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Competitiveness and Effects of Policies on Plantain Production Systems in Southwestern Nigeria

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Abstract

Plantain is one of the most important staple crops in Nigeria and has the potential to contribute to food security and economic development of the country. There is inadequate information on competitiveness, comparative advantage and effects of government policies on the commodity. The study therefore analyzed competitiveness and effects of government policies on plantain production systems in Southwestern Nigeria. Primary data were collected using structured questionnaire from 260 producers randomly selected from major production areas in the zone. Secondary data on port charges and world prices were also utilized. Data were analyzed using Policy Analysis Matrix (PAM). Results indicated that plantain production was privately and socially profitable in all the productions systems. Domestic resource cost ratio of 0.16 – 0.19 and social cost benefit ratio of 0.20-0.23 revealed that southwestern Nigeria had comparative advantage in the production of the commodity. The policy indicators and incentives structure such as the nominal protection coefficient on output (0.31-0.42) and input (1.02-1.04), effective protection coefficient (0.26-0.37), profitability coefficient (0.21- 0.32), subsidy ratio to produces (-0.51 to -0.62) and producers subsidy estimate (-1.70 to -2.02) showed that the producers were taxed and there exists transfers of resources from the systems. The study recommends formulation of policies which are consistent with the country's goals of agricultural transformation, food security and economic development.

Keywords:

Plantain, competitiveness, policy incentives, Southwestern Nigeria.

Introduction

Plantain is an economic crop which has a relatively high value in common with most other horticultural crops (Aina et al, 2012). Plantain is critical in bridging the gap between demand and supply of the basic carbohydrate staples (Fakayode et al, 2011). It is an important staple crop in the region (Cauthen et al, 2013) and play a key role in providing food security in food-scarce months when most other starchy staples are difficult to harvest (Akinyemi et al., 2010). Plantain cultivation is attractive to farmers due to relatively lower labour requirements compared to cassava, maize, rice and yam (Kayode et al., 2013). Available trade records and associated indices showed that Nigeria is one of the largest producers of plantain in the world (FAO, 2013). Nigeria is among the major producers of plantain in Africa and fifth in the world producing 2,722,000 metric tonnes in 2011 (FAO, 2012). Plantain and its products have the potential to serve as a vehicle for poverty reduction and source of livelihood for a majority of smallholder farmers and traders.

Despite the production potential of Nigeria in plantain, her role in world plantain economy is relatively minor and does not project a promising outlook (Akinyemi et al, 2010). Nigeria does not feature among plantain exporting nations (Akinyemi et al, 2010) and according to Agricultural Transformation Agenda (ATA), (2011), the country is not prominent in the export of agricultural commodities, her agricultural exports are negligible and represent about 0.2 percent of total exports. Her export share of plantain declined rapidly and has been eclipsed by many countries such as Ghana, Cote d'Ivore, Cameroon amongst others. Potential annual revenue of 1.6 trillion Naira has been lost due to the inability of Nigeria to maintain the 1961 market share in agricultural exports (ATA, 2011).

Plantain production in Nigeria is characterized

by low usage of agricultural inputs, low mechanization and irrigation intensity. This is due to Nigeria's low investment in agriculture averaging approximately 2% of government expenditure (Olomola, 2007). It is apparent that Nigeria, relative to most African countries, has a huge domestic market which can drive growth in agricultural and industrial production, including agro-based value addition. Poor infrastructure and high input costs (for example energy and credit) put Nigerian goods at a competitive disadvantage (ATA, 2011). In order for a commodity to contribute to food security and economic empowerment, analysis of its competitiveness is imperative.

Competitiveness can be defined as the set of institutions, policies, and factors that determine the level of productivity of a country (Martin et al., 1991). It is the fundamental determinant of the level of prosperity a country can sustain (Porter, 2005) and the ability of an economy to provide its population with high and rising standards of living and employment for all those willing to work, on a sustainable basis (EU Commission, 2003). The level of productivity determines the country's ability to sustain a high level of income; it is also one of the central determinants of the returns to investment, which is one of the key factors explaining an economy's growth potential (Martin et al., 2009).

A number of studies have been carried out on Competitiveness in Africa such as Ghada et al. (2014), Toure et al., (2013) and in Nigeria for grains like rice, maize (Ogbe et al, 2011, Liverpool et al., 2009, Oguntade, 2011 and Cassava (Liverpool et al., 2011, Ugochuckwu and Ezedinma, 2011), potato (Ugonna et al, 2013) and pineapple (Adegbite et al., 2014). The existing literature indicated lack of research in the use of Policy Analysis Matrix in the Plantain sub sector in Southwestern Nigeria. The study therefore aims to analyze the competitiveness, comparative advantage and effect of government policies on plantain production systems in Southwestern Nigeria. The outcome of the study is expected to assist relevant stakeholders in coming up with appropriate policies that will lead to the development of the plantain sub sector to the level where it shall be able to contribute to economic development and poverty reduction.

Materials and methods

Study Area

The study was carried out in Southwestern Nigeria. The zone was chosen because it is one of the major plantain growing areas in the country. Large volume of plantain is traded in urban centers located in the zone (Akinyemi et al, 2010). Also, the prospect for value addition is promising due to the presence of emerging processing industries. The South Western is one of the six geo political zones in Nigeria. The zone is made up of six states namely Lagos, Oyo, Ogun, Osun, Ekiti and Ondo states. It falls on latitude 60 to the north and latitude 40 to the south. It is marked by longitude 40 to the west and 60 to the east. It is bounded in the north by Kogi and Kwara states, in the east by Edo and Delta states in the south by Atlantic Ocean and in the west by the Republic of Benin. The zone is characterized by a tropical climate with distinct dry season between November and March and a wet season between April and October. The mean annual rainfall is 1480 mm with a mean monthly temperature range of 18^{o}C – 24^{o}C during the rainy season and 30^{o}C – 35^{o}C during the dry season. The Southwest Nigeria covers about 114,271 kilometers square land area. The total population is 27,581,992 and predominantly agrarian. Major food crops grown in the zone include cassava, plantain, cowpea and yam (NPC, 2006).

Sampling Technique and Data collection

The study employed multistage sampling technique. 10 high plantain production local government areas were selected from the zone followed by selection of two villages from each of the local government. In the last stage of the sampling, farmers were randomly selected from the villages using probability proportionate to size to give a total number of 260 producers from the zone. Primary and Secondary data were utilized for this study. Primary data were obtained through the use of well structured questionnaire. The primary data collected include: yield, input requirements, market prices for inputs and outputs, transportation cost, storage cost while secondary data include production subsidy, port charges, import and export tariffs and exchange rates. The secondary data were sourced from Nigeria Port Authority, the International Trade Statistics and the Central Bank of Nigeria.

Analytical framework

The study evaluated competitiveness and effect of policies on plantain production systems using Policy Analysis Matrix (PAM).

Policy Analysis Matrix (PAM)

PAM (Table 1) is a computational framework developed by Monke and Pearson, (1989) and augmented by Masters and Winter–Nelson (1995) for measuring input use efficiency in production, comparative advantage and degree of government interventions (Nelson, Panggabean, 1991). It is an accounting matrix of two basic identities. The first identity defines profitability as the difference between income and costs (rows), whereas the second measures the effects of the differences in incomes, costs and profits arising from distorting policies and market failures.

Measures of competitiveness

Private profitability

The private profitability demonstrates the competitiveness of the agricultural system given current technologies, prices of input and output and policy (Monke, Pearson, 1989, Pearson et al., 2003). The term private refers to observed revenues and costs reflecting actual market prices received or paid by farmers, merchants, or processors in the agricultural system. Private profit is calculated on the first row of the matrix and it is the difference between observed revenues and costs valued at market prices (private values) received by the producers.

$$D = A - (B + C) \quad (1)$$

Where: D = private profits; A = private revenue, B = tradable input cost at private price, C = domestic factor cost at private price.

Positive private profit indicates competitiveness of the agricultural system while negative private profits implied that the system is not competitive.

Private Cost Ratio (PCR)

PCR shows the private efficiency of the farmers and it is an indication of how much one can afford to pay domestic factors and still remain competitive (Monke, Pearson, 1989).

$$PCR = \frac{\sum_{j=k+1}^{n} a_{ij} P_k^P}{P_i^p - \sum_{j=1}^{k} a_{ij} P_j^P} = \frac{C}{A - B} \quad (2)$$

a_{ij} for ($j = k + 1$ to n) = technical coefficient for domestic input used in plantain production.

a_{ij} for ($j = 1$ to k) = technical coefficient for traded input used in plantain production.

P_k^p = price of domestic input evaluated privately; P_i^p = price of plantain fruit evaluated privately; P_j^p = price of traded input (₦) evaluated privately in plantain production, C = cost of domestic factors; A = revenues in private prices; B = cost of tradable inputs.

Thus PCR<1 indicates that entrepreneurs are earning profits while PCR>1 implies entrepreneurs are making losses; PCR = 1 indicates the breakeven point.

Item	Revenues	Cost of tradable inputs	Domestic factors	Profits
Private prices	A = P_i^P	B = $\sum_{j=1}^{k} a_{ij} P_j^p$	C = $\sum_{j=k+1}^{n} a_{ij} P_k^P$	D = $A - B - C$
Social prices	E = P_i^S	F = $\sum_{j=1}^{k} a_{ij} P_j^S$	G = $\sum_{j=k+1}^{n} a_{ij} P_k^S$	H = $E - F - G$
Effects of policy and other divergences	$I = A - E$	$J = B - F$	$K = C - G$	$L = D - H = I - J - K$

Note:

A = private revenue, B = tradable input cost at private price, C = domestic factor cost at private price, D = private profit, E = social revenue, F = tradable input at social price, G = domestic factor cost at social price, H = social profit; I = output transfer, J = input transfer, K = factor transfer, L = net policy transfer = [$D - H$].

P_i^P = price of plantain fruit produced evaluated privately (₦)
P_i^S = price of plantain fruit produced evaluated socially (₦)
a_{ij} for (j = 1 to k) = technical coefficient for traded input used in plantain production
a_{ij} for ($j = k + 1$ to n) = technical coefficient for domestic input used in plantain production.
P_j^p = price of traded input evaluated privately in plantain production (₦)
P_j^s = price of traded input evaluated socially in plantain production (₦)
P_k^p = price of domestic factor input evaluated privately in plantain production (₦)
P_k^s = price of domestic input factor evaluated socially in plantain production (₦)

Source: Monke and Pearson, 1989

Table 1: Policy analysis matrix.

Measures of comparative advantage

Social profitability

The social profitability is a measure of comparative advantage and efficiency because outputs and inputs are valued in prices that reflect scarcity values (Monke and Pearson, 1989). This is calculated on the second row of the Policy Analysis Matrix.

$$H = E - (F + G) \quad (3)$$

E = social revenue, F = tradable input at social price, G = domestic factor cost at social price, H = social profit.

A positive social profit indicates that the system uses scarce resources efficiently and the commodity has a static comparative advantage while negative Social profits indicate that the sector cannot sustain its current output without assistance from the government.

Domestic Resource Cost (DRC)

The Domestic Resource Cost (DRC) is a measure of relative efficiency of domestic production by comparing the opportunity cost of domestic production to the value generated by the product (Tsakok, 1990). The measure is calculated as the ratio of the cost of domestic resources and non-traded inputs of producing the commodity to the net foreign exchange earned or saved by producing the good domestically.

$$DRC = \frac{\sum_{j=k+1}^{n} a_{ij} P_k^S}{P_i^s - \sum_{j=1}^{k} a_{ij} P_j^S} = \frac{G}{E - F} \quad (4)$$

a_{ij} for (j = *1* to k) = technical coefficient for traded input used in plantain production. a_{ij} for (j = k + *1* to n) = technical coefficient for domestic input used in plantain production; P_k^S = price of domestic input evaluated socially (₦); P_i^S = prices of plantain fruit evaluated socially (₦); P_j^S = price of traded input evaluated socially in plantain production (₦); G = costs of domestic factor in social prices; E = measures revenue in social prices, F = cost of tradable input in social prices.

DRC<1 indicates comparative advantage in producing the commodity using domestic resources.

