice	Farm Vajglov
Geographic coordinates	49°32'14"N 17°23'45"E	49°53'56"N 17°21'30"E
Average elevation of fields	284 m	626 m
Average year temperature	8.9°C	5.8°C
Total amount of precipitation per year	570 mm	842 mm
Total area	1'291 ha	1'089 ha
Arable land	1'214 ha	-
Grassland	-	1'089 ha
Orchards	74 ha (hopfields)	-
Organic farming	NO	YES (all fields)

Source: owin processing

Table 1: Basic information about both pilot farms from LPIS database and climatic data.

The improvement of future management of agricultural companies in the Czech pilot is divided into three scenarios:

- Scenario A - Improving efficiency of transportation of a large service organization, which will support better logistics on different levels of agriculture services.
- Scenario B - Telematics of farm machinery for evaluation of the economic efficiency of field operations and improvement of the machinery management.
- Scenario C - Optimization of crop management practices by considering in-field variability for variable rate application of fertilizers.

Scenario A – Improving efficiency of transport in agriculture

In relation to farms, MJM acts as agriculture service organisation, trade partner and advisory organisation. MJM deals to both sided of the market, supply and demand side. On the market of inputs to agriculture, MJM plays the role of supply side by offering fertilizers, pesticides, and other materials to farms as the products or in form of providing complete services including application on fields. In connection with these supplies, MJM must fulfil their legal obligation to take back empty packing. On the market of crop product MJM act as demand side purchasing products from farms. All these tasks meet demands for intelligent logistics system within the organisation.

The main purpose of this scenario is to implement a new system for optimization of transport in agriculture for a use case of MJM. This system should achieve better overview about transport related topics for purposes of MJM management, efficient information sharing between individual departments and between elements involved in the transport processes, and increased economic and energy efficiency of transport.

There are several possible steps to reach the desired optimization, which will be further analysed in the cooperation with MJM and involved into the Foodie platform:

- Creating transport schedules, which satisfy all constraints and minimizing transport costs.
- Creating schedules, which minimize deviation from requested times of loading/ unloading (taking in account priorities) and satisfy other constraints. In this case, allowed costs of transport will be additional constraint defined by a user of the Foodie platform.
- Assigning costs to unsatisfied loading/ unloading times and aggregating the costs with transportation costs. Furthermore, creating schedule respecting other constraints and minimizing the aggregated costs.
- Creating schedules based on some of multi-criteria decision methods.

Scenario B – Telematics of farm machinery

Operation of agricultural machinery significantly influences the economic profitability of the crop management. First of all, it applies to the fuel consumption, machines and operators' workload, control of performed treatments and the environmental effects such as reducing the risk of deterioration of soil physical properties. Verification of the monitoring system will be done at both pilot farms by an evaluation of tractors' work during basic operation such as soil tillage, fertilization, sowing, crop protection as well as harvest and grass management. Similar monitoring will be tested at the enterprise which offers services for farmers (MJM Litovel) for assessing the quality of work for customers.

Main purposes of this scenario is:

- Evaluation of the economic efficiency

of machinery operations within the fields.

- Precise records of crop management treatments (mainly for fertilizers, pesticides).
- Improved management of machinery operations and planning of crop management treatments.
- Control of quality of field operations, such as pass-to-pass errors and overlaps, coverage of maintained area, recommended work speed.
- Control of applied input material in comparison to prescribed rates.
- Compliance of agro-environmental limits (Nitrate Directive, Good Agricultural and Environmental Conditions - GAEC, protection of water resources, etc.).

From the technical point of view, the monitoring system involves tracking of the vehicles position using GPS combined with acquisition of information from on-board terminal (CAN-BUS) and their online/offline transfer to GIS environment for spatial analysis and visualization.

Scenario C – Monitoring of in-field variability for site specific crop management

Site specific crop management requires information about the within-field variability of soil condition and crop stand. The use of remote sensing is a key step in obtaining whole-area data to support agronomical treatments during the vegetation season. The aim is to develop a stable monitoring system for effective identification of spatio-temporal variability of crops and to use this information for optimization of the crop management practices.

The monitoring system includes three types of observation to provide information about crop variability at different spatial and temporal level:

1. **Operative aerial remote sensing** for whole-area mapping of the fields at high spatial resolution but with low frequency – temporal resolution. The aim is to prepare the prescription maps for variable applications of fertilizers and pesticides, estimated by the spectral measurement of crop parameters. The frequency of the survey depends on the crop type, agronomical operations, crop management intensity and weather conditions. Aerial imaging will be carried out using multispectral camera by an external provider of photogrammetric services. Within the Foodie project, a workflow will be developed for pre-processing of acquired images (radiometric and geometric corrections) and their analysis and classification according to the MJM interpretation algorithms.
2. **Periodic satellite remote sensing** for wide-ranging identification of spatial variability and simultaneously capturing the dynamics of vegetation growth, both at medium level of spatial resolution (30 metres per pixel, once per 14 days). Suggested satellite survey is based on the free available data of Landsat 8 or in 2015 launched Sentinel-2. The main information is the vegetation index NDVI determined from R (red) and NIR (near infra-red) bands. The absolute values of NDVI, their relative to mean value of the field and change detection will be implemented for assessment of crop stands and delineating of management zones.
3. **Meteorological monitoring** at farm level to capture detailed dynamics of weather conditions on the ground. Weather data will be recorded at the specific localities in high frequency (between 10 and 15 minutes). The main goal is to obtain data for modelling of crop growth and to support decision making by agronomist for plant protection (prediction of the plant pests and diseases infestation), plant nutrition (crop growth and nutrient supply), soil tillage (soil moisture regime) and irrigation (soil moisture).

Conclusion

The discussed Foodie platform represents a new approach to the precision agriculture domain. It uses observing and measuring tools, like remote sensing techniques, similarly to the advanced precision agriculture/farming systems. Moreover, the Foodie platform offers the complex set of tasks in order to enhance the "traditional" view on the precision agriculture/farming. To be more specific, the Foodie platform deals with the issues of telematics to/from the field, fleet management, reduction of environmental impacts, improving the energy balance, etc. that are mostly beyond the advanced precision agriculture/farming systems.

One of the greatest differences is the openness of the Foodie platform when using the cloud computing. As such, it enables the agricultural data interoperability. Pan European activities

like INSPIRE, COPERNICUS and/or GODAN may be integrated as a part of the Foodie hub. On the technological level, for instance, any Web service respecting the standards in the geospatial domain may be connected to the system. Examples in this direction may be found in the Open Geospatial Consortium's Web Map Services (WMS), Web Feature Services (WFS), RESTful APIs, etc. As the result, the Foodie platform is significantly customizable and scalable.

One of the main open issues lies in the area that affects Big Data in all its forms. Farmers usually distrust the companies aggregating data. Farmers afraid, that their sensitive detailed data may be misused. Future development would therefore be on the technological level as well as on the personal level to ensure the usefulness of the Foodie platform in daily life.

Acknowledgements

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No. 621074 and from the project MUNI/A/0952/2013 called "Analysis, evaluation and visualization of global environmental changes in the Component Earth's Spheres".

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Agris on-line Papers in Economics and Informatics

Volume VII Number 1, 2015

Impact of Irrigation Technologies on Rural Households' Poverty Status: the Case of Fogera District, North-Western Ethiopia

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Abstract

This study tries to analyze whether irrigation technologies have reduced the incidence, depth, and severity of poverty in Fogera district of the Amhara National Regional State of Ethiopia. It also assesses the possible impact brought about by irrigation technologies on households' per capita consumption expenditure. Foster-Greer-Thorbeck (FGT) index and Propensity Score Matching (PSM) were used for analyzing the data collected from 180 farm households through formal survey techniques. The result indicated that annual per capita consumption expenditure of irrigation technology users is better than that of non-users. Among the different irrigation technology user groups, per capita consumption expenditure of diversion irrigation users is higher followed by that of motor pump users and treadle pump users in that order. Results from FGT index showed that users of different irrigation technologies are in a better position in terms of incidence, depth, and severity of poverty as compared to the non-users group. The PSM result also indicated that irrigation has increased per capita consumption expenditure of user households by 21 percent. It is, therefore, necessary to develop small-scale irrigation technologies and to encourage farm households to use the technologies in order to reduce poverty.

Keywords:

Ethiopia, poverty, irrigation technologies, propensity score matching.

Introduction

Irrigated agriculture has been increasing from time. World irrigated areas have changed from 139 million ha in the 1961 to over 273 million ha in 2001 (IWMI, 2002) and then to 309.6 million ha in 2011 (World Fact Book, 2012). Much of this expansion has taken place in developing countries of Asia (IWMI, 2002). Those regions that have the greatest proportion of cultivated area irrigated (namely East Asia and Pacific and North Africa and Middle East) have experienced the greatest poverty reduction. In Africa, only around 3% of cropland is irrigated and the region has experienced very little reduction in poverty in 1990s, for instance (World Bank, 2000). These are indications that the differences across different areas and countries in irrigation is an important factor in determining rates of poverty reduction.

Ethiopia is located in a geographical region where it is endowed with a favorable climate which receives a relatively higher amount of rainfall in the region. Much of the water, however, flows across the borders being carried away by the trans-boundary rivers to the neighboring countries. Many studies and professional estimates indicate that the country has an annual surface runoff of close to 122 billion metric cube of water excluding ground water, and has about 3.7 million hectares of potentially irrigable land (Bekele, 2010). However, reliable food supply is almost impossible due to the temporal imbalance in the distribution of rainfall and the consequential limited availability of the required water at the required period. Consequently, the country remains one of the world's poorest nations with around 25 million people, out of over 80 million, living in extreme poverty.

The Amhara National Regional State where this study was conducted is in the vulnerable regions characterized by subsistence farming which produce predominantly cereal crops for household consumption and local markets. Crop production in the region failed to produce sufficient food for the population due to various reasons including the recurrence of drought in the region and the degradation of the environmental. Like other parts of the Amhara Region, the South Gonder zone is also drought prone area. Many studies show that many districts of the zone are food insufficient.

However, this area has surface and ground water resources which are not being accessed to full potential for production purposes. The Fogera district located east of Lake Tana includes the Fogera plain which has been identified as land with potential to be irrigated as there is a sufficient water resource. However, the district has not used its resources to full potential due to socio-economic, technical and institutional challenges.

Many households in Fogera district are using irrigation technologies to increase production levels. Different irrigation technologies like diversion irrigation, motor pump, and treadle pump are being practiced by the farmers in the area. On the other hand, there are farmers who are not using irrigation technologies even if their land is on irrigable soils. This is may be because of the fact that some farmers have inadequate knowledge on the benefits of irrigation or that they have various impediments to adopt the available irrigation technologies.

While there is empirical evidence in various countries that irrigation development has a substantial impact on poverty reduction, such impact may be determined by a number of factors including farm level characteristics, irrigated technology characteristics, household level variables, institutional setup and others. Owing to the fact that irrigation can generally contribute in reducing poverty and increasing crop production, it is necessary to look into whether irrigation technology users are significantly better off as compared to non-users in terms of incidence, depth, and severity of poverty and in terms of impact on consumption levels brought about by irrigation. Furthermore, it is also important to assess if there are some differences in consumption levels among the different households using different types of irrigation technologies.

In this connection, available previous studies in the country are very scanty on one hand and are relatively older on the other (Bacha et al., 2009; Van der Berg, Ruben, 2006; Tesfay et al., 2006). Because of the fact that socio-cultural, political and economic features are likely to change overtime, it is necessary to have updated research findings on which preparation and implementation of different policies for improving livelihoods and food security are based. It is, therefore, with this assumption that the current study was carried out in Fogera district of South Gondar zone.

The specific aims of this study were measuring incidence, depth and severity of poverty between users and non users of irrigation and assessing impact of irrigation on households' consumption expenditure as a measure of poverty.

Materials and methods

Description of the study area

The study was conducted in Fogera district, South Gondar administrative zone of Amhara National Regional State (ANRS). Fogera district is one of the 10 districts in South Gondar administrative zone. It is bordered with Libo Kemkem district in the North, Dera district in the South, Farta and Estie districts in the East and Lake Tana in the West. Woreta is the district town and is found 625 km from Addis Ababa, 55 km from the regional capital, Bahir Dar, and 42 km from Debre Tabor (Zonal city of South Gondar). According to the relatively recent population census, the district has a total population of 249,824 of which 127,286 are males and the remaining 122,540 are females in 2012. Rural dwellers constitute about 89 percent of the population (CSA, 2013).

The district is divided in to 27 rural and 1 urban *kebeles*[1]. It encompasses 102,809 ha. The land use constitute 44.1 percent of cultivated land, 23 percent of pasture land, 1.9 percent of forest and bush land, 19.9 percent of land covered with water, 6 percent of land covered with constructions, 1.4 percent of swamp land, and 3.7 percent of wasteland. The district is characterized under Weinadega agro-ecological zone. Its average rainfall ranges between 1,103-1,336 mm. The main rainy season extends from May to September. The district's altitude ranges between 1,774 to 2,410 m.a.s.l. Flat land accounts for 76 percent and mountain and hills the remaining 24 percent. The farming system of the district comprises mixed crop-livestock farming system dominated by crop production.

The district is one of the eight districts bordering Lake Tana and has an estimated water body of 23,354 ha. Gumara and Ribb are the two major permanent rivers in the district. There are also 277 different springs, and 16001 hand-dug wells used for irrigation. The district has about 886 motor pumps, 631 treadle pump and 3 diversion irrigation technologies. A total of 20635 hectare of land was developed with irrigation, according to unpublished

[1] *Kebele is the smallest administration unit in the government structure.*

report from Fogera district office of agriculture.