DRC>1 indicates comparative disadvantage in producing and requires policy interventions.

Social Cost Benefit ratio (comparative advantage)

A good alternative for the DRC is the Social Cost-Benefit ratio (SCB) which accounts for all cost and avoids classification errors in the calculation of DRC (Masters,Winter-Nelson, 1995). Social Cost/Benefit (SCB), which accounts for all costs (Fang, Beghin, 1999) while DRC may be biased against activities that rely heavily on domestic non traded factors such as land and labor.

$$SCB = \frac{\sum_{j=1}^{k} a_{ij} P_j^S + \sum_{j=K+1}^{n} a_{ij} P_k^S}{P_i^S} = \frac{F + G}{E} \quad (5)$$

a_{ij} for (j = *1* to k) = technical coefficient for traded input used in plantain production.

a_{ij} for (j = k + *1* to n) = technical coefficient for domestic input used in plantain production; P_j^S = price of traded input evaluated socially in plantain production (₦); P_k^S = price of domestic input evaluated socially (₦); P_i^S = private prices of plantain fruit evaluated socially (₦); G = costs of domestic factor in social prices; E = measures revenue in social prices; F = cost of tradable input in social prices.

SCBR ratio > 1 indicates that the system does not have comparative advantages.

SCBR ratio <1 indicates that the system have comparative advantages.

Measures of protection and effect of policies

The most common protection coefficients in PAM are the Nominal Protection Coefficient (NPC), the Effective Protection Coefficient (EPC), the Profitability Coefficient (PC), the Subsidy Ratio to Producers (SRP) and the Producer Subsidy Estimate (PSE).

Nominal Protection Coefficient (NPC)

The NPC is a measure of the extent to which domestic price policy protects domestic producers or consumers from the direct input or output of foreign markets (Tsakok, 1990). The NPC is calculated as a ratio of domestic price to border parity price. It can be calculated for the output (NPCO) and input (NPCI).

$$NPCO = \frac{Pi^p}{Pi^s} = \frac{A}{E} \quad (6)$$

$NPCO$ = Nominal Protection Coefficient on plantain fruit produced.

$$NPCi = \frac{\sum a_{ij} Pj^{p}}{\sum a_{ij} Pj^{s}} = \frac{B}{F} \quad (7)$$

NPCi = Nominal Protection Coefficient on input used for plantain production.

P_i^S = prices of plantain fruit produced evaluated socially (₦)

P_i^p = prices of plantain fruit produced evaluated privately

A = Private revenue

E = Social revenue

B = cost of tradable inputs in private prices

F = cost of tradable input in social prices

P_j^p = private prices per unit of tradeable input

P_j^s = social prices per unit of tradeable input

a_{ij}, *k+1* to *n* = coefficients for domestic resources and non traded inputs

a_{ij}, *1+k* = coefficients for traded inputs

NPCO > 1 = the domestic price is higher than the export price and the system is receiving protection.

NPCO < 1 = the domestic price is lower than the comparable world price and the system is not protected by policy.

NPCI > 1 = domestic input cost is higher than the input cost at world prices and the system is taxed by policy.

NPCI < 1 = domestic price is lower than the comparable world price and the system is subsidized by policy.

Effective Protection Coefficient (EPC)

This is the ratio of value added at domestic prices (A - B) to value added at world reference prices (E - F). The EPC combines the two NPC's to assess the overall effect of implicit tax and subsidy through both inputs and outputs (Beghin, Fang, 2002).

$$EPCi = \frac{VAD}{VAB} = \frac{A - B}{E - F} \quad (8)$$

VAB = value added at border price; *VAD* = value added at domestic price; *A, B, E, F* are defined above in PAM framework.

A value of EPC greater than one indicates a net subsidy to value added (Beghin, Fang, 2002).

EPC<1 represents a net disincentive.

Profitability Coefficient

The PC measures the incentive effects of all policies and thus serves as a proxy for the net policy transfer, since *L = (D - H)*. The index is calculated as a ratio of private profit to social profit (Pearson et al., 2003).

$$PC = \frac{P_i^P - \sum_{j=1}^{k} a_{ij} P_j^P - \sum_{j=k+1}^{n} a_{ij} P_k^P}{P_i^S - \sum_{j=1}^{k} a_{ij} P_j^S - \sum_{j=k+1}^{n} a_{ij} P_k^S} = \frac{A - B - C}{E - F - G} = \frac{D}{H} \quad (9)$$

PC = profitability coefficient

a_{ij} for (*j = 1* to *k*) = technical coefficient for traded input used in the value chain of plantain

a_{ij} for (*j = k* to *n*) = technical coefficient for domestic input used in the value chain of plantain

P_i^p = private prices of plantain output evaluated privately

P_i^S = private prices of plantain output evaluated socially (₦)

P_j^p = price of traded input evaluated privately in plantain value chain (₦)

P_j^S = price of traded input evaluated socially in plantain value chain (₦)

P_k^p = price of domestic input evaluated privately

P_k^S = price of domestic input evaluated socially (₦)

A, B, C, D, E, F, G, H is defined above in the PAM table.

PC < 1: net disincentives to production

PC >1: incentives to production

Subsidy Ratio to Producers (SRP)

SRP is the net policy transfer as a proportion of total social revenues (Monke, Pearson, 1989). The SRP shows the proportion of revenues in world prices that would be required if a single subsidy or tax were substituted for the entire set of commodity and macroeconomic policies.

$$SRP = \frac{L}{E} = \frac{(D - H)}{E} \quad (10)$$

D = private profit, *E* = social revenue, *H* = social profit; *L* = net policy transfer.

The positive value of SRP indicates the overall transfer from society to producer while Negative value of SRP means overall transfer from producer to society and taxpayers.

Producer subsidy equivalent (PSE) is a more complete measure of protection from trade as it accounts for factors affecting input and output prices (Monke, Pearson, 1989). The PSE is extracted

from the PAM as (L) divided by A. it measures the impact of policies on profits of as share of revenue. The negative value of PSE indicates overall transfer from producer to consumer and taxpayers while the positive value means the overall transfer from consumer to producer.

$$PSE = \frac{L}{A} \quad (11)$$

L = net policy transfer; A = private revenue

Results and Discussion

1. Competitiveness of plantain production systems

Four plantain production systems were identified in the study are: sole plantain, plantain/cocoa, plantain/cocoyam and plantain/cassava. The results of the analysis (Table 2) showed that plantain production was privately profitable in the four production systems. Positive private profit of ₦348,352/ha ($2,114.33/ha) was estimated for sole plantain production system, plantain/cocoa (₦303,150/ha), plantain/cocoyam (₦514,547/ha) and plantain/cassava (₦354,579/ha). This indicates that plantain production is competitive and the producers are realizing financial gains under existing policies, technologies, output values, input costs, and policy transfers. It also implies that farmers in the study area can produce plantain without transfer from government. plantain/cocoyam production system was the most competitive out of the four evaluated production system with a private profitability of ₦514,547/ha followed by plantain/cassava production systems (₦354,579), sole plantain (₦348,352/ha) while the least competitive production system was the plantain/cocoa (₦303,150/ha). The high private profitability recorded in plantain/cocoyam production system was due to additional income realized from the sale of Cocoyam tubers and the associated higher price per unit of Cocoyam.

The competitiveness of plantain production system was also confirmed by the private cost ratio (PCR). PCR is another indicator of competitiveness and is an indication of how much a system can afford to pay domestic factors and still remain competitive (Monke, Pearson, 1989). A ratio of PCR less than 1 indicates a profitable enterprise while a ratio greater than 1 indicates a non-profitable enterprise. The lower the PCR ratio the higher the competitiveness of the system (Rasmikayati, Nurasiyah, 2004). The result of the analysis (Table 4) indicated that the PCR of the production systems ranged between 0.27 – 0.36. PCR ratio of 0.30 was obtained for sole plantain production systems, plantain cocoa (0.35), plantain/cocoyam (0.27), plantain/cassava (0.36). The PCR value of plantain/cocoyam was also the lowest and this further confirmed competitiveness of the production system compared to the other systems of production. The PCR which was less than unity indicated that value added was relatively large in comparison with domestic factor costs. It also indicated that costs involved in the production were smaller than the corresponding benefits. Thus plantain production is profitable and competitive and the producers have incentives to expand production. Similar trends about profitability of plantain production enterprise were also reported by Baruwa et al, (2011), Kainga and Seiyabo, (2012). Baruwa et al, (2011) found that net returns accruing to an average plantain farmer was ₦65, 781.67 per ha per annum. Kainga and Seiyabo, (2012) reported that net income estimated from plantain production in Bayelsa was ₦223, 420.00 indicating that plantain production is competitive at the market price.

2. Social profitability and comparative advantage in plantain production systems

Result of the analysis (Table 3) indicated that plantain production is socially profitable in the study area. Positive social profit of ₦1,533,489.88/ha was estimated for sole plantain, plantain/cocoa (₦1,492,691.88/ha), plantain/cocoyam (₦1,593,610.88/ha) while

Production system	Revenue (₦)	Cost of tradeable input (₦)	Cost of domestic factors (₦)	Private profitability/ha (₦)	PCR
Sole plantain	591,969	92,926	150,691	348,352	0.30
Plantain/cocoa	591,969	127,380	161,439	303,150	0.35
Plantain/cocoyam	877,969	168,961	194,461	514,547	0.27
Plantain/cassava	669,249	113,975	200,695	354,579	0.36

Source: Field survey, 2013 (1$= ₦160)

Table 2: Competitiveness of plantain production systems in southwestern Nigeria.

Production system	Revenue (₦)	Cost of tradeable input (₦)	Cost of domestic factors (₦)	Social profitability/ ha (₦)	Domestic resource cost ratio	Social cost benefit ratio
Sole plantain	1,920,594.88	92,115	294,989.63	1,533,489.88	0.16	0.21
Plantain/cocoa	1,920,594.88	124,365	303,538	1,492,691.88	0.17	0.24
Plantain/cocoyam	2,092,194.88	166,974	331,610	1,593,610.88	0.17	0.26
Plantain/cassava	1,931,414.08	111,860	337,843	1,481,711.08	0.19	0.23

Source: Field survey, 2013 (1$= ₦160)

Table 3: Social profitability in plantain production systems.

positive social profit of ₦1,481,711.08/ha was realized in plantain/cassava production system. Positive social profit implied that the producers were utilizing scarce resources efficiently in the production of the commodity. It also indicated that the system can survive without government interventions. However, social profitability was highest in plantain/cocoyam production systems (₦1,593,610.88/ha) followed by sole plantain (₦1,533,489.88/ha), plantain/cocoa (₦1,492,691.88/ha) while the least social profitability was obtained with plantain/cassava production systems (₦1,481,711.08/ha). The high social profitability in plantain/cocoyam system compared to the other system was due to additional revenue from cocoyam. This is an indication that yield component is a very important criteria in achieving positive or negative social profitability. The result of the social profitability analysis indicated that plantain could be produced in southwestern Nigeria for export.

The result of the analysis of Domestic Resource Cost (DRC) (Table 3) for plantain production system indicated that the DRC values were less than 1. A DRC value of 0.16 was obtained in sole plantain, plantain/cocoa (0.17), plantain/cocoyam (0.17) and plantain/cassava (0.19). This indicates economic profitability and comparative advantage in plantain production system. It also implies that the social net value added is greater than the social costs of domestic production factors. Based on comparative advantage ranking of the production system, the comparative advantage was higher (lowest DRC ratio) in sole plantain (0.16) while the least was obtained with plantain/cassava (0.19). The result of DRC is supported by the SCB ratio. SCB ratio of 0.21 was obtained in sole plantain, plantain/cocoa (0.24), plantain/cocoyam (0.26) and plantain/cassava (0.23) respectively. The result of the SCB indicates that the sum of tradable inputs and domestic factors costs are less than the gross revenue under the prevailing output and input market conditions. These results are supported by the findings of Liverpool et al. (2009) and Ugochuckwu and Ezedinma (2011). In Liverpool et al. (2009) and Ugochuckwu and Ezedinma (2011) social profitability was positive for staple crop production (rice) systems with DRC and SCB ratio less than one indicating that the country had comparative advantage in the production of the commodity.

3. Measures of protection and effects of policies on plantain production systems

The Nominal Protection Coefficient (NPC) is the ratio between the observed market price paid to producers of a given product and the good's underlying social opportunity cost. If NPCO is less than one, the domestic price of plantain fruit produced is lower than the comparable world price and the system is not protected by policy (Monke, Pearson, 1989) while NPCO greater than one indicates protection of the system. Nominal Protection Coefficient on output (NPCO) for the production systems were less than 1 (Table 4). NPCO value of 0.31 was obtained for sole plantain, plantain/cocoa (0.31), plantain/cocoyam (0.42) and plantain/cassava (0.34). This implies that the domestic price of plantain fruit produced is less than the border price. This further implies implicit transfer of resources from the system and the system is unprotected by policy since the actors are earning less in private value compared to social value. The result of the NPCO in the plantain production system is also an indication that the outputs are under priced compared to the border price.

Nominal Protection Coefficient on Input (NPCI) is a ratio used to measure tradable input transfers. If NPCI exceeds one, the domestic input cost is higher than the input cost at world prices and the system is taxed by policy. NPCI less than one implied that the domestic price is lower than the comparable world price and the system is subsidized by policy. The NPCI on input such as chemical, fertilizers, sprayers (NPCI)

Production system	NPCO	NPCI	EPC	PC	SRP	PSE
Sole plantain	0.31	1.04	0.27	0.23	-0.62	-2.00
Plantain/cocoa	0.31	1.03	0.26	0.20	-0.62	-2.01
Plantain/cocoyam	0.42	1.02	0.37	0.32	-0.52	-1.23
Plantain/cassava	0.34	1.03	0.31	0.24	-0.58	-1.68

Note: NPCO, NPCI, EPC, PC, SRP and PSE are ratio and are used in measuring the level of protection received by a commodity.

Source: Field survey, 2013

Table 4: Protection coefficient and incentives in plantain production.

for the production systems were greater than one. NPCI value of 1.04 was obtained for sole plantain, plantain/cocoa (1.03), plantain/cocoyam (1.02) and plantain/cassava (1.03). This implies that input price at market price is greater than what is observed in the world reference price. The absence of incentives was further confirmed by the result of the Effective Protection Coefficient (EPC) that was less than one in the production system. EPC ratio compares valued added in domestic prices with value added in world prices. An EPC > 1 is an indicator that producers are protected, while an EPC < 1 indicates that producers are taxed (Monke, Pearson, 1989). EPC values of 0.27, 0.26, 0.37 and 0.31 were obtained for sole plantain, plantain/cocoa, plantain/cocoyam and plantain/cassava production systems indicating that the producers are taxed. The absence of incentives was further reinforced by the result of the profitability coefficient presented in Table 4. The profitability coefficient (PC) measures the impact of all transfers on private profits and indicates the proportion of incentives provided to producers through policy effects. PC equals the ratio of private profits to social profits. The profitability coefficient was also less than one for the production system. Profitability coefficient of 0.23, 0.20, 0.32 and 0.24 were obtained for sole plantain, plantain/cocoa, plantain/cocoyam and plantain/cassava productions system. Higher profitability coefficient of 0.32 obtained in plantain/cocoyam production system was due to combined income realized form plantain and cocoyam. The result of the analysis of the profitability coefficient indicates that private profits are less than the profits evaluated at world reference price indicating net disincentives to the producers. Subsidy Ratio to Producers (SRP) compared net policy transfer to value of output at world reference price. The positive value of SRP indicates the overall transfer from society to producer while negative value of SRP means overall transfer from producer to society and taxpayers. SRP values of -0.62, -0.62, -0.52 and -0.58 were obtained for sole plantain, plantain/cocoa, plantain/cocoyam and plantain/cassava production systems. The negative SRP indicates that the producers are taxed in the production of the commodity and there is decrease in gross revenue. The equivalent Producer Subsidy Estimate for the production systems were also less than one indicating implicit tax and transfer of resources from the system.

Conclusion

The result of the policy analysis matrix showed that plantain production was privately and socially profitable in all the production systems. Although, plantain/cocoyam production system was the most competitive out of the four evaluated production system with a private profitability of ₦514,547/ha followed by plantain/cassava production systems (₦354,579), sole plantain (₦348,352/ha) while the least competitive production system was the plantain/cocoa (₦303,150/ha). Additionally, social profitability was highest in plantain/cocoyam production systems (₦1,593,610/ha) followed by sole plantain (₦1,533,489/ha), plantain/cocoa (₦1,492,691/ha) while the least net social profitability was obtained with plantain/cassava production systems (₦1,481,711/ha). Social Cost Benefit ratio (SCB) of 0.21 was obtained in sole plantain, plantain/cocoa (0.24), plantain/cocoyam (0.26) and plantain/cassava (0.23) respectively indicating comparative advantage of the production systems. There was absence of incentives in the production system and this was revealed by the result of the Effective Protection Coefficient (EPC) that was less than one in the production system. Producer subsidy ratio of -0.62, -0.62, -0.52 and -0.58 were obtained for sole plantain, plantain/cocoa, plantain/cocoyam and plantain/cassava production systems respectively indicating that the producers were taxed in the production of the commodity and there is decrease in gross

revenue. The study therefore recommends formulation of policies which are consistent with the country's goals of agricultural transformation, food security and economic development.

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Comparative Economic Study of Mixed and Sole Cassava Cropping Systems in Nigeria

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Abstract

Agricultural economists continue to argue if mixed or sole cassava cropping system is more economically profitable and in terms of yield and returns to farmers particularly for Nigeria which is the world's largest producer of the crop. The study was carried out to analyse the economics comparatively of mixed and sole cassava cropping systems in Nigeria. The study made use of both primary and secondary data. Primary data were collected with the aid of well-structured questionnaires assisted with interview schedules. Field data collection was conducted between March and April, 2014. Multi-stage sampling technique was used to select four hundred and eighty (480) respondents across the six major cassava-producing states in Nigeria (Benue, Cross Rivers, Enugu, Kogi, Ondo, and Oyo). Data collected were analysed using descriptive statistics and comparative budgetary analysis. The study showed that mixed cropping system is more male-dominated than sole cropping system. The study also revealed that sole cassava cropping system is more economically profitable than mixed cassava cropping system while the later provides opportunities of all-year-round farm incomes to serve as a better poverty- alleviating mechanism.

Keywords:

Comparative economic study, mixed cropping, sole cropping, cassava, Nigeria.

Introduction

Nigeria is the world's largest producer of cassava while cassava continues to remain the most important crop in terms of production reaching a record high of 45 million tonnes in 2013. The low cost of production has made cassava to remain, the commodity with very high poverty reduction potentials for the Nigerian economy that is characterised with very poor citizens. In 1999, Nigeria produced 33 million tonnes, in 2000, the average yield per hectare was 10.6 tonnes, in 2010 production values reached about 37.5 million tonnes while yield and area values reached 12 tonnes per hectare and 3.13 million hectares respectively while a decade later, it produced approximately 45 million tonnes, which is almost 19% of production in the world. The production saw an increase of 15% between 2000 and 2006, with yields developing in correlation to production trends. The yield of cassava per hectare continues to increase due to several committed government initiatives and that of the international community in the crop (Adekanye et al, 2013; Asante-Pok, 2013; IITA, 2013).

There are two main categories of cassava varieties produced in Nigeria: *Manihot palmata* and *Manihot aipi*, or bitter and sweet cassava respectively (Nwabueze, 2009). Cassava is grown throughout the year, making it preferable to the seasonal crops of yam, beans or peas. It displays an exceptional ability to adapt to climate change (HarvestPlus, 2013) with a tolerance to low soil fertility, resistance to drought conditions, pests and diseases, and suitability to store its roots for long periods underground even after they mature. In Nigeria, the application of fertilizer for cassava production is very limited due to unavailability and high cost, and it is also grown on fallow lands (Adeniji et al, 2005). Harvesting of the roots after planting varies from 6 months to 3 years. There are four planting seasons in Nigeria, which vary according to the geo-ecological zone; these are from March to November in the rain forest, April to August in the derived savanna, May to July in the Southern Guinea savanna (SGS) and July to August in the Northern Guinea savanna (IITA, 2005). Pests and diseases are a concurrent cause of low cassava yields in Nigeria. The main pests affecting yields include the cassava green mite,

the cassava mealy bug, and the variegated grasshopper. The main diseases impacting the productivity of cassava are the cassava mosaic disease, cassava bacterial blight, cassava anthracnose disease, and root rot (Allison Oguru et al, 2008, IITA, 2007; PIND, 2011)

Economic importance of cassava in Nigeria

Cassava is by far the most important of the arable food crops grown in the Southern agro-ecological zones of Nigeria closely followed, in order of economic importance, by yam, maize and rice. It is the most paramount staple, food–security crop in the Sub-Saharan Africa and a mainstay of the rural and increasingly also the urban population. Famine rarely occurs in a community where cassava is widely grown, because in some places they are harvested continuously throughout the year, thus tidying farmers over hungry seasons after other crops have been planted but are not yet mature (IITA, 1982; IITA, 1997; Nweke, 1997; Kathundu and Chiwona-Karltun, 2001, Allison Oguru et al, 2008).

Nigeria's output of cassava is by far the highest in the world; about a third more than production in Brazil and almost double the respective volume of production of Indonesia and Thailand. Cassava production in each of the other African countries, who are also major producers, namely Democratic Republic of the Congo, Ghana, Madagascar, Mozambique, Tanzania and Uganda appears small in comparison to Nigeria's substantial output. By the year 2002, estimate of cassava output in Nigeria was put at about 34 million tonnes, but by 2003 the output has risen to about 37 million tonnes (CBN, 2002; FAO, 2004).

The production and marketing of cassava have several challenges which include high cost of input materials, high cost of labour, high cost of mechansation, inadequate extension services/ technical advice, inadequate funds, inadequate supply of high yielding cassava cuttings, bad access farm roads, effects of weather and climate, production and price fluctuations, lack of price control, preservation and storage, value addition among others (Bryceson et al, 2002; Daron et al, 2014; Mafimisebi, 2008; Anselm et al, 2005; Ajayi, 2014; Reed et al, 2013 and Richter et al, 2013)

Methods of cassava cultivation in Nigeria

The three conventional cropping systems practised in the world are sole cropping, mixed cropping and inter-cropping. Sole cropping is practised when a farm is planted with only one crop throughout a given cropping or farming season. This system of cropping is common among large commercial farms particularly in Europe, Australia and America. In mixed cropping, a major crop say plantain, cassava or yam with one or more supplementary crops are planted on a farm in a given cropping or farming season. This system of cropping is common among small-scale farmers in Africa, Asia, and Latin America. Lastly, inter-cropping is practised when two or more crops are planted together on a farm either in pure stands or in alternate rows (Allison-Oguru, 2004). Multiple or mixed cropping and inter- cropping are therefore known traditional cropping systems practised in most parts of Africa, Asia and Central America (Papendrick, et al, 1976; Beets, 1982; Francis, 1986, Allison Oguru et al, 2008).

Hoof (1987) and Reijtjes (1992) have observed that in most multiple cropping systems developed by small-holder farmers in the tropics, productivity in terms of harvestable products per land area is higher than under sole cropping. Steiner (1984) and Francis (1986) have also reported yield increases ranging between 20% and 60%. The relevant questions that readily come to mind are: what are the other advantages associated with multiple or mixed cropping and inter-cropping? Do these advantages translate to higher monetary returns i.e. could it be that multiple or mixed cropping enterprises are relatively more profitable than sole cropping enterprises? If multiple or mixed cropping and inter-cropping are so advantageous, how come that even in tropical Africa some farmers still practice sole cropping? This research is therefore set to addressing these questions in an empirical manner and to recommend among the two conventional cropping systems the one that is more profitable and suited to the factor of Nigeria. In view of above, the comparative economic study of mixed and sole cassava cropping systems in Nigeria was conducted with the following specific objectives which include to:

i. Examine the comparative socio-economic characteristics of mixed and sole cassava farmers in Nigeria
ii. Determine the comparative returns on mixed and sole cassava production in Nigeria
iii. Evaluate the comparative profitability of mixed and sole cassava production in Nigeria.