Sources and methods of data collection

Fogera district was selected purposively. From 27 rural kebeles of the district 16 were purposively identified based on the existence of irrigation technologies and experience of irrigation for long time. At the third stage, 4 *kebeles* were randomly selected. Then, households in the selected *kebeles* were stratified into users and non users of irrigation technologies. Irrigation users are defined as those who used lift system irrigation technologies such as treadle pump, motor pump and diversion irrigation. Non-user households are defined as farmers who do not make use of the irrigation technologies mentioned above during the same period. Then a total of 180 households (90 from users and 90 from non users) were selected from the 4 kebeles based on the proportion of participant households in the selected kebeles using random sampling techniques. The numbers of non-participant farmers selected were based on the number of participant farmers in the *kebeles* (i.e. equal to the number of participants sample size in each *kebele*).The required data were collected using formal survey methods employing questionnaires prepared for the purpose.

Data analysis

The Foster-Greer-Thorbeck (FGT) index was used to determine the incidence, depth and severity of poverty between users and non-users of irrigation technologies. It is specified as follows:

$$P_{(\alpha)} = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{y_p - y_i}{y_p}\right)^{\alpha} \quad (1)$$

Where n is the number of sample households, yi is per capita consumption expenditure (consumption expenditure per adult equivalent) of the ith household, y_p represents the poverty line, q is the number of households below the poverty line and α is the poverty aversion parameter. The poverty aversion parameter takes a value of 0, 1, or 2. If α = 0, then the result (p) is poverty head count ratio, which measures the incidence of poverty within the sample. When α = 1, the result (p) is a poverty gap index, which measures depth of poverty or the aggregate consumption shortfall of the poor from the poverty line. Finally, if α = 2, the result (p) is a squared poverty gap, which measures the severity or intensity of poverty.

To isolate the independent impact of participation in irrigation on poverty reduction, propensity score matching (PSM) was used. A logit model was used to estimate propensity scores using a composite of pre-intervention characteristics of the sampled households (Rosenbaum, Rubin, 1983) and matching was performed using propensity scores of each observation. In estimating the logit model, the dependent variable was participation in irrigation, which takes the value of 1 if a household is irrigation technology user and 0 otherwise.

The cumulative logistic probability function is specified as

$$P_i = F(Z_i) = F(\alpha + \sum \beta_t X_{ti}) = \left(\frac{1}{1+e^{-(\alpha+\sum \beta_t X_{ti})}}\right) \quad (2)$$

Where:

e represents the base of natural logarithms (≈2.718)

X_{ti} represents the tth explanatory variable (t=1,2,…,m) for the ith individual

P_i is the probability that ith individual will make a certain choice (in this case use of irrigation technology) given m explanatory variables

α & β_t are parameters to be estimated ($t = 1, 2,.., m$; m is number of explanatory variables).

Interpretation of the coefficients will be understandable if the logistic model is written in terms of the odds and log of odds. The odds ratio implies the ratio of the probability that an individual would choose an alternative (P_i) to the probability that he/she would not choose it (1-P_i).

But,

$$(1 - P_i) = \frac{1}{1+e^{Z_i}} \quad (3)$$

Therefore,

$$\left(\frac{P_i}{1-P_i}\right) = \left(\frac{1+e^{Z_i}}{1+e^{-Z_i}}\right) = e^{Z_i} \quad (4)$$

Or,

$$\left(\frac{P_i}{1-P_i}\right) = \left(\frac{1+e^{Z_i}}{1+e^{-Z_i}}\right) = e^{(\alpha+\sum \beta_t X_{ti})} \quad (5)$$

Taking the natural logarithm of equation (5) will result in what is known as the logit model as indicated below:

$$Z_i = \ln(\frac{P_i}{1-P_i}) = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + ... + \beta_{mi} X_{mi} \quad (6)$$

If the disturbance term U_i is taken in to account, the logit model becomes

$$Z_i = \alpha + \sum \beta_t X_{ti} + U_i \quad (7)$$

After running the logit model, then the common support region where the values of propensity scores of both users and comparison groups can be found was identified. The region of common support was defined by dropping observations below the maximum of the minimums and above the minimum of the maximums of the balancing scores between the two groups (Diaz, Handa, 2005). Then the average treatment effect on treated (ATT) are only determined in the region of common support (Caliendo, Kopeinig, 2008).

The next step in propensity score matching is to get the matching algorithm which best matches the treated observations with untreated based on the propensity scores from the preceding step. Treatment, in this case, is use of irrigation technologies. There are different matching estimators in theory. According to Caliendo and Kopeinig (2008), the most commonly applied matching estimators are nearest neighbor matching, Caliper and Radius matching, Stratification and Interval matching, Kernel and local linear matching. All matching estimators contrast the outcome of a treated individual with outcomes of comparison group members (Caliendo, Kopeinig, 2008).

To estimate the effect of irrigation technologies to a given outcome[2] (consumption expenditure per adult equivalent), is specified as:

$$C = \frac{\sum_{j=1}^{P} C_{ij1} - \sum_{i=1}^{NP} C_{ij0}}{P}$$

Where, C_{ij1} is the post intervention per capita consumption expenditure of household j, C_{ij0} is the per capita consumption expenditure of the i^{th} non-participant matched to the jth participant, P is the total number of participants (users of irrigation), NP is the total number of non-participants (non-users of irrigation) and C is difference in per capita consumption expenditure in Ethiopian birr.

Then the average effect of use of irrigation technologies on outcome variables (consumption expenditure per adult equivalent) was computed and it was specified as:

$$\tau_i = Y_i(D_i = 1) - Y_i(D_i = 0)$$

Where τ_i is treatment effect (effect due to use of irrigation technology), Y_i is the outcome on household , D_i is whether household i has got the treatment or not (i.e. whether a household used irrigation technology or not).

However, one should notice that $\tau_i = Y_i(D_i = 1)$ and $\tau_i = Y_i(D_i = 0)$ cannot be observed for the same household at the same time. Depending on the position of households in the treatment (intervention participation), either $\tau_i = Y_i(D_i = 1)$ or $\tau_i = Y_i(D_i = 0)$ is unobserved outcome (called counterfactual outcome). Due to this fact, estimating household's treatment effect is not possible. One has to shift to estimate the average treatment effect of the population than the individual one. The most commonly used average treatment effect estimation is the average treatment effect on the treated (τ_{ATT}) and is specified as

$$\tau_{ATT} = E(\tau | D = 1) = E[Y(1) | D = 1] - E[Y(0) | D = 1]$$

As the counterfactual mean for those being treated, $E[Y(1) | D = 1]$ is not observed, one has to choose a proper substitute for it in order to estimate ATT. One may think to use the mean outcome of the untreated households, $E[Y(1) | D = 0]$ as a substitute to the counterfactual mean for those being treated, $E[Y(1) | D = 1]$. However, this is not a good idea especially in non-experimental studies. Because, it is most likely that components which determine the treatment decision also determine the outcome variables of interest.

For our particular case, variables that determine household's decision to use irrigation technology could also affect household's consumption expenditure per adult equivalent. Therefore, the outcomes of individuals from treatment and comparison group would differ in the absence of treatment leading to a self selection bias.

By rearranging and subtracting $E[Y(1) | D = 1]$ form both sides, one can get the following specification for ATT.

$$E[Y(1) | D = 1] - E[Y(0) | D = 0] = \tau_{ATT} + E[Y(0) | D = 1] - E[Y(0) | D = 0]$$

Both terms in the left hand side are observables and ATT can be identified if and only

[2] Keeping conditional independence assumption and common support (overlap) assumption

if $E[Y(1)|D=1]-E[Y(0)|D=0]=0$, i.e. when there is no self selection bias. This condition can be ensured only in social experiment where treatments are assigned to units randomly (i.e. when there is no self section bias). In non-experimental studies one has to introduce some identifying assumption to solve the selection problems. The following are two strong assumptions to solve the selection problem.

Conditional independent assumption: Given a set of observables covariates (*X*) which are not affected by treatment (in our case, use of the technology), potential outcome (consumption expenditure per adult equivalent) is independent of treatment assignment (independent of how technology use decision is made by households). This assumption implies that the selection is solely based on observable characteristics and variables that influence treatment assignment (use of irrigation technology made by household) and potential outcomes (consumption expenditure per adult equivalent) are simultaneously observed.

Common support region: This assumption rules out perfect predictability of *D* given *X*. That is $0<P(D=1|X)<1$. This assumption ensures that households with the same *X* values have a positive relation of being both users and non- users.

Given the above two assumptions, the PSM estimators of ATT can be written as

$$\tau_{ATT}^{PSM}=E_{P(x)|D=1}\{E[y(1)|D=1,P(X)]-E[Y(0)|D=0,P(X)]\}$$

Where *P(X)* is the propensity score computed on the covariates *X*. The above equation indicates that the *PSM* estimators is the mean difference in outcome over the common support, appropriately weighted by the propensity score distribution of participants.

Results and discussion

Descriptive results

Descriptive results of the major variables, both for irrigation technology users and non-users, are indicated in Table 1 below together with their units of measurement. According to the results, users of irrigation technologies have higher family size (5.5) as compared to non-users and about 96% of the user households are headed by male as compared to only 86% for the non-users. These are mainly related to the labor requirements of the technologies. Mean values of the other variables for the users and non-users are also indicated in Table 1.

Consumption expenditure under different irrigation technology users

Table 2 indicates that as far as irrigation lift technologies and diversion irrigation are concerned, households using diversion irrigation technology have more per-capita consumption expenditure than users of other irrigation technologies. Users of motor pump irrigation technology users are also better off in terms of per capita consumption expenditure than users of treadle pump irrigation users. This is because of the fact that the operational cost of diversion irrigation is minimum or nil in the study area. Since motor pump irrigation technology users are better in income position

Variables	Measurements	Mean Values		
		All	Users	Non-users
Sex of HH head	1 for male, 0 otherwise	0.906	0.956	0.856
Age of the HH head	Year	42.49	42.42	42.56
Education level of HH head	1 for literate, 0 otherwise	0.317	0.40	0.233
Family size	Number	5.18	5.47	4.89
Distance to market	Kilometers	5.49	4.98	6.01
Distance from DAs' office	Kilometers	2.20	2.19	2.20
Average distance from farm land	Kilometers	1.52	1.45	1.59
Membership to farmers' coops	1 for member, 0 otherwise	0.533	0.567	0.50
Cultivated land size	Hectare	1.20	1.27	1.12
Number of oxen owned	Number	1.59	1.79	1.38

Source: own elaboration

Table 1: Description of household characteristics by irrigation use.

than treadle pump users and irrigation non user households they are better off in consumption expenditure.

Comparison of poverty profile

To estimate poverty line, first the food poverty line was estimated, and then adjusted to account for non-food consumption expenditure. The food poverty line was constructed following the cost of basic needs (CBN) approach. The average quantity of food items that were most frequently consumed by households in the lowest quartile expenditure distribution was derived. These were then converted into calorie consumption and scale up to provide 2200 kcal/person/day, the minimum energy requirement for a person to lead a normal physical life under Ethiopian condition, as estimated by Ethiopian Nutrition Institute and used by similar studies in Ethiopia (Hagos, Holden, 2003; Bacha et al., 2009). To arrive at the food poverty line, this bundle was valued at local market prices in the study area. Therefore, the food poverty line is found to be Birr 1770.37 per person in AE/year. The non-food expenditure component is also calculated using the average food share for households that had failed to attain the food poverty line. The food share for households that had failed to attain the food poverty line is found to be 76.3 percent. This figure is used to estimate allowance of non-food expenditure and found to be Birr 548.99 per person in AE/year and, therefore, gives a total poverty line of Birr 2319.36 per person in AE/year. Hence, when this study refers to 'poor' it means those whose per adult consumption (food and non-food) expenditure per annum falls below 2319.36 Birr at 2010/11 crop prices in the study area.

The FGT index was used to determine the incidence, depth and severity of poverty between users and non-users of irrigation technologies. Based on the above poverty line estimation, the result showed that the headcount index in the area was 16.1 percent (Table 3). About 16.1 percent of the sample households were living below poverty line and unable to fulfill the minimum consumption requirement. This figure is found to be smaller than those reported by other studies in other parts of the country indicating that the study area is in a relatively better position in terms of head count index. The overall poverty gap was 3.4 percent indicating that poor households needed, on average, an additional 3.4 percent of the present expenditure to attain their minimum basic needs. The squared poverty gap was 0.011 showing that there is an inequality among the lowest quartile sample households.

When poverty indices were disaggregated into irrigation technology users and non-users, irrigation users using the absolute overall poverty line of 2319.36 Birr significantly lowered poverty levels in incidence, depth, and severity. The result

Category	Observations	Mean (Birr)	Std. Deviation	t-value
Irrigation water lift technologies and diversion irrigation				
Diversion irrigation	24	4472.40	1678.57	4.76***
Motor pump	52	3781.83	1249.81	3.27***
Treadle	14	3338.42	879.08	0.69
Access to irrigation				
User	90	3897.01	1371.94	4.17***
Non-user	90	3129.52	1082.40	

***statistically significant 1 percent probability levels

Source: own elaboration

Table 2: Comparison of per capita consumption expenditure of respondents among the different irrigation technology users and non-users.

Category	Head Count Index	Poverty Gap Index	Square Poverty Gap
Over all	0.1611	0.0339	0.0110
Irrigation technology users	0.1111	0.0167	0.0042
Non-users	0.2111	0.0511	0.0173

Source: own elaboration

Table 3: Poverty indices of irrigation users and non-users.

showed 11.1 percent of user households were identified as poor while 21.1 percent of non-user households were identified as poor.

Similarly, depth and severity of poverty are also more pronounced among non-irrigators. The poverty gap index (a measure of depth of poverty) is 1.7 percent for irrigators and 5.1 percent for non-irrigators. This implies that to lift the poor non-irrigators out of poverty, their current consumption level would have to increase by 5.1 percent, while poor farmers from the irrigator group need only 1.7 percent increases from their current consumption level to move above the poverty line. The squared poverty gap index (poverty severity) was 0.0042 to users while 0.0173 to irrigation non-users showing inequality among the poor is higher for non-users.