Materials and methods

The study area

The study was carried out in Benue, Cross Rivers, Enugu, Kogi, Ondo and Oyo States, Nigeria. These states were selected for the study because of their high cassava production figures and the availability of both mixed and sole cassava cropping systems.

Sampling technique and size

Multistage sampling technique was used in the selection of the respondents for this study. In the first stage, six (6) States were purposively selected on the basis of having the highest production figures for cassava in the country. Two (2) Local Government Areas (LGAs) were purposively selected in each of the states. In the second stage, two (2) cassava-producing communities were randomly selected in each of the LGAs using a list got from Agricultural Development Project of the Ministry of Agriculture and Rural Development of the States. This gives a total of twenty four (24) communities. Twenty farmers were purposively selected in each of the communities i.e. Ten (10) farmers were purposively selected on basis of having mixed cassava plots and another ten (10) farmers were selected on the basis of having sole cassava plots. The purposive sampling of farmers having each of mixed and sole cassava plots was made possible by snowball method. In this method, the farmer that has just being interviewed was asked to identify one or two other farmers that had mixed and sole cassava plot (s) in both categories in the last planting season. This gives a total of four hundred and eighty (480) cassava farmers and the enumerators proceeded to interview the identified cassava farmers.

Data and method of data collection

Primary data were used for the study. Data were collected by means of a well-structured questionnaire, which was pre-tested to improve data reliability. As a result of low literacy level of farmers, trained enumerators, who understood the local dialects, were used to administer the questionnaire on the farmers. A total of four hundred and eighty (480) questionnaires were administered, completed and returned. Field data collection was conducted between March and April, 2014.

Results and discussion

Comparative socio-economic characteristics of mixed and sole cassava farmers in the study area

Table 1 shows the comparative distribution of the respondents in the study area by their socio-economic characteristics. The results of age distribution from the table revealed that the respondents who were less than 30 years only accounted for 6.67% and 3.75% for mixed and sole cassava cropping systems respectively, while those older than 60 years accounted for 29.58% and 18.33% for mixed and sole cropping systems respectively. In all, 63.75% of the respondents were aged above 50 years for both categories in the study area. This implies that majority of the respondents were in their aging and less productive period. The young, agile and productive cassava farmers were few compared with the aged. Meanwhile sex distribution of the respondents indicates that 74.17% and 25.85% were male and female respectively for mixed cropping system while 65.42% and 34.58% were male and female respectively for sole cropping system. This indicates that mixed cropping system is more male-dominated than female. This is in accordance with the a priori theory that mixed cropping system is more strenuous and requires much more energy than the sole cropping system.

The results of marital distribution of the respondents indicate that mixed cropping system had more married respondents than the sole cropping system while sole cropping system had more single respondents than missed cropping system. The implication of this is that more married respondents for mixed cropping system will afford them the opportunity of getting family labour to be used for the more labour occasioned by cassava production with other crops on their farms. The distribution of level of education as also shown in Table 1 reveals that 57.08% and 32.00% had formal education up to primary school for mixed and sole cropping systems respectively. For mixed cropping, only 14.58% had secondary education while more than half (52.08%) for sole cropping system. The results for other categories of education remain fairly similar. This implies that cassava farmers who cultivated cassava as sole crop were more educated than those who cultivated the crop as mixed in the study area. The higher level of education

Socio-economic characteristics					
		Mixed cropping system		Sole cropping system	
	Range	Frequency	Percentage (%)	Frequency	Percentage (%)
Age of respondents (in years)	< 30	16	6.67	09	3.75
	31-40	41	17.08	29	12.08
	41-50	30	12.50	49	20.42
	51-60	82	34.17	109	45.42
	> 60	71	29.58	44	18.33
Sex of respondents	Male	178	74.17	157	65.42
	Female	62	25.83	83	34.58
Marital Status of respondent	Single	13	5.42	19	7.92
	Married	156	65.00	137	57.08
	Divorced	31	12.92	31	12.92
	Separated	25	10.42	34	14.17
	Widowed	15	6.25	19	7.92
Level of education	No formal education	41	17.08	18	7.50
	Primary school education	137	57.08	77	32.0
	Secondary school education	35	14.58	125	52.08
	Tertiary education	10	4.17	12	5.00
	Others	17	7.08	8	3.33
Family size	<5	103	42.92	143	59.58
	6 to 10	68	28.33	51	21.25
	> 10	69	28.75	48	20.00
Major source of finance	Personal savings	103	42.92	61	25.42
	Friends and relatives	68	28.33	23	9.58
	Cooperatives	30	12.50	18	7.50
	Microcredit institutions	20	8.33	46	19.17
	Commercial banks	19	7.92	92	38.33

Source: Computed from field survey, 2014

Table 1: Socio-economic characteristics of cassava farmers in the study area.

of sole cassava farmers could have influenced their adoption of sole cropping system as against the conventional mixed cropping system. Moreover, the percentage of respondents whose household size were either between 6 and 10 members or more than 10 members were 57.08% for mixed cropping system and 41.25% for sole cropping system. This implies that respondents who practice mixed cropping system had lager household size than those who practiced sole cropping system. This is expected, because the larger household size will find its use for increased labour occasioned by cultivating many crops on same plot.

Comparative cultural characteristics of mixed and sole cassava farmers in the study area

Table 2 shows the distribution of the respondents in the study area by their cultural practices. The distribution of the respondents according to farm size indicates that 61.67% and 21.67% of the respondents had farm size less than 1 hectare for mixed and sole cropping systems respectively. Those that had farm sizes ranging from 1 to 5 hectares constituted 23.75% and 20.42% for mixed and sole cropping systems respectively. Only about 7% and about 13% of the respondents had cassava farms bigger than 10 hectares for mixed and sole cropping systems respectively. It is therefore succinct to say that sole cassava farmers had larger farm size than mixed cassava farmers. The availability of large farm size explained why sole cropping was thriving among the sole cassava farmers in the study area. While combined use of both (42.08%) family and hired labour remained

Cultural practices					
		Mixed cropping system		Sole cropping system	
	Range	Frequency	Percentage (%)	Frequency	Percentage (%)
Farm size (in hectare)	< 1	148	61.67	52	21.67
	1 to 5	57	23.75	49	20.42
	6 to 10	18	07.50	108	45.00
	> 10	17	07.08	31	12.92
Experience in cassava faming (in years)	< 5	19	7.92	25	10.42
	6 to 10	41	17.08	87	36.25
	11 to 15	40	16.67	89	37.08
	15 to 20	49	20.42	26	10.83
	> 20	91	37.92	13	5.42
Type of labour	Family	72	30.00	56	23.33
	Hired	67	27.92	98	40.83
	Both	101	42.08	86	35.83
Method of weed control	Manual weeding	52	21.67	35	14.58
	Chemical control	57	23.75	148	61.67
	Both	131	54.58	57	23.75
Type of herbicides	Primextra	6	2.5	9	3.75
	Dansate	8	3.33	12	5.00
	Sarosate	115	47.92	147	61.25
	Weedoff	21	8.75	57	23.75
	Propan	4	1.67	8	3.33
	Select	4	1.67	4	1.67
	Nil	82	34.17	3	1.25
Extension service & Technical advice	Dev. agencies/ research inst	63	26.25	101	42.08
	ADP	87	36.25	81	33.75
	Farmers' association	50	20.83	40	16.67
	Fellow farmers	40	16.67	18	7.50

Source: Computed from field survey, 2014

Table 2: Cultural characteristics of cassava farmers in the study area.

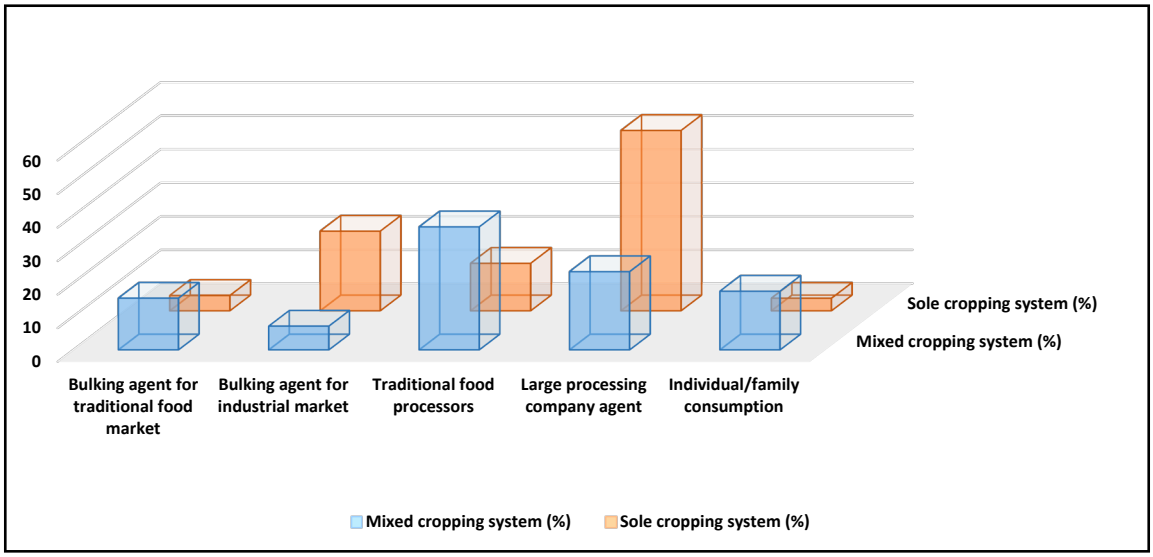
mostly preferred by the respondents from mixed cropping system, the use of hired labour (40.83%) remained the mostly preferred among respondents from sole cropping system. For both mixed and sole cropping systems, the use of both family and hired labour remained very popular. The respondents noted that, it is more cost effective and labour efficient to use both family and hired labour while providing opportunities of continuous farm income. From Table 2 also, the use of both (54.58%) manual weed and chemical control was the commonest among mixed cropping cassava farmers while use chemical control (61.67%) was the commonest among sole cropping cassava farmers in the study area. Sarosate remained the preferred herbicide for both mixed cropping cassava farmers (47.92%) and sole cropping cassava farmers (61.25%). However, most sole cropping cassava farmers used the herbicide than mixed cropping cassava farmers. Other herbicides used included Primextra, Dansate, Weedoff, Propan and Select. Meanwhile a large proportion (34.17%) of the respondents used no herbicide for mixed cropping system. Extension services and technical advice were mostly from Agricultural Development Project (ADP) (32%) for mixed cropping system while development agencies and research institutes (42.08%) provided the most of extension services and technical advice for sole cropping system. The development agencies and research institutes included the World Bank, Bill and Melinda Gates Foundation through the Cassava: Adding Value for Africa (C: AVA) project, the International Institute for Tropical Agriculture (IITA) and National Root Crops Research Institute (NRCRI).

Distribution of respondents by the type of cassava marketers in the study area

Figure 1 shows the distribution of the respondents by the type of cassava marketers the farmers sold their cassava to. Five types of cassava marketers were identified in the study area. They included bulking agent for traditional food market, bulking agent for industrial food market, traditional food processors, large processing company agent and individual/family consumption. From the figure, traditional food processors (36.67%) and large processing company agent (53.75%) were the largest customers for mixed and sole cassava farmers respectively. For mixed cropping system, the proportional of the respondents selling to bulking agent for industrial food market (23.75%) is significant higher than those of sole cropping system selling to the same customers (7.08%). Meanwhile individual/family consumption was higher in sole cropping system (17.50%) than in mixed cropping (3.75%). The traditional food processors included those processing the cassava roots into *gari, lafun, fufun* and *apu* while large company processing company agent involved those who buy cassava roots and process them into dry or wet starch, high quality cassava flour (HQCF) which further served as semi raw materials for food and bakeries, confectionary companies and pharmaceutical companies.

Profitability analysis of cassava production in the study area

The results of the comparative budgetary analyses used to determine the level of profit earned from cassava production from mixed and sole cropping systems are shown in Tables 3 and 4 respectively. The results reveal that the TVC per hectare for mixed cassava cropping system including the cost of other crops cultivated along cassava was ₦ 219,861 (USD 1357.17) while it was ₦ 126,812 (USD 782.79) without incorporating cost of other crops. Meanwhile TVC per hectare for sole cassava cropping system was ₦ 156,568 (USD 966.47). The corresponding value for the TFC per hectare however remained same for both mixed and sole cropping systems which was ₦ 31,658 (USD 195.42). Meanwhile, the TC per hectare was ₦ 252,947 (USD 1561.40) for mixed cropping system and ₦ 188,225 (USD 1161.88) for sole cropping system. This level of TC per hectare for cassava production is smaller and more affordable by farmers for sole cropping system than for mixed cropping system. This is because the TC of other crops add up for TC otherwise when considering the TC for cassava production alone in mixed cropping system, it is far smaller and cheaper than that of the sole cropping system. Hence, cassava production is more cost effective in mixed cropping system than in sole cropping system. Variable costs, which include cost of input materials, cost of labour, transportation among others accounted for 83.12% of TC while FC accounted for the balance. The result of the high percentage of variable costs agrees with the results of (Mafimisebi, 2008) where variable costs accounted for 80% of the TC. The TR, GM and NFI per hectare for mixed cropping



Source: Computed from field survey, 2014

Figure 1: Distribution of respondents by the type of cassava marketers in the study area.

Number of hectares		504			
Total output (in tonnes)		11,229			
Output per hectare (in tonnes)		22			
Price per tonne		16,000			
		Total		Per hectare analysis	
		Amount (in Naira)		Amount (in N)	Amount (in USD)
Variable cost	Input materials	19,005,670			
	Labour	22,488,670			
	Transportation	18,406,400			
	Others	4,012,300			
Total variable cost (TVC)		63,913,040	110,809,935	219,861	1357.166556
Fixed cost	Land and rent	14,685,567			
	Farm equipment	1,989,675			
Total fixed cost (TFC)		16,675,242			
Total cost (TC)= TVC+TFC		80,588,282	127,485,177	252,947	1561.399875
Total revenue (TR)= TO*P		179,664,000	398,561,560	790,797	4881.461395
Gross margin (GM)=TR-TVC		115,750,960.00	287,751,625	570,936	3524.294839
Net farm income=TR-TC		99,075,718.00	271,076,383	537,850	3320.06152

Source: Computed from field survey, 2014

Table 3: Profitability analysis of mixed cropping system of cassava production.

Number of hectares		552			
Total output (in tonnes)		14,186			
Output per hectare (in tonnes)		26			
Price per tonne		16,000			
		Total	Per hectare analysis	Per hectare analysis	
		Amount (in Naira)	Amount (in Naira)	Amount (in USD)	Amount (in USD)
Variable cost	Input materials	19,005,670	34,431	212.53433	
	Labour	34,000,670	61,595	380.21862	
	Transportation	29,406,700	53,273	328.84572	
	Others	4,012,300	7,269	44.868268	
Total variable cost (TVC)		86,425,340	156,568	966.46694	1357.166556
Fixed cost	Land and rent	14,685,567	26,604	164.224	
	Farm equipment	2,789,445	5,053	31.193472	
Total fixed cost (TFC)		17,475,012	31,658	195.41747	
Total cost (TC)= TVC+TFC		103,900,352	188,225	1161.8844	1561.399875
Total revenue (TR)= TO*P		226,976,000	411,188	2538.2	4881.461395
Gross margin (GM)=TR-TVC		140,550,660.00	254,621	1571.7331	3524.294839
Net farm income=TR-TC		123,075,648.00	222,963	1376.3156	

Source: Computed from field survey, 2014

Table 4: Profitability analysis of sole cropping system of cassava production.

system were ₦ 790,797 (USD 4881.46), ₦ 570,936 (USD 3524.30) and ₦ 537,850 (USD 3320.06) while the TR, GM and NFI per hectare were ₦ 411,188 (USD 2538.20), ₦ 254,621 (USD 1571.73) and ₦ 222,963 (USD 1376.32) respectively. The higher GM and NFI from mixed cropping system indicate a more but false profitability level than sole cropping

for cassava production. But when removing the GM and NFI of other crops cultivated alongside cassava in the mixed cropping system. The actual profit earned from cassava production indicate that cassava production under sole cropping system is by far better.

Conclusion

The results of analysis shows that mixed cropping system is more male-dominated than sole cropping system. This is in accordance with the a priori theory that mixed cropping system is more strenuous and requires much more energy than the sole cropping system while sole cassava farmers had larger farm size, were more educated than mixed cassava farmers. The study also revealed that with regards to GM and NFI from mixed cassava cropping and sole cropping systems, mixed cropping system appear to be a better income earner than sole cassava cropping systems. This is because of the aggregation of other incomes from other crops planted alongside cassava and the cost effectiveness of having to share cost with these crops. The scenarios above have been erroneously believed to made mixed cassava cropping system more profitable than sole cropping system. With adequate separation of cost and income of cassava alone under mixed cropping system through a detailed farm accounting system that appropriate individual costs and incomes to each individual crops that make up the mixed cropping system and compared with cassava under sole cropping system as shown in tables 3 and 4 and explained above, the returns to cassava under sole cropping system is higher than that of the mixed cropping system. The sole cropping system is therefore more economically profitable than mixed cropping system. The reasons are not far-fetched. It is usually practiced on commercial scale, there is little or no competition for soil nutrients, soil water, soil air and soil microbes by other crops. On the contrary, the mixed cassava cropping system has remained the more commonly practiced among the people of Nigeria because it provides the people with all-year-round farm incomes from the different crops that make the mix thereby serving a much more poverty-alleviating mechanism than the sole cassava cropping system.

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Travel Cost Model for an Agrifarm Specialised in Horse Riding Activities

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Anotace

Agroturistika přináší turistům cenný kontakt s přírodou. K ocenění takového kontaktu, potažmo i agroturistiky, se používá řada metod, včetně metody cestovních nákladů, která je využita v provedeném výzkumu. Konkrétně je využit model jednoho rekreačního místa, který je aplikován na farmách zabývajících se hipoturistikou. Na farmách však hipoturistiku a aktivity spojené s jezdectvím nevyužívají pouze turisté, kteří jsou na farmě ubytováni, ale také turisté, kteří jsou ubytováni v okolí a hipoturistiku využívají jako doplňkovou aktivitu ke své rekreaci. Z tohoto důvodu jsou odvozeny dva modely cestovních nákladů, jeden pro turisty a druhý pro návštěvníky. Výsledky výzkumu ukazují, že cestovní výdaje mají negativní vliv na počet uskutečněných návštěv, čímž je potvrzena ekonomická teorie. Výsledky výzkumu také prokazují podobných vliv parametrů na počet uskutečněných návštěv v obou modelech, kromě parametru vzdělání.

Klíčová slova

Agroturistika, metoda cestovních nákladů, model jednoho regračního místa, hodnota rekreace.

Abstract

Agritourism, as a form of tourism, brings tourists a valuable contact with nature. To assess such a value, several methods can be used. One of these methods is the travel cost method, which is used in conducted research. Especially, a single site model is applied to recreation in a farm specialised in horse riding activities. It is not only tourists staying in the farms that take part in horse riding activities, these are also visitors staying in other places and coming to farms for horse riding as an accompanying activity to their recreation. Therefore, two separate travel cost models are estimated, for tourists and for visitors. Results show that the parameter of travel costs has a negative influence on the number of visits, which confirms the economic theory. The parameters involved in the estimated models for visitors and tourists show similar tendencies, except for the parameter of education.

Keywords:

Agritourism, travel cost method, single-site model, recreational value.

Introduction

The concept of agritourism has been discussed in a variety of contexts in the international literature for last two decades and many definitions have arisen. Even the term “agritourism” is not used in a uniform way in the literature. Researchers use such terms as agritourism (Wall, 2000; Iakovidou, 1997), farm tourism (Ollenburg, Buckley, 2007; Roberts, Hall, 2001), or farm-based tourism (Evans, Ilbery, 1989) for tourism activities conducted on farms. Flanigan et al. (2014) points out that the definitions often correspond with the topics being studied and analysed. Philip et al. (2010) identifies three key debates that relate to the way of how agritourism has been defined. These debates include also the discussion whether the product is based on the working farm or on the nature of contact that visitors have with agriculture or on the authenticity of visitors’ agricultural experience.

Benefits of agriculture are well documented in literature, especially concerning the benefits for providers and farmers (Barbier et al., 2008; Branth and Haugen, 2007; Fisher, 2006, Nickerson et al., 2007, McGehee, 2007). Also benefits for local communities via sales taxes, local employment, stimulation of local business activities and overall country preservation are documented (Saxena et al.,

2007; Sharpley, 2007, Veeck et al., 2006). However, the benefits for consumers (visitors, tourists) are rarely documented.

Therefore, the research presented in this paper focuses on studying the value of agritourism for visitors. To study this value, there are several approaches, including the travel cost method which is applied in this paper. The travel cost method was established by Harold Hotelling in 1947. This method supposes that there exists a relation between the utility of being in a destination and the cost of its consumption (Seják, 1999). It supposes that if a visitor wants to visit a destination and has the utility, he/she has to travel to that destination (Melichar, Ščasný, 2004). Travel cost is a price which the visitor is willing to pay for utility of recreation in the destination. The relation between travel costs and the number of visits enables to determine the demand function. The economic theory supposes that with an increase in travel costs, visitors/tourists tend to decrease their number of visits to the destination (Dvořák, 2007). The number of visits is determined by several factors, including socio-economic characteristics, substitute destinations, recreational experience, or environmental characteristics of the destination (Melichar, Ščasný, 2004). Parson (2003) distinguishes two travel costs models: the single site model and the random utility model. The random utility model takes the visitors' choice of destination into consideration. It does not assess the destination as a whole, unlike the single site model. The single site model enables to assess recreational functions of the whole recreation. It considers the number of visits as a dependent variable and socio-economic and other variables as independent variables (Haab and McConell, 2002).

An advantage of the travel cost method is that it uses measurable variables rather than subjective respondents' opinions, as contingent valuation methods do. It is based on the real rather than hypothetical respondents' behaviour. Of course, there are also limits related to the travel cost method. This method assumes a recreational place as the only destination; however tourists often visit more destinations in the region. It measures only the useful value of a destination, it does not enable to assess any non-useful values. Visitors often travel in groups, and problems arise while dividing costs per person. Other problems are connected with the assessment of cost related to vehicle amortisation. The travel cost method struggles with assessing travel costs for a visitor coming by bicycle or on foot. The agreement on assessing time cost as an opportunity cost does not exist among researches (Boarman, 2001, Ward and Loomis, 1998, Dvořák, 2007).

Even if there is a number of limits of the travel cost method, it is used in literature by research for assessing the recreational value and it is considered to be a suitable instrument (e.g. Balkan, Kahn, 1988; Herald, Kennedy, 2004; Chen, Hong, 2004).

As already mentioned above, the paper studies the value of agritourism. According to a literature survey, the single site model is suitable for conducted research, therefore this model is applied. The research is focused on visitors coming to agrifarms in the Šumava Mountains, especially those providing horse riding. Besides assessing recreation, the research aims to determine the demand function. Agrifarms provide horse riding both for tourist staying in the farm, and for those just coming to do this activity. The paper distinguishes these two groups.

Materials and methods

In order to determine the value of recreation of agrifarms specialised in horse riding in the Šumava Mountains, the visitors/tourists survey needed to be conducted. Tourists are considered to be those accommodated in the farm, visitors are considered to be those staying in other places and coming for horse riding only as an accompanying activity. Accordingly, two single site travel cost models were estimated.

Respondents' survey

The data set was based on a respondents' survey conducted in June – September 2014 in agrifarms in the Šumava Mountains. Respondents were defined, according to research needs, as all participants coming for horse riding activities. Respondents were asked questions in face-to-face interviews in order to ensure that they understood all questions asked. Tourists/visitors were asked about their place of stay, travel cost to get for horse riding, income, and personal characteristics (gender, age, education). In total, 425 questionnaires were processed.