Econometric results

The maximum likelihood estimate of the logistic regression model result shows that participation was influenced by four variables. Sex of the household head, educational level, distance from market and number of oxen owned by the household are variables that significantly affected participation of households in irrigation farming (Table 4). After estimating values of irrigation participation (propensity scores) for irrigation users and non users, the second step is matching users and the control group by imposing a common support condition. As shown in Table 5, the estimated propensity scores vary between 0.092 and 0.920 (mean = 0.589) for treatment households and between 0.036 and 0.905 (mean = 0.411) for control households. In other words, households whose estimated propensity scores are less than 0.092 and larger than 0.905 are not considered for the matching exercise. As a result of this restriction, four households (one treatment and three control households) were discarded from the analysis.

Variables	Coefficients	Standard errors
Sex of household head	1.129*	0.632
Age of household head	-0.013	0.152
Level of education of household head	0.755**	0.367
Family size	0.106	0.124
Distance from the nearest market	-0.289**	0.09
Distance from DA office	-0.088	0.141
Distance from farm land	-0.139	0.206
Membership to coops/organizations	-0.119	0.367
Size of cultivated land	0.441	0.432
Number of oxen owned	0.561**	0.257
Constant	-0.921	1.178
Sample size(n)	180	
Pseudo R^2	0.1375	
LR chi2(10)	34.31	
Pro>chi2	0.0002	
Log likelihood	-107.61	

*, ** and ***statistically significant at 10, 5 and 1 percent probability levels, respectively
Source: own elaboration

Table 4: Logit model results of determinants of households' participation in irrigation technologies.

Group	Obs	Mean	STD	Min	Max
Total HHs	180	0.5	0.209	0.036	0.920
Treatment HHs	90	0.589	0.169	0.092	0.920
Control HHs	90	0.411	0.209	0.036	0.905

Source: own elaboration

Table 5: Distribution of estimated propensity scores.

Alternative matching estimators can be employed in matching the user and comparison households in the common support region. The final choice of a matching estimator can be done taking selection criterion like balancing test, pseudo-R^2 and matched sample size. A matching estimator which balances all explanatory variables (i.e., results in insignificant mean differences between the two groups), a model which bears a low pseudo R^2 value and results in large matched sample size is a preferable matching algorism (Dehejia, Wahba, 2002).

After looking into the results, it has been found that four nearest neighbor matching is selected. Hence, four nearest neighbor matching is the best estimator for the data at hand based on matching quality criteria. Studies by Diaz and Handa (2005), and Bernard et al. (2007) selected nearest neighbor matching as their matching algorithm method based on matching quality criteria. In this case the individual from the control group is chosen as a matching partner for a treated individual with the least distance in terms of propensity score. Each treatment observation is matched with the average value of its four nearest comparison neighbors, again based on the propensity score distribution (Becker, Ichino, 2002).

After controlling for pre-intervention differences of the user and non user households, per-capita consumption expenditure of the treated group was 3888.01 and the control group has per-capita consumption expenditure of 3071.27 birr. The two-group mean difference test was strongly significant at 1 percent level. It has been found that, on average, irrigation user households have significantly increased per capita consumption expenditure by 816.74 birr. That means irrigation has increased per capita consumption of the irrigation technology users by 21 percent. This figure is high especially in areas where rain-fed agriculture is possible with limited scope. This consumption expenditure difference between irrigation users and the control group reflect a household's difference in quality of life and ability to meet basic needs. So there is a great difference in tackling poverty between irrigation users and non-users. The result supported the fact that irrigation reduces poverty as it is also indicated in various other studies (Hussain, Hanjra, 2004).

Conclusion

Diversion irrigation technology users are at relatively higher standard of living than motor and treadle pump users in terms of per capita consumption (consumption per adult equivalent). Motor pump users have also better standard of living than treadle pump irrigation technology user households. The head count index, the poverty gap index and the severity index showed that users of irrigation technology are better off in terms of incidence, depth, and severity of poverty as compared to non-users of irrigation technologies.

After controlling for pre-intervention differences of the user and non-user households, it has been found that irrigation user households have increased per capita consumption expenditure by 21 percent than non-irrigation technology users supporting the fact that irrigation reduces poverty. The sensitivity test result showed that the impact estimates (ATT) are insensitive to unobserved selection bias and are a pure effect of irrigation technologies on poverty status.

Based on the empirical findings reported in this study, small-scale irrigations using different irrigation water lift technologies and diversion irrigation need to be encouraged to increase crop production and hence reduce poverty. Even though use of irrigation water lift system technologies and diversion irrigation technologies have a strong poverty reduction potential, priority should be given to promotion of diversion irrigation technologies. Its minimum operation costs and ability to poverty reduction made it to be selected but it should be designed appropriately to surface water resources. Unless the landscape and water source prohibit doing so, construction of diversion irrigation is a best strategy.

Motor pump is an appropriate technology for intensive farming especially in areas with undulating and ragged topography having difficulties of diverting water sources to farm lands. Therefore, it is necessary to deliver best quality motor pumps technologies in such areas.

Alleviating oxen power shortage and upgrading education level of farmers need special attention to improve the irrigation system and to motivate farmers towards irrigation technologies participation. Market distance from the producer is also one problem to the area. Facilitating market centers and improving market infrastructures need special attention.

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Agris on-line Papers in Economics and Informatics

Volume VII Number 1, 2015

Position of Agriculture in Sub-Saharan GDP Structure and Economic Performance

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Anotace

Afrika je kontinent se specifickými problémy, které odlišují tuto část světa od jiných regionů. Nízká ekonomická výkonnost řadí většinu států mezi nejchudší země světa. Avšak africké zdroje a nevyužité příležitosti skýtají značný potenciál pro ekonomický rozvoj. Zemědělský sektor hraje v africkém ekonomickém rozvoji specifickou roli, jelikož jeho podíl na celkové zaměstnanosti a tvorbě HDP je vysoký. Cílem příspěvku je analyzovat změny ve struktuře HDP (zemědělství, průmyslu a sektoru služeb), k nimž došlo ve vybraných afrických (subsaharských) zemích během uplynulého dvacetiletého období. Vývoj hodnoty HDP a HDP/obyvatele v sub-saharské Africe je komparován s vývojem světového HDP a HDP/obyvatele. Vlastní srovnání je realizováno prostřednictvím analýzy postavené na logaritmické regresy a výpočtu elasticity HDP a HDP/obyvatele ve vztahu k vývoji hodnoty HDP generovaného zemědělstvím, průmyslem a službami. Zvláštní pozornost je věnována postavení zemědělství ve vztahu k ostatním odvětvím. Výsledky indikují hlavní trendy v ekonomickém rozvoji a poukazují na specifikum, že zatímco řada subsaharských států dosáhla moderního typu ekonomiky s převahou služeb ve struktuře HDP, zemědělství dominuje ve většině zemí z hlediska zaměstnanosti. Proces transformace v subsaharské Africe stále nedosáhl úrovně globální ekonomické transformace. V budoucnu lze očekávat výrazné snížení podílu zemědělství na celkovém HDP a rostoucí roli zpracovatelského průmyslu a zejména služeb v HDP daného regionu.

Klíčová slova

Subsaharská Afrika, hospodářský rozvoj, zemědělství, průmysl, služby, hrubý domácí produkt.

Abstract

Africa is a continent with specific problems differentiating this part of the world from other regions. Low economic performance ranks most of African countries among the poorest. On the other hand, African resources and unexploited opportunities offer a potential for a considerable economic development. Agricultural sector plays a specific role in African economic development because its share in total employment and GDP formation is enormous high. The aim of the paper is to analyze main changes in area of GDP structure formation (agricultural, industrial and services sector) which have occurred in selected African (Sub-Saharan) countries during a twenty-year period. The GDP and GDP per capita in Sub-Saharan countries are compared with the world GDP and GDP per capita. The comparative analysis is performed through logarithmic regression and elasticity analysis. The idea is to analyse the relationship existing between GDP and GDP per cap in relation to the GDP value generated by agriculture, industry and services sectors. The special attention is devoted to the position of agricultural sector in relation to the other sectors. The results indicate main trends in economic development and point to the specifics that while many Sub-Saharan countries have reached the modern type of economy with prevailing services in GDP composition, agriculture still dominates in most countries in terms of employment. From the economic point of view it is worth noting that the transformation process in Sub-Saharan Africa still has not reached the level of the global economic transformation. A significant reduction of agriculture's share in total GDP is to be expected in the future, it is also possible to expect an increasing role of processing industry and especially of services in the regional GDP.

JEL classification: E

Key words

Sub-Saharan Africa, economic development, agriculture, industry, services, gross domestic product.

Introduction

Africa is one of the most specific regions within the world economy. More than one billion people living in Africa represent over 15% of total world population Jenicek (2010). However, its share in global economy is about 2 – 3%. African specifics are apparent mostly in the Sub-Saharan region. Population in this part of Africa reaches about 900 million which represents 12.7% of total world population but its share in global economy (in terms of GDP) is less than 1.7%. Africa and especially its Sub-Saharan part has experienced a very specific and also very dynamic economic development over the recent two decades Thies (2007); Ahmed andSuardit (2007); Ndulu (2006).

The world economy changed significantly in the period after the end of the cold war. The removal of barriers between the western and eastern blocks affected not only the countries directly involved in the west-east competition, but a significant effect was experienced in the case of those countries which were formerly satellites of the antagonistic blocks or which were performing their policies on the edge between the two competing groups. In the early ´90s, African and especially the Sub-Saharan countries opened a new chapter of their economic development (Maitah et al., 2014). During the recent two decades (1990 – 2011), the countries transformed their economies, and the structure of their GDP formation changed significantly. African countries experienced a rapid growth in the service and industrial sectors and a decreasing proportion of agriculture and mining. Another important factor influencing economic development in Sub-Sahara has been a growth of foreign trade in individual countries Johnson (2005); Bussmann et al. (2005). The Sub-Saharan countries have become more involved in the world trade Anderson et al. (2004). During the last two decades, foreign trade became an important component of their GDP formation. Unfortunately, territorial and commodity structure of the foreign trade is still not developed enough Kirkpatrick and Watanabe (2005). This applies especially to the intra-regional trade Tekle et al. (2008). Despite many formal agreements, the mutual trade remains at a low level. Intra-regional trade thus represents only about 10% of the total Sub-Saharan foreign trade. African countries are more dependent on trade with Europe and Asia than on trade within the region. Such situation is specific compared with other regions, e.g. Europe (about 70% of foreign trade operations are performed within Europe), Asia (50%) and America (over 50%).

Very strong position of the agricultural sector belongs to specific features of African economies. The agricultural population represents almost 60% of the total African population (675 million). Agricultural sector also provides working opportunities for more than 51% of the total economically active population (237 million). The share of the agricultural sector in total GDP formation is very high (in comparison to the rest of the World), the value exceeds 10% in average, but there are also countries where the share this share reaches 30 – 40%.

The aim of the paper is to analyze main changes in area of GDP structure formation (agricultural, industrial and services sector) which have occurred in selected African (Sub-Saharan) countries during a twenty-year period.

Materials and methods

The paper is analysing the GDP formation and structure in selected Sub-Saharan countries in the period 1990 – 2011 (The mentioned time period is chosen because of limited data availability. Available data for 2012 and 2013 are not complete for all Sub-Saharan countries.). The GDP is expressed in USD, both in current and constant prices (2005). The changes are analysed both in relation to total value and on a per capita basis. The idea is to identify main development trends in the Sub-Saharan region and differences among individual Sub-Saharan countries with the aim to determine particular groups of African countries by their economic structure as well as to find differences in their GDP formation. For this reason, the paper divides the countries surveyed into four groups according to the structure of their GDP formation: agriculture, services, industry (ASI); industry, services, agriculture (ISA); services, industry, agriculture (SIA); and services, agriculture, industry (SAI).

The above mentioned typology of classifying countries by their economic structure is based

on a method defined by A. Holub (1970). According to Holub (1970), three historical stages of economic development exist: the traditional stage (where agriculture is the main economic driving force), transitional (with main economic driving force of industry) and modern economy (the sector of services as the main economic driving force). This theory provides a basis for analysing structural development of the GDP formation in Sub-Saharan countries and for identifying differences among the analysed countries in relation to their GDP structure and formation.

Main data have been provided by the World Bank (WDI database). The analysis is focused especially on the Sub-Saharan region which consists of about fifty countries at different stages of their economic development. Because of limited data availability, 37 countries located in Sub-Sahara and North Africa have been selected.

GDP formation in the selected countries has been analysed from three different perspectives, namely the GDP in agricultural, industrial and service sectors. A special part of the paper is focused on the GDP analysis at the per capita level. The GDP per capita is analysed on the same methodological basis used for the GDP as a total. The analysis aims to highlight the existing differences between the total GDP and GDP per capita development trends, which makes it possible to understand real problems of economic development in Sub-Saharan Africa.

The Sub-Saharan countries' GDP and GDP per capita are analysed in relation to agricultural, industrial and services sectors. The mutual relationship between the total GDP and its particular components is analysed using methods of regression and elasticity analysis (Hindls et al, 2007). The analysis of elasticity is based on logarithmic regression. The values coming into the analyses are collected at constant 2005, USD prices.

Y (total GDP) = $\beta_0 + \beta_1 \ln X_1$ (Agricultural GDP) + $\beta_2 \ln X_2$ (Industrial GDP) + $\beta_3 \ln X_3$ (Services GDP)

Y (total GDP/cap) = $\beta_0 + \beta_1 \ln X_1$ (Agricultural GDP/cap) + $\beta_2 \ln X_2$ (Industrial GDP/cap) + $\beta_3 \ln X_3$ (Services GDP/cap)

The ambition of the regression is to determine functional elasticity existing between the total GDP or total GDP per capita on one side, and agricultural, industrial and services sectors' GDP respectively GDP per capita on the other side. The logarithmic regression is conducted both for Sub-Saharan economy and also for the World economy as a whole. The idea is to compare the African and World economy and to highlight differences existing between Sub-Saharan Africa and the World. All calculations are conducted in STATISTICA 7.0.

Analysis and discussion

During the last two decades, global economy experienced a significant growth. The world GDP has increased from 22 trillion USD to more than 74 trillion USD during the period 1990 – 2013. It means the world GDP has increased 3.4 times and its average annual growth rate reached cc 6% during the twenty year period. The GDP growth seems not to be as extreme when constant prices (USD, 2005) are applied, but it is still remarkable (from about 30 trillion to 55.9 trillion USD). From this perspective, the world GDP has increased 1.84 times which represents the annual growth rate at the level of 3%. When performing the analysis of individual GDP components (both in current and constant USD prices, 2005;) the following characteristics will result (figures in brackets are related to constant prices): the world agricultural GDP grew 3.2 times (1.8 times) in the reference period, the world industrial GDP increased 2.45 times (1.32 times) and the world GDP in the service sector rose 4.07 times (2.24 times) during the surveyed period (see table 1 for more details). The share of particular sectors in the total world GDP has changed subsequently (agriculture from 5.14% to 4.36%, industry from 37.50% to 27.03%, and services from 57.35% to 68.60%).

Taking into account the Sub-Saharan countries, their GDP has increased from about 300 billion USD to almost 1.6 trillion USD during the reference period; expressed in constant prices, it jumped from 412 billion USD to about 945 billion USD. In other words, the value of the GDP rose 5.36 times (or 2.29 times using constant prices). In terms of the average annual growth rate, the Sub-Saharan countries experienced a significant growth both in current and constant prices by 7% a year (resp. 3%). The contribution of agriculture to the total GDP increased 2.01 times (0.85 times expressed in constant prices), industrial GDP rose 6.94 times (3.44 times) and GDP in the service sector went up 6.25 times (2.34 times).

Analysing the composition of the GDP in Sub-Saharan countries, the following changes can be observed: the share of agriculture in total GDP decreased significantly from 26.0% in 1990 to 9.78% in 2013; on the other hand, the share

of industry increased from 30.1% to 45.24% during the same period and the share of the service sector in total regional GDP remained approximately on the same level (43.9 % in 1990 and 44.97 % in 2013).

Comparing the Sub-Saharan economic development and the development of the world economy, much more dynamic growth in the Sub-Saharan economy can be observed. African economy has been growing much faster especially in the industrial and service sectors. Despite the dynamic growth in the agricultural sector, its share in the economy has been decreasing; on the other hand, the share of services and especially industry in total GDP is becoming more and more important. It is worth highlighting the much higher dynamics of the industrial added value in comparison with the service sector. While the service sector has been the leader of the world's economic growth during the recent two decades, it was the sector of industry in Africa. While almost 70% of GDP is represented by the service sector at the global level, it is about 45% in Sub-Saharan Africa. Sub-Saharan economies thus stand in contrast to the developed countries, where the share of services in total GDP ranges usually from 70 to 90% (Table 1).

Different GDP structure indicates that a typical economic structure based on the SIA model has not been reached in many Sub-Saharan countries (reference year 2011), mainly due to their transition processes. Sub-Saharan Africa is represented by all four basic types of economies based on their GDP structure. The most important type of the GDP formation is represented by the SIA model (18 from the total 37 surveyed countries, namely Seychelles, Eritrea, Gambia, Mauritius, Chad, South Africa, Namibia, Senegal, Madagascar, Lesotho, Kenya, Uganda, Cameroon, Sudan, Ghana, Mozambique, Zambia and Tanzania). The share of services in total GDP ranges in these countries from 42.9% (Zambia and Tanzania) to 84.2% (Seychelles) which is the highest proportion of all surveyed countries. High share is observed for Eritrea (70.5%), the other economies do not reach the value of 70%. Comparing to the year 1990, all countries (with an exception of Madagascar) have strengthened the proportion of services in their total GDP structure (Zambia by more than 18%, Uganda by more than 16%). Industry as the second most important GDP component reaches high values in Lesotho (41%) or Zambia (nearly 38%) and with an exception of five states (Seychelles, Eritrea, Gambia, Madagascar and Kenya) it does not fall below 30%. Although these Sub-Saharan economies have reached the modern SIA model, their share of agriculture in total GDP formation remains high (over 20% in Tanzania, Zambia, Kenya, Sudan,

			1990 bn USD	2013 bn USD	Fix base index (base, 1990)
World	constant 2005 UDS	GDP total	30291	55929	1.84
		Agriculture	1557	1836	1.18
		Industry	11363	15100	1.32
		Services	17371	38992	2.24
	current USD	GDP total	22001	74909	3.40
		Agriculture	1131	3269	2.89
		Industry	8253	20250	2.45
		Services	12617	51390	4.07
Sub-Saharan Africa	constant 2005 UDS	GDP total	412	945	2.29
		Agriculture	107	92	0.85
		Industry	124	427	3.44
		Services	181	425	2.34
	current USD	GDP total	300	1.607	5.36
		Agriculture	78	157	2.01
		Industry	90	625	6.94
		Services	132	825	6.25

Source: WDI database and own calculation, 2014

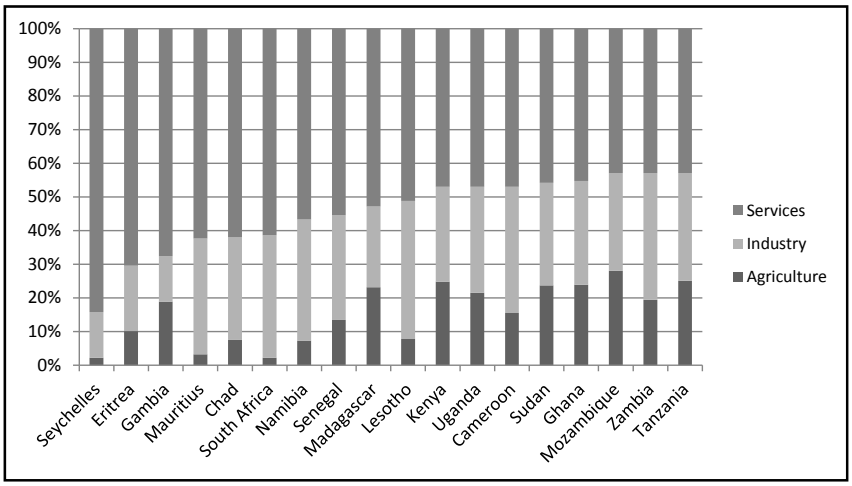
Table 1: The world and Sub-Saharan GDP value and structure (1990 – 2013).

Ghana, Uganda, Madagascar), just some counties reach the structure comparable to developed countries (Seychelles, South Africa). Comparing with the situation in 1990, all countries (with an exception of Zambia) experienced decline in the share of agriculture in GDP (nearly by 32% in Uganda) (Figure 1).

Seven Sub-Saharan economies (Togo, Benin, Rwanda, Malawi, Comoros, Burundi and Burkina Faso) are characterized by the SAI model. The most important sector of services reaches proportions in GDP in a range from 38.6% (Burkina Faso) to 58.2% (Togo). Comparing to 1990, the share declined in Burkina Faso, Comoros and Benin at the expense of growing industry (Figure 2).

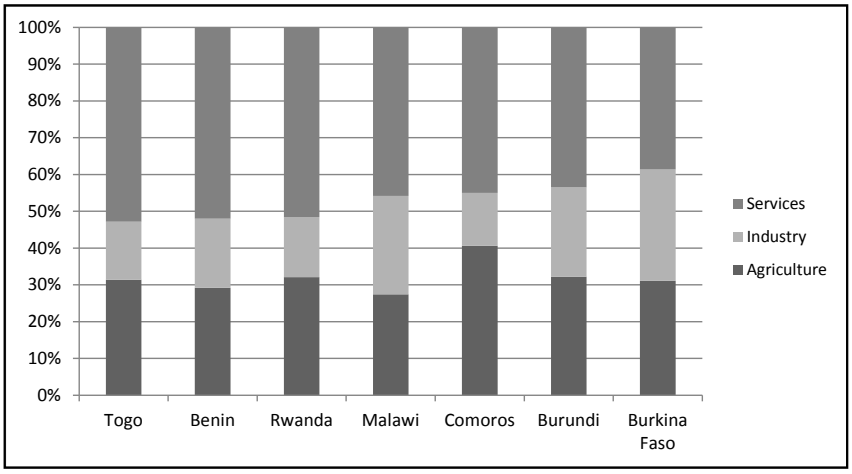
The share of industrial sector in the GDP is relatively low ranging from 14.4% (Comoros) to 30.3% (Burkina Faso). Economies of these states have been developing differently over the last two decades. While industry strengthened its position in the GDP structure in some above mentioned countries, a decline experienced the other four states (Malawi by more than 12% from 1990 to 2011). Agriculture plays an important role reaching nearly one-third share in the GDP formation (more than 40% in Comoros). In all countries (with an exception of Burkina Faso), the share has been shrunk over the surveyed period.

The ISA model has been found in the case of 8 economies (Botswana, Zimbabwe, Swaziland, Cote d'Ivoire, Mauritania, Guinea, Angola and Republic Congo). The countries are characterized by high share of industry in their GDP structure which ranges from 42.9% (Cote



Source: WDI database and own processing, 2014

Figure 1: GDP structure in Sub-Saharan SIA countries (in 2011).



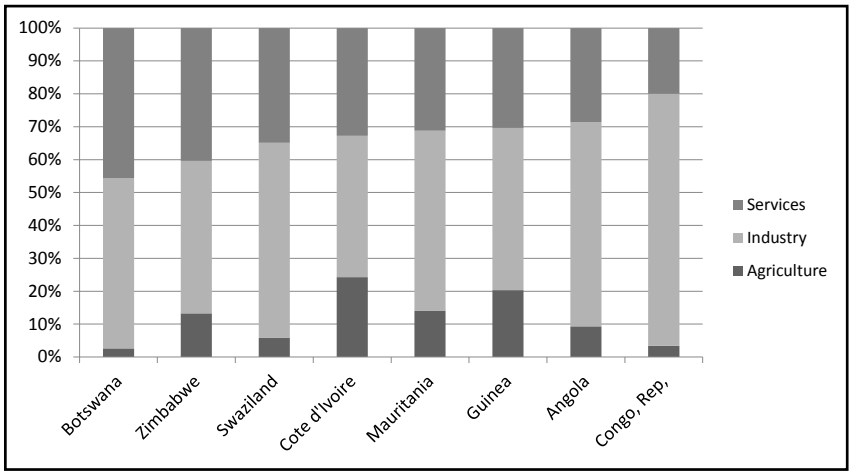
Source: WDI database and own processing, 2014

Figure 2: GDP structure in Sub-Saharan SAI countries (in 2011).

d'Ivoire) to 76.6% (Republic Congo). All surveyed economies have increased their industrial GDP share over last two decades at the expense of services with an exception of Botswana where the position of services is continuously strengthening and moves closer to the SIA model. Agriculture as the smallest component of the GDP formation reaches shares from 2.6% in Botswana to nearly 25% in Cote d'Ivoire (Figure 3).

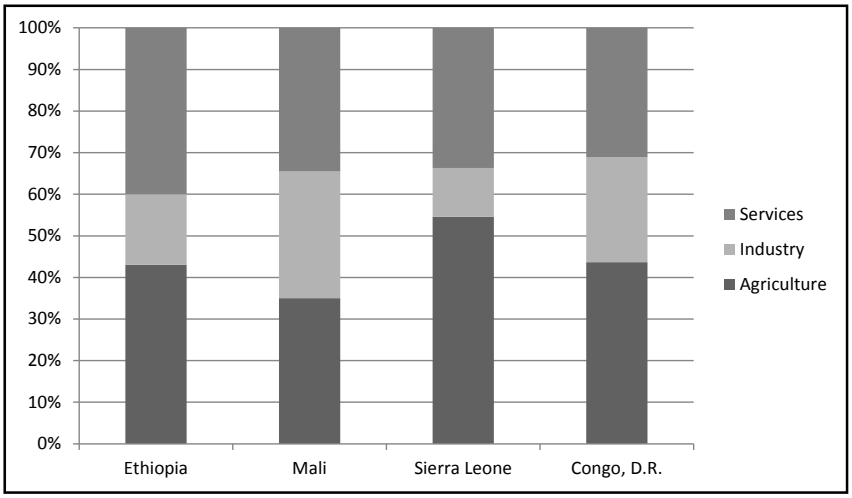
The last type, represented by ASI model, is a model of 4 surveyed Sub-Saharan economies (Ethiopia, Mali, Sierra Leone and Democratic Republic of the Congo). The share of agriculture in GDP ranges from 35.0% (Mali) to 54.6% (Sierra Leone). While Ethiopia and Mali have reduced their agricultural share in GDP in comparison with 1990, Sierra Leone and Democratic Republic of the Congo experienced an opposite trend (increase by 10.5%, resp. 13.5% over the same period). Industrial development remains at a low level, expressed as a percentage of GDP formation, it ranges from less than 12% in Sierra Leone (decreasing trend) to slightly over 30% in Mali (increasing trend). The composition of Mali's GDP is nearly balanced and current trends may lead to a shift to the SAI model in the near future (Figure 4).

When analysing Sub-Saharan Africa as a whole, the SIA model will result; however comparing the region with the world economy two significantly different SIA models (with regard to their composition) will be found. While the share of agriculture in the world`s GDP reaches about 4%, it is about 12% in Sub-Sahara.



Source: WDI database and own processing, 2014

Figure 3: GDP structure in Sub-Saharan ISA countries (in 2011).



Source: WDI database and own processing, 2014

Figure 4: GDP structure in Sub-Saharan ISA countries (in 2011).

Sub-Saharan Africa has higher proportion of industry in relation to the total GDP (43%) than the world economy (38%). The services sector is much less important in Sub-Sahara (45%), compared with the world average (over 57%).

To understand the economic development in Sub-Saharan Africa, it is necessary to take into consideration the fact that the region experienced significant changes not only with respect to its economic development as a whole, but especially with respect to the development of its economic structure during the recent two decades. All surveyed countries experienced much bigger changes in their GDP structure than those typical for the world economy. The share of the agricultural GDP in the total GDP shrunk only by 0.78% in the world, while by 16.2% in Africa. A disproportion can be found also when evaluating proportion of industry in the total GDP (the share of industry in the world GDP dropped by 10.48%, but in Sub-Saharan Africa, it increased by 8.89%). Less divergent development was experienced in services, where the share of services increased by 11.26% in the world economy and by 7.34% in surveyed African countries. The above mentioned results make it evident that the Sub-Saharan economy has been changing rapidly. Despite of the fact that the region and its countries have reached such structure, which is in general comparable to the world economic structure, the current state of African economy is still far from modern standards and the process of economic transformation has not been completed yet.