Single site models

Regarding the predefined aims, the single site model was applied. A linear single site model, according to Parson (2003), has the following general function:

$r = f(tc_r, tc_s, y, z)$,

where r represents the number of visits by an individual to the destination for certain period, tc_r are total travel costs to the destination including travel expenses, entrance fee, and other costs; tc_s is a vector of travel cost of substitute destinations; y is a vector of individual income, and z is a vector of socio-economic characteristics. Concerning travel costs to substitute destinations, empirical studies do not often take travel cost to substitute destinations into consideration, because respondents' do not consider travelling to other destinations (Creeel, Loomis, 1990). The Poisson regression was applied, as a suitable method which is used in similar studies. (Parodi, Bottarelli, 2006).

The data gathered from visitors' surveys was adjusted to fit Parson's model, travel costs per person were determined and travel time costs for getting to and from the destination were assessed. Travel times to get to and from the destination were assessed as 2/5 of visitor's hourly wage (see Cesario, 1976). For an unbiased model, working time hours are considered to be 40 working hours per week. An average hourly wage was computed from the mean of the income interval (see Špaček, Antoušková, 2013). The fee for horse riding is included in travel cost in the estimated models (Seják, 1999).

Subsequently, two travel cost models were developed, one related to tourists staying in the farm, the other one related to visitors coming only for horse riding activities. The dependent variable in developed models is the number of visits; independent variables are age, education, income, gender, accompaniment of children. Developed models were tested by Akaike criteria, and coefficients were predicted by using the maximum likelihood method. Variables used in the estimated models are characterised in table 1.

Variable	Description
Number of visits	Number of visits in the period (September 2013 – August 2014)
Costs	Total travel expenses spent on coming to the farm per person
Gender	1 - man, 0 - woman
Age	a - 1 (0-14 years), 0 (other) b - 1 (25-34 years), 0 (other) c - 1 (35-44 years), 0 (other) d - 1 (45-54 years), 0 (other) e - 1 (55-64 years), 0 (other) f - over 65 years of age
Children	Number of children accompanying the respondent
Education	a - 1 (elementary), 0 (other) b - 1 (high school), 0 (other) c - university
Economic activity	a - 1 (employed), 0 (other) b - 1 (not employed), 0 (other) c - not economically active
Income (a-k)	Net income of the household a - 1 (CZK 0-10,000), 0 (other) b - 1 (CZK 10,001-20,000), 0 (other) c - 1 (CZK 20,001-30,000), 0 (other) d - 1 (CZK 30,001-40,000), 0 (other) e - 1 (CZK 40,001-50,000), 0 (other) f - 1 (CZK 50,001-60,000), 0 (other) g - 1 (CZK 60,001-70,000), 0 (other) h - 1 (CZK 70,001-80,000), 0 (other) i - 1 (CZK 80,001-90,000), 0 (other) j - 1 (CZK 90,001-100,000,-Kč), 0 (other) k – CZK 100.001 and more

Sourse: author´s elaboration

Table 1: Description of variables.

Results

Visitors coming to farms for horse riding activities were predominantly local people (60.2%). Tourists coming to farms were mostly accommodated in other places than in the farm they come to (86.4%). Visitors' travel distance to the farm was usually up to 10 km (48.3%), 63.2% of visitors travel up to 15 km, 74.4% of visitors travel up to 20 km, and 83.4% of visitors travel up to 30 km. Tourists live predominantly up to 100 km far from the farm (76.3%).

Gender characteristics correspond to the normal population distribution (men 48%, women 62%), however the farm visitors were families (20.6%), or an adult person accompanying child/children (13.9%). Children were mostly 10 – 15 years old (60.3%), 23.1% of children were adolescent, 26.6% of children were younger than 10 years old.

Tourists accommodated in farms

Tourists coming to the farm were predominantly living up to 100 km far from the farm (76.3%), 89.7% of tourists lived up to 200 km, and 96.3% of tourists lived up to 250 km. Tourists spent on average 3.87 hours on their way to the farm and back to the place of their residence. Tourists spent on average CZK 369 on the travel there and back per person. The conducted travel cost model shows that the statistically significant variable of cost has a negative influence on the number of visits. Compared to the reference category, a negative influence is seen for incomes exceeding CZK 50,000, economic activity, and age category 55-64 years, however these variables are not statistically significant. Estimated parameters indicate that visitors in the age of 0 – 34 years increase the number of visits compared to visitors older than 65 years of age more than twice. Visitors in another age category also increase the number of visits compared to visitors older than 65 years. Visitors with elementary and high school education are more likely to come more often than visitors with university degree (exp{β}, the coefficient for visitors with elementary education being 1.28; exp{β} for visitors with high school education being 1.47). Visitors having their family income up to CZK 50,000 are more likely to increase the number of visits than visitors with incomes exceeding CZK 100,000; especially those with an income of CZK 10,001 - 30,000 having the highest exp{β} coefficients over 2.35. The parameters of the estimated model are characterised in table 2.

Term	Estimate (B)	Std. Error	Sig.
Intercept	1.863	0.395	0.000**
Costs	-0.003	0.015	0.001**
Age a	0.949	0.206	0.067*
Age b	0.876	0.232	0.097*
Age c	0.570	0.245	0.067*
Age d	0.588	0.195	0.205
Age e	-0.452	0.201	0.456
Education a	0.249	0.207	0.004**
Education b	0.389	0.105	0.032**
Economic activity a	-0.378	0.095	0.775
Economic activity b	-0.489	0.194	0.132
Income a	0.589	0.067	0.156
Income b	0.903	0.589	0.019**
Income c	0.855	0.394	0.006**
Income d	0.071	0.295	0.004**
Income e	0.001	0.351	0.001**
Income f	-0.589	0.032	0.057
Income g	-0.342	0.054	0.255
Income h	-0.872	0.369	0.235
Income i	-0.898	0.333	0.139
Income j	-0.790	0.253	0.146

Note: *Statistical significance $\alpha < 0.1$

Source: Author's own calculation **Statistical significance $\alpha < 0.05$;

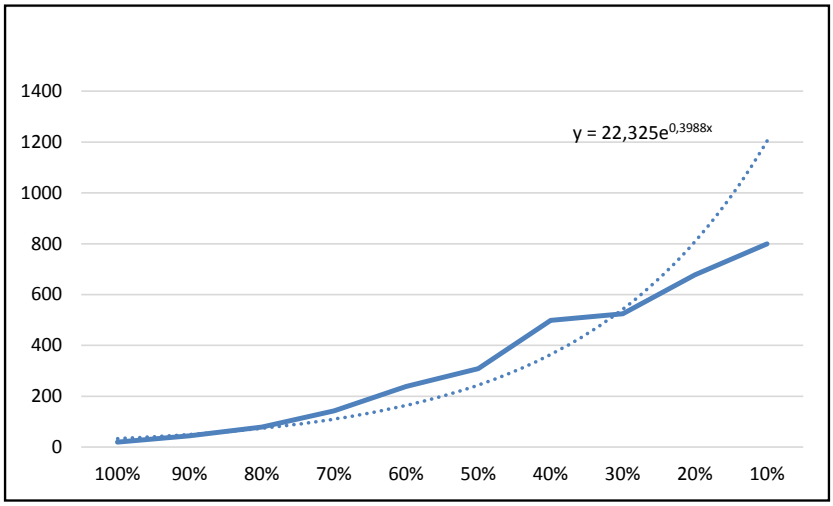
Table 2: Single site travel cost model for tourists.

The demand function reflecting the relation between the number of tourists and their travel costs representing their willingness to pay for recreation is seen in figure 1, which indicates that only 10% of tourists pay over CZK 800 per person and trip. Tourists come on average 1.24 times to the farm for the studied period (one year).

Visitors staying in other places than the visited farm

Almost one half of visitors coming for horse riding activities live within 10 km from the farm, including both local people and tourists not living on the farm. Tourists usually come for horse riding once or twice during their stay (70.3%). For 18.6% of tourists, the farm with horse riding was a reason for coming to the region for recreation. The other 81.4% of tourists came to the region for other purposes, and horse riding was only an accompanying activity during their stay. Local people come for horse riding regularly (75.8%), 15.9% of local people come irregularly and 8.3% visited the farm for the first time.

The time needed to get to the farm and back



Source: Author's own calculation

Figure 1: Tourists' demand function.

to the place of accommodation or place of living is 37.8 minute on average. Travel costs spent on getting there and back are on average CZK 50.4 per person.

The estimated travel cost model shows that the variable of travel cost is statistically significant and has a negative influence on the number of visits, similarly as it was proven for tourists. Age is also a statistically significant parameter in the estimated model, proving that visitors in all age categories (0 – 64 years) are more likely to increase the number of visits than visitors over 65 years of age. Especially visitors in the age of 0 – 34 years are more than 2.3 times more likely to come than visitors over 65 years of age. The parameter of education has an opposite relation to the number of visits than it was estimated for tourists, the parameter is positive, which indicates that visitors with university education are more likely to conduct more visits than visitors with elementary or high school education, even though the parameter of elementary education is not statistically significant. The parameter of economic activity shows that visitors who are not economically active are more likely to come for more times to the farm for horse riding than other visitors (both employed and unemployed). The parameter of income shows that visitors with family income to CZK 100,000 are more likely to conduct more visits than visitors with incomes exceeding CZK 100,001, however only one of the studied income categories is statistically significant (see table 3).

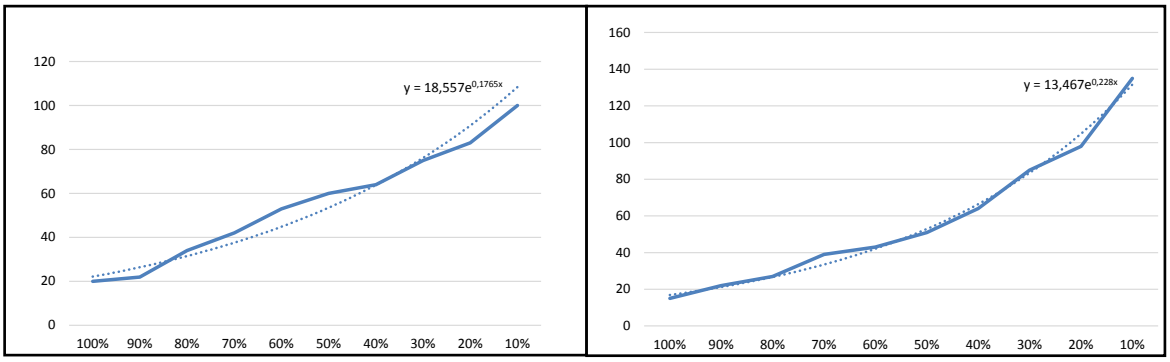
Term	Estimate (B)	Std. Error	Sig.
Intercept	4.835	0.394	0.000**
Costs	-0.014	0.145	0.000**
Age a	0.876	0.012	0.035**
Age b	0.841	0.098	0.003**
Age c	0.208	0.145	0.021**
Age d	0.380	0.203	0.076*
Age e	0.378	0.061	0.098*
Education a	-0.589	0.034	0.103
Education b	-0.893	0.063	0.063*
Economic activity a	-0.034	0.095	0.065*
Economic activity b	-0.295	0.194	0.031**
Income a	0.498	0.067	0.102
Income b	0.357	0.452	0.212
Income c	0.295	0.432	0.125
Income d	0.235	0.343	0.182
Income e	0.948	0.325	0.205
Income f	0.084	0.205	0.146
Income g	0.874	0.056	0.076*
Income h	0.487	0.301	0.253
Income i	0.274	0.311	0.118
Income j	0.003	0.298	0.149

Note: *Statistical significance $\alpha < 0.1$

Source: Author's own calculation **Statistical significance $\alpha < 0.05$;

Table 3: Visitors' single site model.

The tourists coming spent on average CZK 54.3 per person to get to the farm and back to the place of stay. The demand function revealed that there



Source: Author's own calculation

Figure 1: Tourists' demand function.

were only less than 10% of tourists paying more than CZK 135 (see figure 2). The demand function of local people shows that these visitors pay lower travel costs than tourists do.