There are also very significant differences between African countries. The Republic of Congo, for example, experienced a major change in its GDP structure (the share of agriculture in total GDP has changed almost by 10%; the shares of industry and services have changed by 36%, resp. 27%). On the other hand, Kenya reached only a limited change in its GDP structure. The regions and countries in Sub-Saharan Africa are going through different stages of their economic development. While some of them have already fully transformed their economies, many others have not yet completed their process of transformation. The fully transformed countries can be found in Northern Africa. Focusing on the Sub-Saharan part, the following countries may be considered as transformed: Seychelles, Eritrea, the Gambia, Mauritius, Chad, South Africa, Namibia, Senegal and Lesotho. The other countries are still going through different stages of transformation, despite of the fact that their economies have already reached the SIA or SAI structure. Many countries still have not reached an appropriate level of services in their total GDP and the share of the agricultural sector in the GDP remains enormously high (as evident from the Figure 4).

The differences are apparent not only in relation to annual growth (both to total and per capita GDP growth), but they also exist in the GDP sensitivity and correlation in relation to changes in their individual components (agriculture, industry and services).

The Tables 2 and 3 provide information about GDP formation in Sub-Saharan Africa and in the world. Substantial differences are evident if comparing Sub-Saharan Africa and the world in their GDP formation. Differences are apparent not only in relation to the annual growth (both total and per capita), but they also exist in the GDP sensitivity and correlation in relation to changes in its particular components (agriculture, industry and services).

High level of correlation is apparent in relation of total Sub-Saharan GDP and GDP generated by industry and services. On the other hand, very low correlation can be observed in mutual relation of total and agricultural GDP; expressed on per capita basis, it is even negative. The sensitivity of total Sub-Saharan GDP on changes in its particular components differs in comparison with the rest of the world. Differences are evident especially in relation to agriculture. African GDP is more sensitive to changes in agricultural sector. Contrary, the sensitivity of GDP to changes in industry is almost the same both in Sub-Sahara and the other world regions. There is only little dependence of African GDP on changes in the service sector compared to the world economy. It can be stated that primary and secondary sectors play much more important role in generating total GDP in Africa than it is typical in the rest of the world, especially in developed countries.

As mentioned above, Sub-Saharan Africa experienced much higher dynamics of the economic development in comparison with the world economy during the period observed. However, another picture appears when comparing trends in the GDP on a per capita basis. While the world GDP per capita has increased from 5,738 USD in 1990 to 7,538 USD in 2011 (by 31%), the increment from 811 USD (1990) to 978 (2011) in Sub-Saharan Africa represented an increase only by 21%. The reason for such

	World					Sub-Saharan Africa				
	Services	Industry	Agricult.	Constant	Correl.	Services	Industry	Agricult.	Constant	Correl.
Endogenous variables	0.608	0.353	0.041	0.7824		0.562	0.322	0.195	0.58	
Stand. error for indiv. var. incl. constant	0.004	0.006	0.004	0.0198	0.3237	0.042	0.015	0.026	0.345	-0.816
R2, Standard error for y	0.999	0.001	#N/A	#N/A	0.8962	0.994	0.008	#N/A	#N/A	0.974
F-stat, DOF	68578	18	#N/A	#N/A	0.9612	918.09	18	#N/A	#N/A	0.896

Source: own calculation – using data from WDI database, 2014

Table 2: Logarithm regression results (GDP per capita, USD, const. 2005).

	World					Sub-Saharan Africa				
	Services	Industry	Agricult.	Constant	Correl.	Services	Industry	Agricult.	Constant	Correl.
Endogenous variables	0.607	0.3532	0.0412	0.7619		0.511	0.319	0.152	1.459	
Stand. error for indiv. var. incl. constant	0.0036	0.0059	0.0039	0.0454	0.794	0.028	0.016	0.027	0.718	0.297
R2, Standard error for y	0.9999	0.001	#N/A	#N/A	0.966	0.999	0.008	#N/A	#N/A	0.993
F-stat, DOF	233247	18	#N/A	#N/A	0.986	6753.7	18	#N/A	#N/A	0.989

Source: own calculation – using data from WDI database, 2014

Table 3: Logarithm regression results (GDP, bn. USD, const. 2005).

development can be explained by very dynamic population growth in Africa. Information on GDP development on a per capita basis in the world and in Sub-Saharan Africa is provided in Table 4.

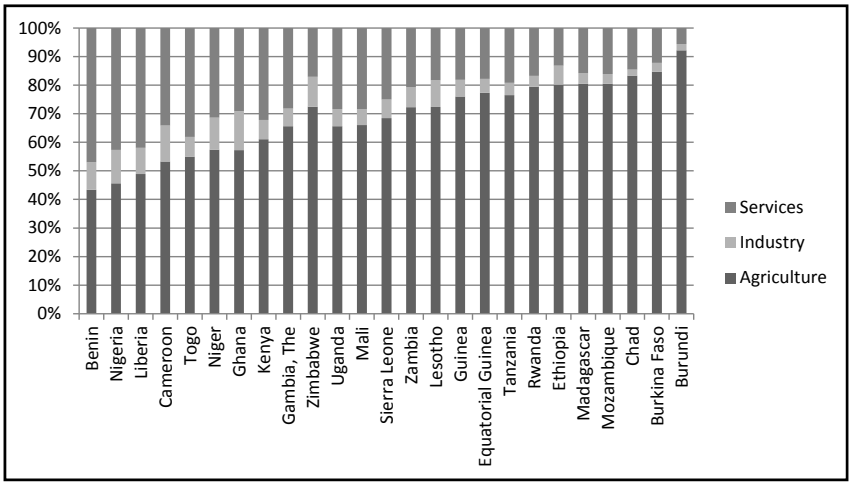
The results confirm the findings that the GDP development in Africa much more depends on agricultural and industrial sectors than it is common in the rest of the world. This can be also confirmed by the analysis of the GDP development at a per capita basis (for details see table 4). Further analysis performed at a per capita basis also proved a significant relationship between total GDP per capita and GDP per capita generated by agricultural sector. This result points to high dependency of the people living in the Sub-Saharan region on agricultural activities and on the performance of the agricultural sector Mwabu and Thorbecke, (2004).

Sub-Sahara is heavily dependent on agriculture, especially when taking into account the number of economically active population. When applying the Holub's methodology on the labour market structure in the countries surveyed, agriculture plays the most significant role in job creation in many countries. It is evident that most Sub-Saharan countries are still in the traditional stage of economic development (ASI model) in terms of labour market. Only several countries have reached the SIA (Angola, Namibia, Mauritius, South Africa and Algeria) or SAI (Gabon, Botswana, Sao Tome and Principe, Republic of the Congo and Senegal) structure. While the majority of the Sub-Saharan countries surveyed has already reached the SAI or SIA model (modern type of economy) in terms of economic structure, the traditional type of economy (ASI) dominates when labour market is taken into account (see Figure 5). Low number of workforce in industry and low level of industrial development on the one hand, and very high level of employment in agriculture on the other remain essential problems of the region Tiffen (2003); Kingdon et al. (2006). Underdeveloped infrastructure Ajakiye and Ncube (2010and low level of development in industrial and service sectors are factors dragging Sub-Saharan economy down. Population living in the region does not have any other choice but to remain in agriculture, however agriculture is characterized by low economic performance and also by limited added value per capita as well as by low level of wages Rezek et al. (2011); Henley (2012) (Figure 5).

		1990	2011	Basic index	Chain index
		USD	USD		
World	GDP per capita	5738	7538	1.31	1.013
	Agriculture	295	317	1.08	1.003
	Industry	2153	2916	1.35	1.015
	Services	3291	4305	1.31	1.013
Sub-Saharan Africa	GDP per capita	811	978	1.21	1.009
	Agriculture	211	115	0.55	0.972
	Industry	244	421	1.72	1.026
	Services	356	442	1.24	1.010

Source: own calculation – using data from WDI database, 2014

Table 4: The world and Sub-Saharan GDP per capita and its structure (1990 – 2011, constant prices 2005).



Source: WDI database and own processing, 2014

Figure 5: Sub-Saharan ASI countries according to labour employment (in 2011).

Conclusion

The analysis illustrates the specificity of Sub-Saharan Africa in the world economy. Its GDP and GDP per capita performance is very low, however the annual GDP growth rate is much higher in comparison to the world average. The problem of Sub-Saharan Africa remains in high level of population growth Jenicek (2010) which is not accompanied by a proportional growth of the economy Ezeh et al. (2012). This can explain why the annual growth of the GDP per capita in the Sub-Saharan region is far behind the annual growth of the Sub-Saharan economy as a total. Another remarkable fact is the quite specific structure of the Sub-Saharan economy. The whole region is characterized by high importance of agriculture and industry within the whole economy (much more than it is typical for the world economy). On the other hand, the service sector is still not fully developed. It is to be noticed that Sub-Saharan Africa recorded significant changes in its GDP structure during the last two decades. In many countries, the share of agriculture in the GDP has been reduced significantly while the share of industry increased. The sector of services remains a weakness of the region. Its share in the total Sub-Saharan GDP is high; nevertheless, its growth is constrained. It is worth noting that agriculture remains an important source of job opportunities and especially an important income source for a significant share of population living in the region, despite the dominancy of services and industry in relation to total GDP.

Another important finding resulting from the analysis is the existence of significant differences within the Sub-Saharan countries in relation to the development of their total GDP value and GDP structure. Considering the economic structure of the countries surveyed, all four types of economies (SAI, SIA, ISA and ASI) can be found

in Sub-Sahara. Taking into account the labour market, three types of economies SIA, SAI and ASI will result. It is evident that many economies are still in the process of development or transformation. When analysing differences which exist among the Sub-Saharan countries, they appear distinct in their GDP, especially in a per capita expression. Many countries of the surveyed sample reach their GDP per capita in the range from 1,000 to 12,000 USD a year (22 out of 43 countries), but there are also many countries (21 out of 43), where the GDP per capita reaches a value just from 245 to 900 USD a year. When analysing individual countries in greater detail, significant differences will appear in relation to annual economic growth and GDP per capita. There are countries (Uganda, Mozambique, Angola, Ethiopia, Burkina Faso, Chad, Ghana, Sudan, Botswana and Tanzania) where GDP exceeded a 5% growth a year during the monitored period, but there are even countries with a negative GDP growth (Congo D.R. or Zimbabwe).

Sub-Saharan economy is very vulnerable and sensitive both in regional and world economic development. The region is still facing many political, economic and social problems such as instability, democratic deficit, low level of education, insufficient investments, local conflicts, etc. Collier and Vicente (2012); Bezemer and Jong-A-Pin (2013); Barbier (2010). Sub-Saharan Africa is also plagued by an intensive population growth, which is not accompanied by proportional economic growth. Some authors Go et al. (2007); Thorbecke (2013) point out the disproportion in income distribution might become a problem for the stability and further development of the region in future. From the economic point of view it is worth noting that the transformation process in Sub-Saharan Africa still has not reached the level of the global economic transformation. A significant reduction of agriculture in total GDP is to be expected in the future, it is also possible to expect an increasing role of processing industry (food and raw materials processing as well as light industry) and services (financial, communication and transportation services) in regional GDP (both in relation to GDP and its structure and in relation to labour market). International trade could be another important factor to have a significant impact on Sub-Saharan economic development. A growth of inter-regional and especially intra-regional trade has a potential to stimulate development of African economy and its restructuring.

Acknowledgements

This paper was prepared with financial support of the projects „Socio-economic practices of sustainable development in the new industrialization“. The project is founded by the Government of the Russian Federation, Grant 074-U01 and conducted within the ITMO University.

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Agris on-line Papers in Economics and Informatics

Volume VII Number 1, 2015

Evaluation of Elements Uptake in Soil and Different Plants

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Abstract

The applied informatics undergone a significant development at the end of XXth century, which is allowed analyzing of soil pollution by computer controlled system. On account of opening of the pollution we can process the experimental data fast and exactly so we can get such a large number of new information. The environmental pollutant affect of the molybdenum was studied by elements load experiment in Nagyhörcsök Experimental Station. The relation was analyzed between the uptake of molybdenum and other micro-elements and its effect on plant organs (loaf, seed) using by different statistical methods. The aim of our investigations to search for answers on how to arable crops respond to a possible soil contamination. It is also important to determine the extent of mobilized elements from the soil into the plants, which type of effect on them, and how leach the harmful substances into deeper layers (groundwater). A computer programme based on Visual C# was developed to process of the large amount of data. The MySQL was applied to prepare the database, since we want to allow access to the newly developed database via internet technology. The data was filled up to the data tables mainly from the Excel tables. Data in internet-based databases must be properly protected. The program can provide access for two types of users at present: the database administrator who is authorised to do everything in connection with the database, and the user who is authorised to make queries only.

Keywords:

Multidisciplinary science, micro-elements, pollution, molybdenum, food chain, data-processing, Hungary.

Introduction

The informatics - especially applied informatics - undergone a significant development at the end of XXth century. This is allowed analyzing of soil pollution by computer controlled system. The importance of this explains the soil is polluted especially by pesticides, wastes, nitrogen and phosphorus fertilizer (Bramryd, 2013), which through plants get into our food direct and indirect way (Brännval et al., 2014). In this way polluted foods can cause ill (Liu et al., 2013) in our vitally important organs (Patócs, 1990). On account of opening of the mentioned pollution we can process the experimental data fast and exactly so we can get such a large number of new information (Pais, 1990). Being aware of this valuable information we can make indispensable arrangements and we can hinder the impairing micro-elements – other elements as well – segregate in food chain (Marschner, 2012). The environmental pollutant affect (Rodrigues et al., 2012a & 2012b) of the molybdenum was studied by elements load experiment in Nagyhörcsök Experimental Station. The relation was analyzed between the uptake of molybdenum and other micro-elements (Raguža et al., 2013) and its effect on plant organs (loaf, seed) using by different statistical methods (Adamo et al., 2014).

1. Experiment description in Nagyhörcsök experimental station

The trial was set up in Nagyhörcsök (Hungary) in 1991 on a calcareous chernozem soil formed on loess, containing 5% $CaCO_3$ and 3% humus in average in the ploughed layer. Soil texture is loamy with 20% clay and 40% fine fraction (Németh, Kádár, 2005).

Soil characteristics of the ploughed layer are: pH (KCl): 7.3, AL-P_2O_5 (ammonium lactate-soluble P_2O_5): 80-100, AL-K_2O (ammonium lactate-soluble K_2O): 140-160, KCl-Mg: 150-180, and KCl + EDTA soluble Mn, Cu and Zn

are 80-150, 2-3 and 1-2 mg/kg, respectively (Jan et al., 2013).

The soil is well supplied with Mn, sufficiently supplied with Mg and Cu, moderately supplied with N and K, and weakly supplied with P and Zn. The water table is at a depth of 13-15 m, which practically excludes its contamination by leaching. The climate is dry and the area is drought sensitive with 500-550 mm annual precipitation and negative water balance.

The applied treatments simulate soil contamination conditions that may occur in industrial areas, near highways, settlements and in city gardens. The 4 load levels (0, 90, 270 and 810 kg element/ha) were applied as a single dose in the spring of 1991 in the form of $AlCl_3$, $NaAsO_2$, $BaCl_2$, $CdSO_4$, K_2CrO_4, $CuSO_4$, $HgCl_2$, $(NH_4)_6Mo_7O_{24}$, $NiSO_4$, $Pb(NO_3)_2$, Na_2SeO_3, $SrSO_4$, and $ZnSO_4$ (Kádár, 1995).

Fertilization was done yearly with 100-100-100 kg/ha N, P_2O_5 and K_2O active agents, in the form of ammonium nitrate, superphosphate, and potash fertilizers. The 13* 4 = 52 treatments with 2 replications were arranged in a split-plot design in altogether 104 plots.

Soils were sampled in 1993, 1996 and 2000 at the maximal depths of 60, 90 and 290 cm, respectively. In all cases the control and the maximal rate (810 kg/ha) treatments were analyzed.

The samples were dried at 40°C, homogenized and the ammonium acetate + EDTA-soluble element contents were analyzed by the method of Lakanen and Erviö (Lakanen, Erviö, 1971).

Materials and methods

The aims of the study were the determining the optimum measurement conditions for the content of elements for plant and soil samples and finding multi-element measurement method to analyze the following elements (i.e: As, Cd, Mo, Pb, and Se) and investigate (Månsson et al., 2012) the theoretical detection limit (approximately 1 ng/kg), which is nowadays the best available value (Alloway, 2012). However, the measurement of real samples which showed an unexpected factor is greatly influenced the size of the intensity on the detector. At the time of analytical measurements could figure out that the carbon content of samples significantly depends on the size of the intensity of the same concentration. Therefore the signals is investigated on the various mass peaks (interferences). (Filep, Rékási, 2011). The investigations are carried out by different alcohols, such as C-containing solvents, this can be the reason of the above phenomenon.

1. Sample preparation method to ICP-OES/MS

Wet destruction sample preparation methods (HNO_3-H_2O_2) are used (Kovács et al., 2000) for the total element concentration determination of the plant and soil samples in the Central Laboratory of University of Debrecen. In case of higher concentrations - an Optima 3300 DV inductively coupled plasma optical emission spectrometer (ICP-OES, parameters are in Table 1.), in case of relatively lower concentrations, an inductively coupled plasma mass spectrometer (ICP-MS) (Thermo Elemental manufactured X7-type) are used to the analytical determination (O'Sullivan et al., 2013). The analyzed elements are 45.

Inductive Coupled Plasma Optical Emission Spectrometer	
Type:	OPTIMA 3300 DV
Manufacturer:	Perkin-Elmer Ltd.
Optical system:	Echelle-system, argon purged
Range of wavelength:	160-782 nm
Detector:	Solid-state circuit detection, SCD
Plasma monitoring:	Axial
Type of nebulizer:	concentric (Meinhard Type A)
The type of peristaltic pump:	black-black
Resolution of the optical system:	Normal
Resolving parameter:	0.007 nm

Source: own processing

Table 1: The parameters of the ICP optical emission spectrometer.

ICP-MS technique (parameters are in Table 2.) was used to analyze the trace element contents (As, Cd, Mo, Pb and Se) of the plants (Filep, Rékási, 2012). Inductively coupled plasma mass spectrometer (ICP-MS) was used for analyses for microelements due to ppb concentrations (ug/kg). During analysis, collision and reaction gas (CCT = collisional cell technique) was applied in order to reach the lower limit of detection of elements analyzed.

ICP-MS	
Type:	Thermo Elemental X7
RF power output:	1400 W
Plasma gas flow rate:	14 l•min^{-1}
Nebulizer flow rate:	0.8 l•min^{-1}
Sample flow rate:	1 l•min^{-1}
Pole Bias:	- 3.1 V
Hexapole bias	4.5 V
Extraction	-118 V
Focus:	3 V
Analog detector:	2500 V
PC detector	3850 V
CCT gas (H_2-He, 7%-93%) flow rate	5.9 cm^3•min^{-1}

Source: own processing

Table 2: The ICP-MS instrument settings and measurement parameters.

2. Conversion of the ICP-OES/MS measured data by excel macro

The ICP-OES/MS instrument averages the measured data and calculates the deviation for each element. The measured data have to be converted, rounded and placed into a table on the basis of a certain aspect for further processing. This process takes a long time in spite of the fact that a fixed Excel macro (http://www.excel-easy.com/vba.html) was available at the department. Processing of the databases takes at least one hour depending on the number of measured elements and samples.

3. The developer system and the database handling

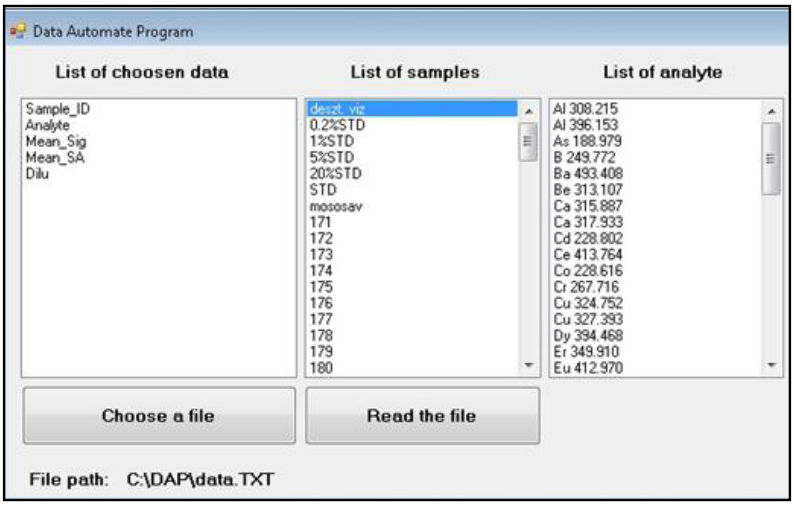
New features are introduced in Visual Studio 2010 C# that improve Microsoft Office programming (Heljsberg et al., 2010). Many computer users live in the Microsoft Office suite, using Excel as the core tools to perform the majority of their daily computer tasks. Enhancements in the .NET Framework 4 and Visual Studio 2010 make Office automation solutions easier than ever to write and deploy, in either Visual C#. Visual Studio 2010 offers a number of Office templates. Choosing the Excel 2010 Workbook template opens a blank Excel workbook template that is the spreadsheet shown when the solution is run. The Excel programming can be started from this point in Visual Studio C# environment (http://visualstudiomagazine.com/articles/2011/06/20/wcovb_automate-excel.aspx).

The MySQL (http://www.mysql.com) was applied to prepare the database, since we want to allow access to the newly developed database via internet technology. The data was filled up to the data tables mainly from the Excel tables. Data in internet-based databases must be properly protected. The program can provide access for two types of users at present: the database administrator who is authorised to do everything in connection with the database, and the user who is authorised to make queries only.

Results and discussions

1. The developed programme

The conversion of the measured data was carried out. The data was rounded and placed into table by using Microsoft Visual C# 2010 (http://www.visualstudio.com) developing system (Fig. 1.), since its objects and programming opportunities provided more possibilities than an Excel macro.



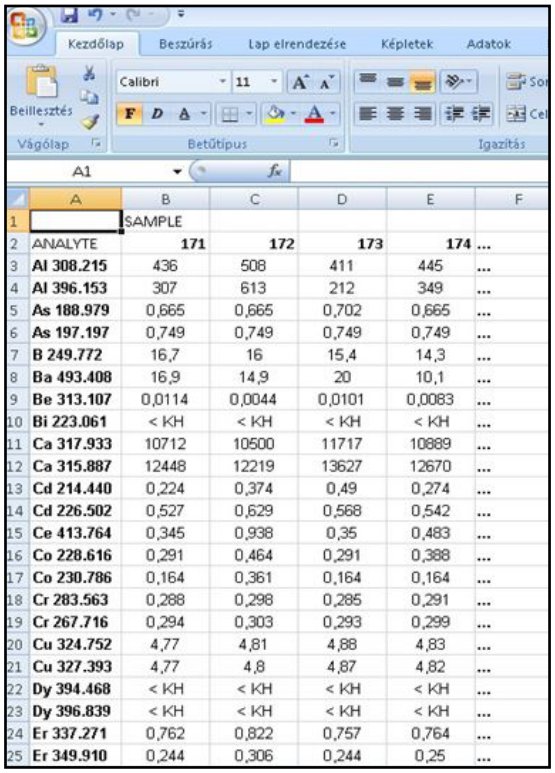
Source: own processing

Figure 1. Conversion and rounding measured data.

The received figures was saved when running the program into an Excel worksheet in order to make further data processing easier (Fig. 2.).

The selected data file is shown in the first list. The CSV file headers (Sample ID, Analytical lines, average signal size, average standard deviation and dilution) were read and formed the selected data file by the programme. This can be seen in the first list (Fig. 1.).

The ”sample_ID” was read to the second list. Distilled water wash, the standard samples measurement and the acid washing is done before any samples. The first sample always comes after the acid washing.



	A	B	C	D	E	F
1		SAMPLE				
2	ANALYTE	171	172	173	174	...
3	Al 308.215	436	508	411	445	...
4	Al 396.153	307	613	212	349	...
5	As 188.979	0,665	0,665	0,702	0,665	...
6	As 197.197	0,749	0,749	0,749	0,749	...
7	B 249.772	16,7	16	15,4	14,3	...
8	Ba 493.408	16,9	14,9	20	10,1	...
9	Be 313.107	0,0114	0,0044	0,0101	0,0083	...
10	Bi 223.061	< KH	< KH	< KH	< KH	...
11	Ca 317.933	10712	10500	11717	10889	...
12	Ca 315.887	12448	12219	13627	12670	...
13	Cd 214.440	0,224	0,374	0,49	0,274	...
14	Cd 226.502	0,527	0,629	0,568	0,542	...
15	Ce 413.764	0,345	0,938	0,35	0,483	...
16	Co 228.616	0,291	0,464	0,291	0,388	...
17	Co 230.786	0,164	0,361	0,164	0,164	...
18	Cr 283.563	0,288	0,298	0,285	0,291	...
19	Cr 267.716	0,294	0,303	0,293	0,299	...
20	Cu 324.752	4,77	4,81	4,88	4,83	...
21	Cu 327.393	4,77	4,8	4,87	4,82	...
22	Dy 394.468	< KH	< KH	< KH	< KH	...
23	Dy 396.839	< KH	< KH	< KH	< KH	...
24	Er 337.271	0,762	0,822	0,757	0,764	...
25	Er 349.910	0,244	0,306	0,244	0,25	...

Source: own processing

Figure 2: Converted and rounded data exported to excel.

Various items analytical lines are visible in the third list. In case of ICP-OES/MS it is given, which item line can be measured most efficiently.

The saved figures exported into an Excel worksheet (Fig. 2.). This data are converted and rounded. The column headers are the sample_IDs, the row headers are the analytical lines. The ”<KH” symbol meaning that under the detection limit.

2. Storing the converted data in the MySQL database

The next step is save these data into a database.

The central table is the ”Element”, where the chemical symbols and the measured microelement concentrations of the plant and plant part, the type of soil and how much dose the soil were treated, where the plant was grown are stored (Fig. 3.). It is important to store the year of the sampling.

The different plants, plant parts and the soil type are stored in the other three tables. In case of soil measurement is important to know which depth profile the soil derived from.

The major plants, which are investigated, the followings: carrot, maize, pea winter wheat, potato.

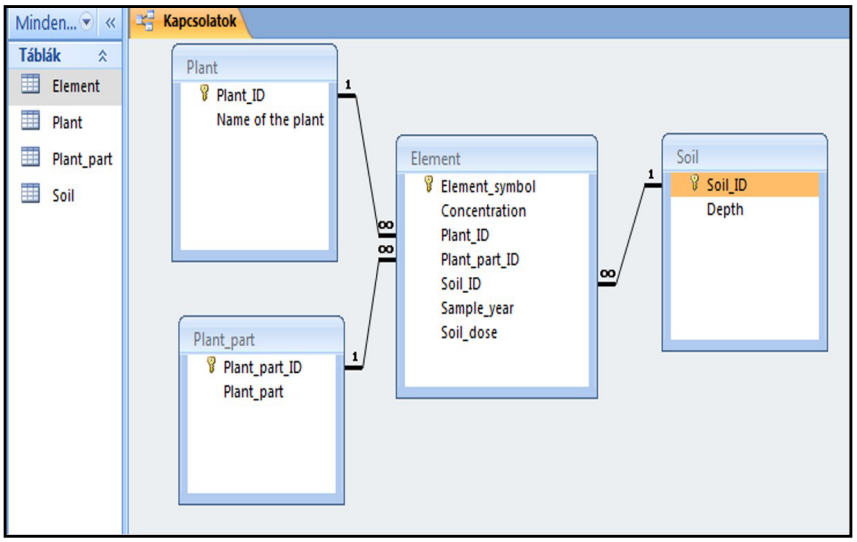
The plant parts are the followings: root, stem, leaf, bloom, and seed.