Conclusion

Conducted research and the estimated travel cost model of tourists and visitors show that travel costs have negative influence on the number of visits to the farm, which confirms the general economic theory. However, estimated parameters in the model do not correspond to findings in other international studies. This is particularly evident for the parameter of age. Tintian (2009) confirms that the age is a parameter increasing the number of visits. Nevertheless, the conducted models show an opposite relation. This might be explained by a relatively high number of children and adolescents coming for horse riding activities. On the other hand, the lower number of visits is by tourists and visitors in the age category over 65, which confirms the conclusion of Wang, Norma and McGuire (2005). Also the parameter of income cannot unequivocally confirm the conclusions of other studies.

The travel cost models of visitors and tourists indicate similar tendencies for the estimated parameter, except for the parameter of education. Tourists with university education are less likely to conduct multiple visits than tourists with other education, which can be explained by the low age of tourists on average. Conversely, visitors with a university degree are more likely to conduct multiple visits, which may be explained by a higher average age of visitors.

Even though not all the results obtained from the estimated model confirm findings in related studies, the results distinguishing tourists and visitors are a valuable source for ongoing research activities.

Acknowledgement

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Analysis of the Technical and Scale Efficiency of Farms Operating in LFA

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Anotace

Článek analyzuje technickou efektivnost a efektivnost z rozsahu zemědělců hospodařících v LFA. Analýza se zejména zaměřuje na vztah mezi velikostí farem a technickou efektivností, resp. efektivností z rozsahu. Výsledky odhadnutého stochastického hraničního modelu ukazují na signifikantní rozdíly ve vztahu velikost farmy a efektivnosti pouze u technické efektivnosti a velikostní skupiny farem nad 1 000 hektarů.

Článek vznikl v rámci řešení projektu IGA 20131039.

Klíčová slova

Technická efektivnost, efektivnost z rozsahu, dotace, LFA, SFA.

Abstract

The paper deals with an analysis of the technical and scale efficiency of farms operating in LFA. In particular, we provide an analysis of the relationship between farm size and technical and scale efficiency. The results of the fitted stochastic frontier model show that significant differences in the relationship between efficiency and farm size can only be found for technical efficiency in the group of farms with more than 1000 hectares.

The paper arose within the framework of solution IGA 20131039.

Keywords:

Technical efficiency, scale efficiency, subsidies, LFA, SFA.

Introduction

The analysis of efficiency and productivity has been a prominent topic in agricultural economics research over the last two decades. Since efficiency and productivity are often used as indicators of overall competitiveness, the results of such an analysis are important information sources for policy makers. Along with questions concerning competitiveness, questions related to the efficiency and productivity of different groups of farms are also of special interest for policy targeting. This focus is reinforced in the Czech Republic due to the significant dual structure of Czech agriculture.

This study focuses on farms located in LFA. The aim is to identify differences in technical and scale efficiency between size groups of farms. In particular, the paper addresses the following research question. The question concerns the relationship between farm size and efficiency. Is farm size positively correlated with technical and scale efficiency, or can we consider large farms to be more efficient and thus more competitive from this point of view?

The measurement of technical and scale efficiency cannot determine the extent to which farms are economically efficient, but it does address at least a part of this question. If the farm is not technically and/or scale efficient, then it cannot be economically efficient (Kumbhakar, Lovell, 2000). From a given quantity of input, technically inefficient farms cannot produce as much output as more efficient farms or they consume more inputs for the production of a given output, respectively, and their average costs are higher compared to more efficient farms. An inefficient farm can survive on the market in the short run, but its existence in the long run depends on the competitive environment and policy interventions.

The identified differences in technical efficiency can be due to either objective or subjective

reasons. Objective reasons are connected with the environment in which the farm produces (e.g. land quality, higher attitude). Subjective reasons are linked to the quality of management, labour and material inputs.

The technical and/or scale efficiency of Czech agriculture was recently analysed in several studies: Methijs et al. (1999a, 1999b and 2001), Hughes (1999), Curtiss (2002), Juřica et al. (2004), Medonos (2006), Jelínek (2006) and Čechura (2009, 2010). However, a detailed analysis of farms in LFA is missing. Moreover, in the majority of cases the analysed period is not relevant to the needs of policy makers.

The paper is organized as follows: Chapter 2 contains the theoretical framework, presents the estimation strategy and describes the data set; Chapter 3 presents the results of the stochastic frontier function estimate, discusses estimated technology and technological change and compares technical and scale efficiency among a defined group of farms. Chapter 4 contains concluding remarks.

Materials and methods

1. Data

The data set was drawn from the database FADN. The data represents an unbalanced panel data set which contains 926 farms and 3205 observations in the period from 2005 to 2010. The price indices were taken from the Czech Statistical Office (CZSO) database.

2. Econometric model

We assume that the production process can be well approximated by a translog production frontier model. The deterministic part of the model is:

$$\ln f(t, \mathbf{x}_{it};\boldsymbol{\beta}) = \alpha_0 + \sum_{j=1}^{K} \beta_j \ln x_{ijt} + \frac{1}{2}\sum_{j=1}^{K}\sum_{k=1}^{K} \beta_{jk} \ln x_{ijt} \ln x_{ikt} + \beta_t t + \frac{1}{2}\beta_t t^2 + \sum_{j=1}^{K} \beta_{jt} \ln x_{ijt} t \qquad (1)$$

where x_{it} is a vector of inputs containing the production factors – Labour (A_{it}), Land (L_{it}), Capital (K_{it}) and Material (M_{it}). Indices i, where i = 1, 2,…, N, and t, where $t \in \tau(i)$, refer to a certain agricultural company and time, respectively, and $\tau(i)$ represents a subset of years T_i from the whole set of years T (1, 2,…T), for which the observations of the i-th farm are in the data set (see unbalanced panel). α_0 is an intercept (productivity parameter).

The employed variables are defined as follows:

- Output (y) represents the value of total production. The output was deflated by the index of agricultural prices (2005 = 100).
- Labour input (A) is the total amount of AWU.
- Land (L) cultivated by the i-th farm is adjusted (multiplied) by the land quality (the land quality index is expressed as the ratio of the official land price of a given region to the maximum official regional price of land).
- Capital (K) represents the book value of tangible assets and was deflated by the index of processing prices (2005=100).
- Material inputs (M) represent the total costs of material and energy consumption and were deflated by the index of processing prices (2005=100).

The heteroscedasticity problem is controlled by: Intensity variable (INTO) (the variable states for intensity of breeding), Number of Livestock units (DJ), Ratio of cultivated area in LFA (LFA) and a Dummy variable for farms operating in protected landscape area (CHK).

We use a "True" Random Effects model (TREM) in the analysis (Green, 2002)[1]:

$$y_{it} = (\alpha+w) + \mathbf{x_{it}}'\boldsymbol{\beta} + v_{it}-u_{it}. \qquad (2)$$

Inefficiency in relation (2) is time variant and is assumed to have a half-normal distribution. Time-invariant farm heterogeneity is captured by a time-invariant random intercept. The measurement of farm heterogeneity can be done either by $w_i = \mathbf{f_i}'\boldsymbol{\theta} + \omega_i$ (determining the position of the frontier) or as a part of the distribution of inefficiency term u_i with a mean μ_i or μ_{it} (for further reference see Green, 2003). We use the first possibility in the analysis. Finally, we assume that w_i and other variables are not correlated (Green, 2002).

We address the question raised in the introduction through a detailed analysis of technical and scale efficiency in the year 2010. The results for previous

[1] The parameter estimate were found robust under different model specifications. Since the more flexible models forms did not have higher explanatory power according to the LR test we use TREM in the analysis.

years are provided in the appendix. Moreover, the development of technical and scale efficiency is analyzed, and implications with respect to the studied problems are also discussed.

REM is estimated using the maximum simulated likelihood method in the econometric software LIMDEP 9.0.

Results and discussion

Table 1 provides a parameter estimate of the stochastic production frontier model. Since all variables are divided by their geometric mean, the fitted parameters represent production elasticities.

	"True" Random effects model with heteroscedasticity		
Variable	Coefficient	Std. Error	P[|Z|>z]
T	-0.01104	0.00158	0.0000
TT	0.04005	0.00222	0.0000
A	0.17869	0.00661	0.0000
L	0.06688	0.00460	0.0000
K	0.04758	0.00529	0.0000
M	0.67858	0.00725	0.0000
AT	-0.00057	0.00344	0.8681
LT	-0.00465	0.00226	0.0398
KT	-0.00011	0.00305	0.9702
MT	0.00966	0.00384	0.0120
AA	0.10045	0.01620	0.0000
LL	0.03615	0.00285	0.0000
KK	-0.00633	0.00814	0.4371
MM	0.05700	0.01951	0.0035
AL	-0.10078	0.00804	0.0000
AK	-0.00188	0.01231	0.8783
AM	-0.02107	0.01527	0.1677
LK	0.04457	0.00670	0.0000
LM	0.00451	0.00705	0.5222
KM	-0.02127	0.01119	0.0573
suONE	1.12012	0.14435	0.0000
suINTO	-0.41479	0.02834	0.0000
suDJ	-0.00188	0.00009	0.0000
suLFA	0.47753	0.14241	0.0008
suCHK	0.27548	0.02951	0.0000
-	Means for random parameters		
Constant	0.013053	0.00660	0.0000
-	Scale parameters for dist. of random parameters		
Constant	0.28491	0.00292	0.0000
Lambda	2.804		
Log likelihood function	245.2742		
Sigma(u)	0.09103	0.2552	
Sigma(v)		0.00194	0.0000
No. of parameters		28	

Source: own calculations

Table 1: Parameter estimate.

The parameter estimates are consistent with economic theory. The production elasticities comply with both monotonicity and quasi-concavity requirements (evaluated on the sample mean). Moreover, the estimated elasticities are consistent with information in the data set. One exception is that capital elasticity is lower than expected. Material inputs have the highest impact on production, with elasticity of 0.679. On the other hand, capital has the lowest impact, 0.048. The labour elasticity is 0.1787. The lower-than-expected capital elasticity could be influenced by the accounting records of fixed assets. These records do not account for capital inputs financed via leasing, which can lead to the underestimation of capital elasticity. Other reasons could be capital market imperfections and the fact that farmers have poorer access to financial resources. The land elasticity is estimated at 0.067. Land quality is found to be a highly significant factor in the determination of land elasticity. The sum of production elasticities is 0.972, which suggests a slightly decreasing returns to scale.

Technical change has a negative impact on production, but it decelerates over time. The hypothesis about Hicks-neutral technological change was rejected with a 5 % level of significance. Technological change was Material-using and Land-saving. This suggests that added value in Czech agriculture is going down. These results suggest that subsidies, which increase the income of agricultural companies, may not motivate farmers to invest in new technology. This conclusion may have several reasons that differ with respect to the performance and competitiveness of the particular farm.

Heteroscedasticity was found being highly significant. All the variables capturing heteroscedasticity are significant even with 1 % significance level. As was expected the intensity variable and variable representing number of livestock have a positive impact on the technical efficiency. On the other hand the higher is the ratio of cultivated area in LFA (LFA) the lower is the technical efficiency. Moreover, if the farm operates in protected landscape area (CHK), it has in general lower technical efficiency.

The value of λ shows that the variability in inefficiency is more pronounced than the variability in statistical noise. 2.8 suggests that efficiency differences among farms are important reasons for variations in production.

Table 2 provides descriptive statistics of the technical efficiency for the whole sample. The average of the technical efficiency is 85.65 %. With respect to the distribution of technical efficiency, two-thirds of the farms have technical efficiency higher than 80 %. Thus, the variability in technical efficiency around the average is a significant characteristic of the analyzed sample.