A stable relational database is also needed which will handle data and also provide data for the query system. Since the aims were applying standard solutions, we needed an SQL-based system and finally chose the MySQL database server (http://www.mysql.com), because it is free of charge, portable, compact and fast in case of bigger record numbers. Another gain, if we want to access these data through the Internet by a browser program, we can use this database system with the PHP server-side language efficiently, no need any conversion (Hu et al., 2014).

Through the authorisation system, the authorisation level of each user can easily be determined. In case of database administrator authorisation, almost any kind of query can be made in connection with the database through the general query module (Tuya et al., 2007).

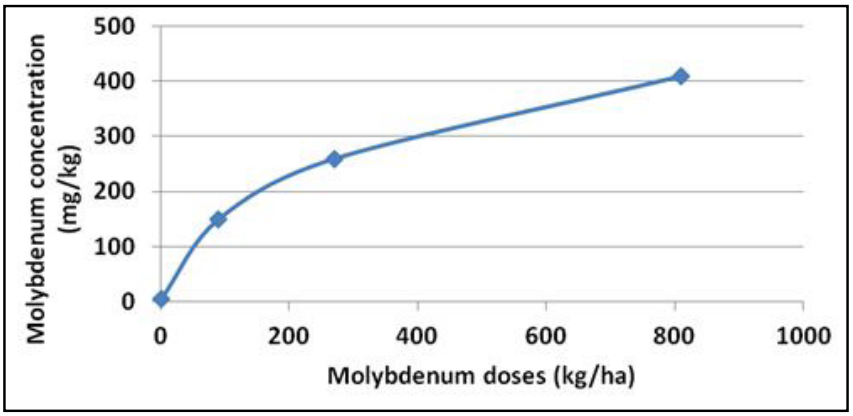
Special queries can be created to give the ”Soil”, the ”Plant” and the ”Plant_part”, the ”Sample_year” and ”Soil dose” parameters. Using these parameters the give element concentration value can be got and exported to Excel or SPSS to analyze the data by statistical method.

The first step is to test this new program. Two examples on the Fig. 4. and 5. can be seen for the molybdenum concentration changes (Anke, 2006) in the maize leaf and seed (Ráthonyi et al., 2010). The molybdenum treatment was 90, 270 and 810 kg/hectare.



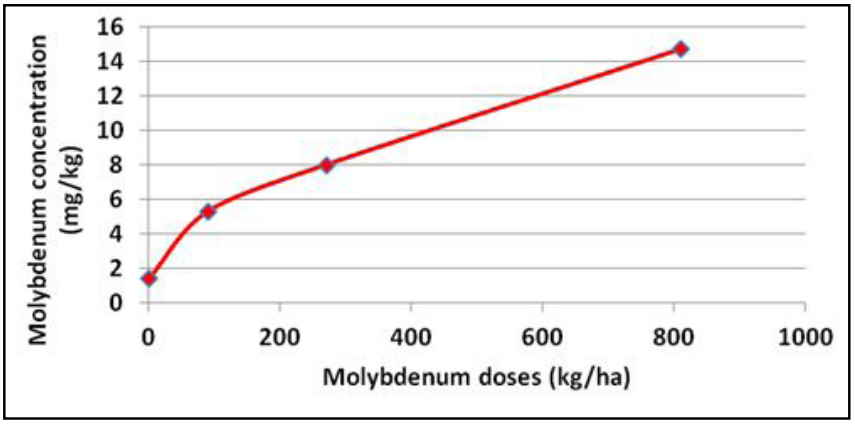
Source: own processing

Figure 3: Database schema.



Source: own processing

Figure 4. Change of the molybdenum concentration of the maize leaf.



Source: own processing

Figure 5. Change of the molybdenum concentration of the maize seed.

Conclusion

The conversion of the measured data was carried out. The data was rounded and placed into table by using Microsoft Visual C# 2010 (http://www.visualstudio.com) developing system (Fig. 1.), since its objects and programming opportunities provided more possibilities than an Excel macro. The received figures was saved when running the program into an Excel worksheet in order to make further data processing easier. The column headers are the sample_IDs, the row headers are the analytical lines in the Excel worksheet.

The saved data was exported into a database. Since the aims were applying standard solutions, we needed an SQL-based system and finally chose the MySQL database server, because it is free of charge, portable, compact and fast in case of bigger record numbers. We have four tables. The central table is the ”Element”, where the chemical symbols and the measured microelement concentrations of the plant and plant part, the type of soil, how much dose the soil were treated, where the plant was grown are stored and the year of the sampling The different plants, plant parts and the soil type are stored in the other three tables.

This database is tested after created and filled up with measured data. The aim of our investigations was searching for answers on how to arable crops respond to a possible soil contamination. It is also important to determine the extent of mobilized elements from the soil into the plants, which type of effect on them, and how leach the harmful substances into deeper layers (groundwater).

The investigates shall be carried out in several crops and elements, have to pay attention to the interactions, each element response to changes of other elements. It is also important to better understand the mechanisms of action in the food chain and the given data has to be accurate information content.

The data are processed in a single database, perform a variety of statistical analyzes, which are extremely important for the time-series analysis in the future (Kirby et al., 2012). These long-term conclusions can be drawn in the case of soil contamination in the environment. It is important to correct resolve the problem.

Two examples are shown by this developed programme on the Fig. 4. and 5., where can be seen for the molybdenum concentration changes in the maize leaf and seed by different molybdenum treatments.

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Agris on-line Papers in Economics and Informatics

Volume VII Number 1, 2015

Basic Outline of the Problem of the "Ageing Population of Farmers" in the Czech Republic

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Anotace

Problém stárnutí populace farmářů je často zmiňován v evropské diskusi o udržitelném vývoji zemědělství a na daný problém reaguje celá řada politických opatření včetně poslední reformy společné zemědělské politiky EU. Cílem článku je konceptualizovat a empiricky zmapovat problém stárnutí populace farmářů v České republice. S využitím sekundární analýzy dat jsou popsány základní trendy týkající se věkové struktury farem včetně srovnání hlavních parametrů farem u mladších a starších zemědělců. Výsledky studie naznačují, že Česká republika patří mezi země, které nejsou tolik stiženy problémem stárnutí populace farmářů a rozdíly mezi farmami mladších a starších zemědělců nejsou tak výrazné jako v zahraničí. Hodnocení celého problému je však částečně zkresleno metodikou výběru farem, kterou aplikuje Eurostat.

Klíčová slova

Mladí zemědělci, sekundární analýza, Eurostat, sociální udržitelnost, reforma CAP.

Abstract

The problem of the ageing population of farmers is often mentioned in European discussion on the future sustainability of Agriculture and is addressed by several policy measures including those belonging to the new CAP reform. The goal of this paper is to conceptualise and empirically map the problem of ageing in the Czech Republic. Using secondary data analysis, the paper outlines the basic trends related to changes in the age structure of farmers, including the main parameters of the young and older farmers' holdings. Findings of the study suggest that the Czech Republic belongs among the group of countries which is not so much affected by the problem of ageing and that the differences between farms run by young and older farmers are not as large as in other European countries. Evaluation of the problem is partly distorted by the survey methods used by Eurostat.

Key words

Young farmers, secondary analysis, Eurostat, social sustainability, CAP reform.

Introduction

"Who will feed us?" This question is discussed in debates on the ageing population of farmers in the Czech Republic and other European countries (Balabánová, 2012; Bika, 2007; DGIP, 2012). The average age of farmers is increasing due to the minimal presence of younger entrepreneurs in the agricultural sector. Available statistics show that approximately every second farm (53.1%) in Europe is managed by a farmer aged over 55 years, and almost one-third of all farms (29.6%) has a holder aged over 65 years. In contrast, young farmers (in the under-35 age category) manage a relatively smaller proportion of farms (7.5% of all farms in EU member countries). This raises the aforementioned concerns about the social sustainability of farming, and even concerns about the future ability of the agricultural sector to fulfil its basic societal purpose.

The problem of ageing has also been accentuated in the CAP reform, which took into account the need for a generational renewal on farms (ENRD, 2014a; ENRD, 2014b). The additional payment to young farmers (under 40 years of age, for the period of five years after setting up a new business) has become one of the most important measures intended to facilitate the entrance of young people into Agriculture (European Commission, 2014; European Parliament, 2014).

The problem of ageing as such is comprised

of several different aspects. The main goal of this paper is to review what is known about the problem of the ageing population of farmers in the Czech Republic. More specifically, it seeks to provide answers to the following questions:

1. How urgent is the problem of the ageing population of farmers in the Czech Republic with respect to recent changes in the age structure of farm holders?
2. What structural features are retained by agricultural holdings managed by young farmers?
3. What are the implications of the problem of ageing for the Czech agricultural sector?

The above-mentioned questions are investigated with the use of secondary data analysis. Prior to a presentation of the empirical results, a conceptual framework is set out to review the main findings in the academic literature and policy documents.

Conceptual framework

The problem of ageing in Agriculture is associated with two basic phenomena:

(1) increased proportion of older employees in the labour structure; and/or

(2) increased proportion of older farmers (i.e. sole holders) in the age structure of agricultural holders.

The first perspective points out the problem of ageing within the agricultural labour force, while the second perspective is associated with the problem of the ageing population of farmers as such. The European discourse aimed at the issue of ageing in Agriculture corresponds with the second perspective. The increasing proportion of older farmers, together with the decreasing proportion of young farmers, is thus viewed as a key point in the problem of ageing in Agriculture. Such a viewpoint is also applied in our analysis.

The key indicators used for investigating the problem of ageing come from the Farm Structure Surveys and Agricultural Census organised by Eurostat (Eurostat, 2013a; Eurostat, 2013b). These surveys encapsulate the basic demographic variables of sole farm holders, including age. In this way, farmers are classified in the following age intervals: under 35 years, 35 – 44, 45 – 54, 55 – 64, over 65 years. Representatives of the first age category are considered as 'young farmers', and 'older farmers' are thus associated with the last age category.

However, Zagata and Sutherland (2014) challenged the assessment of the "young farmer problem" at the European level. One of the reasons is that EU member countries have such different agricultural sectors that an international comparison of age structure is distorted. At the same time, they argue that it is not clear what ratio of younger and older farmers in the population actually implies the existence of a problem threatening the functions of the agricultural sector.

According to the findings of these authors, it is possible to divide European countries into two groups. The first is formed by countries with a relatively high proportion of young farmers in the population, outnumbering the proportion of older farmers. This group includes countries such as Poland and Austria, where 11% of young farmers (i.e. those under 35) manage cca 15% of all agricultural holdings, while older farmers (i.e. those aged 65+) manage less than 10% of agricultural holdings.

In contrast to this, the second group of countries has a high proportion of farms run by older farmers, at the expense of younger farmers. Examples include Portugal and Greece, where 5% of young farmers manage approximately 3% of all holdings, while older farmers manage a much higher proportion of farms. In Portugal, this is 47% i.e. almost half of all farms in the country, while in Greece it is every third farm (33%). European countries thus significantly vary in the age structure of their farmers and the problem of ageing in Agriculture varies in its urgency.

Public discourse in the Czech Republic includes only sporadic arguments about the ageing population of farmers. Arguments used during this debate draw mostly on the European statistics and consider the problem of ageing as part of a pan-European phenomenon (Balabánová, 2008; Balabánová, 2011).

The Czech discussion of the ageing problem often includes arguments about the ageing of agricultural employees (Deník, 2014). What is considered as the key problem is the lack of agricultural experts, due to the growing share of employees in the oldest age group. However, the ageing population of farmers, i.e. the second approach to the problem, is overlooked. Specific illustration is provided by the annual reports (the so-called Green Reports) published by the Czech Ministry of Agriculture.

The Report for the year 2012 claims that "ageing in Agriculture is considered a problem in most European countries." (MZe, 2014: 145). This is supported by statistics describing the changes in the age structure of labour forces in Agriculture.

It is possible to hypothesise that this approach is a historical continuation of the former approach to Agriculture. Studies investigating the structure of labour forces in Agriculture were typically conducted together with stratification studies, which did not take into account the position of the main sole holders of farms. Due to the fact that this approach does not match the framework of the ongoing European discourse (Calus et al., 2008; Mann, 2007; Glauben et al., 2009; Gonzáles et al., 2001; Symes, 1990), it is not possible to evaluate the situation objectively in the Czech Republic. What is more, to our knowledge, there is a shortage of academic publications dealing with the topic of the ageing population of farmers, with only a few exceptions (e.g. Boháčková, Hrabánková, 2011). The 'young farmer' problem is in the European discourse very closely related to issue succession (Burton, 2006; Burton et al., 2005; Fischer et al., 2014), and new entrants (Ingram et al. 2011).

Materials and methods

The main source of data is the structural survey conducted by the EU member states within Regulation 1166/2008 (Eurostat 2013a). The survey is based on a sample of farms and is repeated every 3 to 4 years. Once per decade, the survey focuses on the entire population of farmers in the form of a census.

The basic unit of analysis is an agricultural holding, which represents an independent technico-economic unit, individually managed and focused on agricultural production. The survey includes only holdings that have at least 1 ha of UAA (utilised agricultural area), or smaller holdings with a market production that goes beyond a set level. Besides the main variables of production, data are also collected on the education, gender and age of farmers. Since this dataset is the generally used source of information, the Eurostat's methodological approach forms the basic framework for analysis and evaluation of the entire problem. One of the direct consequences is, for instance, the definition of 'young' and 'older' farmers based on the age intervals used in their survey. 'Young farmers' are therefore the sole main holders in the under-35 age category, in spite of the fact that this definition is not universal and varies from the definition of 'young farmers' included in policy measures. For example, Measure 112 of 2007-2013: 'Setting up young farmers' views young farmers as those who are under 40 years of age.

This study focuses on the basic trends in this area as they developed between 2005 and 2010, i.e. the period after the Czech Republic joined the EU, and also the time points at which the farm structure survey was carried out. Analysis of the time series data is limited due to the low compatibility of each dataset. This problem applies mainly to the data for the Czech Republic, which show a significant decrease in the number of agricultural holdings. Due to changes in definitions of the basic statistical unit, the number of farms in the Czech Republic dropped from 39 400 farms in 2007 to 22 860 farms in 2010. Such a rapid decline does not reflect a decrease in the numbers of agricultural businesses, but clearly results from the changes in survey methods, in particular from the increased threshold level for agricultural holdings from 1 ha to 5 ha. The official dataset provided by Eurostat does not enable transformation of the datasets from different years to the same baseline. The aforementioned limitation represents important contextual information that we took into account during the analysis and interpretation of the results.

Results and discussion

a) Evidence about young farmers in the Czech Republic

In 2005 there were 42 450 farms registered in the Czech Republic. According to the 2010 survey, the number of holdings decreased by 45.9% (39 400 farms in 2007 and 22 860 farms in 2010). This declining trend affected absolute figures for the age categories of farmers "under 35 years" and "65+". The relative proportion of young farmers decreased by 36.4% (from 4200 farms in 2005 to 2670 farms in 2010) and the category of older farmers decreased by 58.6% (from 7050 farms in 2005 to 2920 farms in 2010). However, the relative proportion of these age categories was not significantly decreased, as shown in Table 1. Young farmers managed approximately 10%, while older farmers managed approximately 15% of all agricultural holdings in the Czech Republic.

It is important to mention that the methodology used in the survey has changed over the years. This

change affected the number of holdings included in the survey due to the different threshold level (for more detailed information, see the explanation in the section "Materials and Methods"). Overall, it is difficult to distinguish between the effects of these changes in methodology and the actual structural changes in the sector.

Year	2005	2007	2010
Holdings total	42 250	39 400	22 860
Less than 35 years	4 200	3 810	2 670
(%)	9.9 %	9.7 %	11.7 %
35-44 years	7 310	6 850	4 730
(%)	17.3 %	17.4 %	20.7 %
45-54 years	12 080	10 730	6 140
(%)	28.6 %	27.2 %	26.9 %
55-64 years	11 610	11 210	6 410
(%)	27.5 %	28.5 %	28.0 %
65 years or over	7 050	6 790	2 920
(%)	16.7 %	17.2 %	12.8 %

Source: Eurostat, 2013a

Table 1: Number of agricultural holdings and their relative shares in the Czech.

The increase in the relative counts of young farmers (up to 11.7% in 2010) needs to be viewed with respect to this context, as well as the decrease in the proportion of older farmers to 12.8%, despite the fact that these changes may indicate a positive trend in generational turnover in Agriculture. It is possible to assume that the changes in methodology have mostly affected the number of farmers in the oldest age category. If one examines the relative proportion of the smallest holdings in 2007 (i.e. the last survey before the radical decrease in the overall number of holdings), one notes that the farms in the size category below 4.9 ha are mostly owned by older farmers. About two-thirds of all holdings in this age category (66.1%) represent the smallest farms. However, in the case of the young farmers, farms of less than 5 ha represent only one-third of all holdings (32.0%). Modification of the survey methodology sorted out a significant proportion of agricultural holdings run by older farmers, which consequently affected the relative representation of the other age groups – a decrease in the percentage of older farmers and an increase in the percentage of young farmers – with no relation to the structural changes in the sector.

Such a radical decline in numbers of holdings did not occur in other EU member states, except Slovakia, where the number of farms decreased by 46%. In Poland, Latvia, the United Kingdom and Bulgaria, the number of holdings decreased by 30 to 40%. The change mostly affected the same age categories as in the Czech Republic.

In 2005, young farmers managed overall 36 962 holdings (6.9% of all agricultural holdings). The last farm structure survey in 2010 identified 32 607 farms in the age category of farmers under 35 (7.5%) and 129 701 farms (29.7%) in the age category of 65+ years. The numbers of holdings in the marginal age categories were affected by changes in the survey methodology. It is possible to prove that both older and younger farmers probably hold farms in the smallest size category throughout Europe (Zagata and Sutherland, 2015).

b) Size of young farmers' holdings

According to the surveys conducted between 2005 and 2010, the average size of agricultural holdings in the Czech Republic almost doubled. The growth of the mean value (121 ha in 2005 to 221 ha in 2010) accounts for the fact that the smallest farms were excluded from the sample. The average farm size of young farmers reached 91.5 ha, which means that, between 2007 and 2010, the given value increased by 160%. In the case of the category of older farmers, the increase was even more rapid, reaching 360%. However, a discrete change by 310% due to the change in survey methodology only occurred between 2007 and 2010.

For a better understanding of the concentration processes in Agriculture and their effects on the selected age categories, it is also useful to take into account the figures of the overall land. The value of the UAA indicator (Utilised Agricultural Area) presented in Table 2 shows changes in the total volume of land farmed by selected age categories.

Year	2005	2007	2010
Total UAA (ha	5 126 190	5 032 220	5 065 270
Less than 35 years	245 080	243 520	244 400
ha/ %	4.8%	4.8%	4.8%
35-44 years	2 001 290	608 140	601 330
ha/ %	39.0%	12.1%	11.9%
45-54 years	1 329 900	2 617 670	2 661 520
ha/ %	25.9%	52.0%	52.5%
55-64 years	1 357 730	1 351 040	1 272 100
ha/ %	26.5%	26.8%	25.1%
65 years or over	192 190	211 860	285 930
ha/ %	3.7%	4.2%	5.6%

Source: Eurostat, 2013a

Table 2: Overall farmed land and its distribution among age categories of farmers.

The figures presented above show that the total area of land managed by young farmers has not changed significantly, remaining at the level of 245 000 hectares. In the opposite age category – older farmers – the total area of land farmed by older managers rapidly declined by more than 93 000 hectares. At the same time, the number of holdings for both age categories decreased significantly (for details, see Table 1).

We can thus argue that the concentration in the agricultural sector – indicated by the increasing size of holdings – probably occurred only among farms registered in the Eurostat survey. Holdings excluded from the sample, those belonging to the smallest size categories, had very little or no effect on the total farmed land, which remained at the same level. However, the decrease in the overall number of holdings resulted in an increase of the average farm size.

In the years 2005 and 2007, the majority of farms managed by young and older farmers were the smallest holdings. Almost one-quarter of all farms managed by young farm holders (930) comprised holdings of less than 2 hectares of land. In 2007, young farmers ran 730 farms in the size category of up to 2 hectares, which represented one-fifth of all the young farmers' holdings. In 2010, the proportion of larger holdings increased (as shown in Table 3).

In 2010, most older farmers managed holdings in the size category of 5 – 9.9 ha (i.e. 810 farms) and in the size category of 10 – 19.9 ha (i.e. 610 farms). In contrast to young farmers, the number of older farmers' holdings grew in each size category (if we disregard the problematic size category of less than 5 ha). The number of young farmers' holdings slightly increased, but only in the size category of 30 – 99.9 ha. The number of farms in other size categories slowly decreased (Table 4).

c) Economic performance of farms

The importance of young farmers and the generational turnover in Agriculture are not related only to social sustainability, but also to the economic sustainability and competitiveness of the sector. These points are derived from the assumed differences in economic performances of young and older farm managers. This performance can be measured by means of standard indicators, such as UAA (Utilised Agricultural Area), AWU (Annual Work Unit) and SO (Standard Output). The AWU indicator can

Year	2005	2007	2010
Total	4200	3810	2670
0 ha	130	90	30
	3.1%	2.4%	1.1%
Less than 2 ha	930	730	170
	22.1%	19.2%	6.4%
2 - 4.9 ha	620	490	110
	14.8%	12.9%	4.1%
5 - 9.9 ha	490	440	430
	11.7%	11.5%	16.1%
10 - 19.9 ha	540	520	460
	12.9%	13.6%	17.2%
20 - 29.9 ha	280	290	260
	6.7%	7.6%	9.7%
30 - 49.9 ha	340	360	370
	8.1%	9.4%	13.9%
50 - 99.9 ha	370	430	400
	8.8%	11.3%	15.00%
100 ha or over	480	450	440
	11.4%	11.8%	16.5%

Source: Eurostat, 2013a

Table 3: Farm size categories of young farmers (lesss than 35 years of age).

Year	2005	2007	2010
Total	7050	6790	2920
0 ha	170	150	30
	2.4%	2.2%	1.00%
Less than 2 ha	3390	3130	380
	48.1%	46.1%	13.00%
2 - 4.9 ha	1500	1360	200
	21.3%	20.00%	6.8%
5 - 9.9 ha	800	820	810
	11.3%	12.1%	27.7%
10 - 19.9 ha	570	570	620
	8.1%	8.4%	21.2%
20 - 29.9 ha	210	220	240
	3.00%	3.2%	8.2%
30 - 49.9 ha	150	180	200
	2.1%	2.7%	6.8%
50 - 99.9 ha	90	140	140
	1.3%	2.1%	4.8%
100 ha or over	180	220	310
	2.6%	3.2%	10.6%

Source: Eurostat, 2013a

Table 4: Farm size categories of elder farmers (above 65 years of age).

be used for calculation of the average farm size. The Annual Work Unit indicates the amount of work provided by the farm in terms of the number of full-time employees. Standard Output of an agricultural product denotes the average monetary value of the generated products on the farm per month. The ratio of SO and AWU shows how efficiently the farm transforms work in the output of agricultural products. The ratio of UAA and AWU therefore indicates how many people the farm employs with respect to the farmed area of the holding.

	Under 35 years of age	Above 65 years of age	Average
UAA	90.3	81.0	152.4
AWU	2.4	3.3	4.7
SO	81 876	101 570	168 513
SO/AWU	34 480	30 862	35 672
UAA/AWU	38.0	24.6	32.3

Source: Eurostat, 2013a

Table 5: Mean values of the key indicators related to economic performance of farms.

Table 5 reviews the values of the key indicators related to the performance of farms managed by young farmers and older farmers. The figures suggest that the young farmers' holdings on average perform better than the farms of the older farmers. One may note that the young farmers' holdings are generally larger than the older farmers' holdings. However, both age groups remain below the national average, young farmers by about 40% and older farmers by 53%. Farms of both young and older farmers are not unusual in the quantity of employment provided by their farms with respect to their sizes. Holdings of older farmers offer on average 3.3 work units, while holdings of young farmers offer 2.4 work units. These figures are again much lower than the national average. Despite the fact that the farms of young farmers are larger, the monetary value of their SO of agricultural products is lower. The value of the SO is indeed much lower than the average value in the Czech Republic. The low value is probably accounted for by the great differentiation in farm size. In the agricultural sector in the Czech Republic there is a greater proportion of large farms than in the case of the studied age groups, whereas these large farms probably generate a higher SO due to the economy of scale.

Farms managed by young farmers are more efficient than farms managed by older farmers. The ratio of the generated output per work unit is only 3% lower than the national average. This value can be regarded as very high, considering that it is produced on small and mid-size farms. This argument supports the last indicator, which measures work productivity on farms. Holdings of young farmers indicate 38 ha of UAA per one work unit, which is about 13.4 ha more than in the case of older farmers' holdings. Work productivity of young farmers is indeed above the national average of the Czech Republic (32.3 hectares per work unit).

The main argument in the European discussion of the ageing population of farmers is the decreasing proportion of farms managed by young farmers (CEJA 2014). This trend is evident from the Eurostat data related to the 2005 and 2007 surveys. The 2010 survey portrayed a slight increase in the relative proportion of young farmers (from 6.2 to 7.5%). Despite the fact that the "young farmer problem" is constructed as a pan-European issue, there are large differences among EU member states. The Czech Republic belongs to the group of countries which is less affected by the problem of the ageing population of farmers. The ratio of holdings managed by young farmers to those managed by older farmers is about 1:1 and the proportion of farms managed by older farmers does not go beyond 13%. It is important to note that the figures related to the number of farms and their development might be distorted by changes in survey methods, which excluded several thousand holdings that did not pass the threshold level.

At the same time, it is not clear when the ageing population of farmers will become a problem. When exactly the situation becomes threatening for the social sustainability of the agricultural sector? The proportion of young and older farmers needs to be interpreted within the national context and the roles which these groups of farmers perform in the national economies. Their roles are thus based on the specific type of production of their farms, their size and/or geographic position. The context-sensitive perspective is not always included in the European debate on young farmers.

Conclusion

1. It is necessary to distinguish precisely between the ageing population of farmers and the ageing population of agricultural workers. The European debate about ageing

in Agriculture is related to the first perspective only.

2. Exact analysis and evaluation of the situation in the Czech Republic is difficult, due to the methods used in the survey, which resulted in excluding a high number of holdings from the sample.
3. The relative proportion of farms managed by young farmers (11.7%) and older farmers (12.8%) seems favourable in comparison to other EU member states.
4. Young farmers in the Czech Republic are not concentrated on small farms. The average farm size for the under-35-year-old farmers is 90.3 hectares.
5. Comparison of the economic performance of farms managed by young farmers and those managed by older farmers did not show large differences. Contrary to the European statistics, which suggest that young farmers' holdings are more efficient, the young farmers' holdings in the Czech Republic perform below average. On the other hand, these farms indicate a higher work productivity.

Acknowledgements

The research leading to these results has received funding from the Czech University of Life Sciences Prague for the CIGA Project "Ageing population of farmers and farm succession in the Czech agrarian sector" (nr. 20141016).

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Agris on-line Papers in Economics and Informatics

Volume VII Number 1, 2015

Editorial board

Agris on-line Papers in Economics and Informatics

The international reviewed scientific journal issued by the Faculty of Economics and Management of the Czech University of Life Sciences Prague.

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ISSN 1804-193