Table 3 provides figures about technical efficiency according to farm size for the year 2010 (results for the years 2005 to 2009 are provided in the appendix). The farms were divided into size groups based on the amount of cultivated area. The size interval was defined in the length of 100-1000 ha and 500-2000 ha. The results show that the technical efficiency of farms with a cultivated area up to 800 ha is between 81 and 85 %. The estimates of technical efficiency for these farms do not show any significant relationship between technical efficiency and the amount of cultivated area (correlation coefficient is 0.26). Standard deviation fluctuates in the interval from 0.092 to 0.155. That is, more than 60 % of farms with a cultivated area up to 800 ha have a technical efficiency in the interval 70 to 95 %. The relative variability is around 15 %, which is quite high. Farms with a cultivated area of more than 800 ha have a higher average technical efficiency. However, the groups of farms with a cultivated area between 800 and 1000 ha still have high variability in technical efficiency. The standard deviations or variation coefficients in these groups are 0.10 and 0.12 or 0.12 and 0.14, respectively. For the group of farms with more than 1000 hectares, technical efficiency significantly increases and variability decreases with land size. Whereas technical efficiency is about 90 %, the relative variability is 7 % for the group of farms with a cultivated area between 1000 and 2000 hectares, and 3.5 % for the group of farms with a cultivated area larger than 2000 hectares.

	Average	Std. Dev.	Minimum	Maximum
"True" Random effects model	0.8565	0.09893	0.28396	0.99166

Source: own calculations

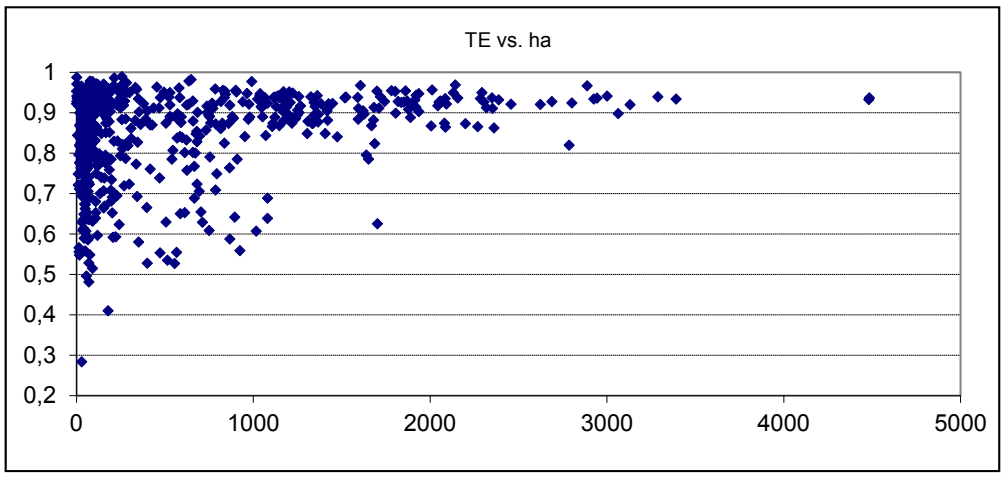
Table 2: Descriptive statistics of technical efficiency.

	No. of ha	0 - 100	101 - 200	201 - 300	301 - 400	401 - 500	501 - 600	601 - 700
TE	Average	0.8210	0.8433	0.8401	0.8476	0.8181	0.8145	0.8295
	Std.Dev.	0.1207	0.1136	0.1234	0.1097	0.1550	0.1396	0.0920
	Var.Coef.	0.1471	0.1347	0.1469	0.1295	0.1894	0.1714	0.1109
	Median	0.8496	0.8764	0.8568	0.8808	0.8700	0.8752	0.8328
	Min.	0.2844	0.4102	0.5918	0.5807	0.5279	0.5277	0.6533
	Max.	0.9876	0.9712	0.9897	0.9628	0.9640	0.9617	0.9820
	No. of farms	214	70	34	17	11	22	21

	No. of ha	701 - 800	801 - 900	901 - 1000	1001 - 1500	1501 - 2000	>2000
TE	Average	0.8271	0.8629	0.8685	0.8953	0.9038	0.9192
	Std.Dev.	0.1138	0.1068	0.1227	0.0632	0.0638	0.0325
	Var.Coef.	0.1376	0.1237	0.1413	0.0706	0.0706	0.0353
	Median	0.8751	0.8866	0.9052	0.9096	0.9223	0.9277
	Min.	0.6089	0.5881	0.5590	0.6073	0.6256	0.8203
	Max.	0.9590	0.9561	0.9774	0.9520	0.9673	0.9690
	No. of farms	17	17	10	64	35	37

Source: own calculations

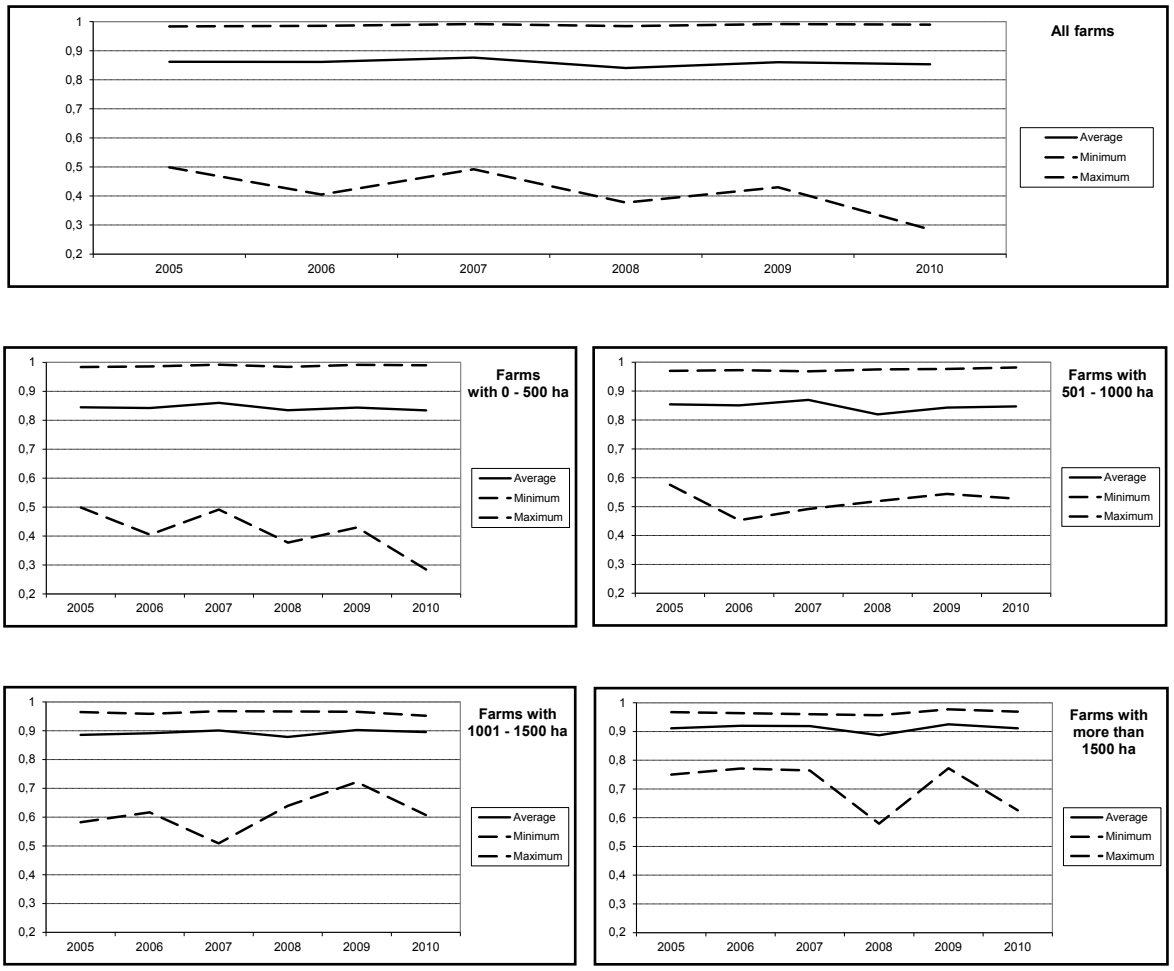
Table 3: Technical efficiency in selected size categories (ha) in 2010.



Source: own calculations

Figure 1: Technical efficiency with respect to cultivated area (ha) in 2010.

The results show that farms with a cultivated area of more than 1000 hectares have significantly higher technical efficiency than farms with less than 1000 hectares. Figure 1 graphically illustrates this conclusion. The same conclusion can be obtained from the technical efficiency estimate in other analysed years, i.e. 2005 to 2009. Detailed figures are provided in the appendix. Here we restrict our attention to the development of technical efficiency between 2005 and 2010. We focus on the total development of technical efficiency and the development in four size groups: 0-500 ha, 501-1000 ha, 1001-1500 and 1501 or more hectares. Figure 2 shows that the development of mean technical efficiency in the whole sample has a nearly constant trend. The same holds true for maximum technical efficiency. We cannot observe any significant change



Source: own calculations

Figure 2: Development of technical efficiency.

in the mean and maximum technical efficiency in the defined size groups. The only change can be observed in the minimum of technical efficiency, and especially in the group of farms with less than 500 hectares of cultivated area. The less technically efficient farms in this group were falling more and more behind. The situation of less efficient farms did not significantly change in the group with 501 to 1000 hectares, and mild improvement could be observed in the group with 1001-1500 hectares. The less efficient farms with more than 1500 hectares experienced a rather stochastic development, which is connected with the entry and exit of the farms in the database (see unbalanced panel data set). To sum up, the development of technical efficiency is in favour of the above-stated conclusion, derived for the year 2010. In other words, it holds true for the analysed period of 2005 to 2010 that farms with a cultivated area larger than 1000 hectares have significantly higher technical efficiency than farms with less than 1000 hectares.

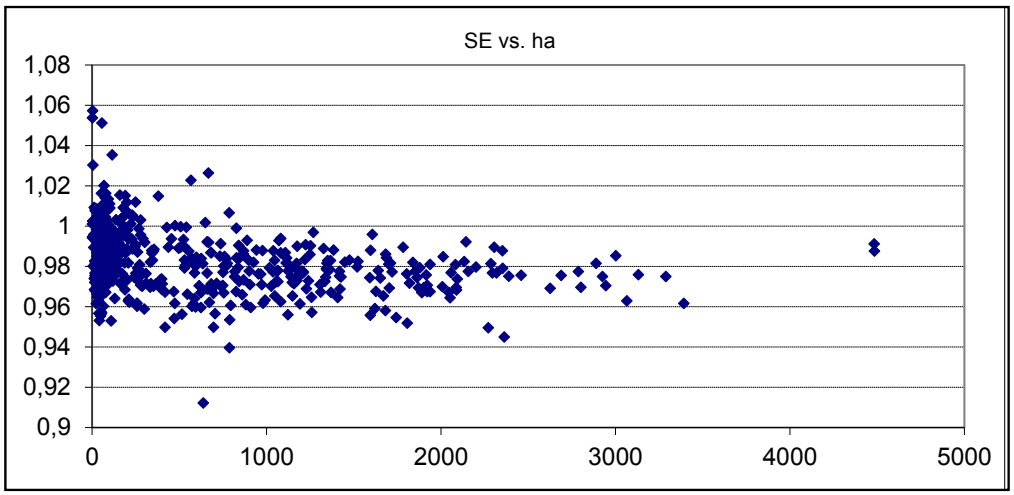
Table 4 provides figures on the scale efficiency estimate for groups with a defined size according to the cultivated area. We can observe small differences both between and within groups. Since the estimated scale efficiency is close to one, we cannot observe any significant exploitation of economies of scale (see also Figure 3). That is, from the static point of view, farms operate at an almost ideal size. The same also holds true for other analysed years (see figures in the appendix).

	No. of ha	0 - 100	101 - 200	201 - 300	301 - 400	401 - 500	501 - 600	601 - 700
TE	Average	0.9887	0.9881	0.9842	0.9805	0.9767	0.9810	0.9751
	Std.Dev.	0.0152	0.0139	0.0154	0.0119	0.0183	0.0158	0.0220
	Var.Coef.	0.0154	0.0140	0.0156	0.0121	0.0187	0.0161	0.0225
	Median	0.9883	0.9865	0.9844	0.9764	0.9714	0.9820	0.9714
	Min.	0.9531	0.9529	0.9589	0.9685	0.9498	0.9563	0.9122
	Max.	1.0574	1.0354	1.0120	1.0149	1.0003	1.0229	1.0264
	No. of farms	214	70	34	17	11	22	21

	No. of ha	701- 800	801 - 900	901 - 1000	1001 - 1500	1501 - 2000	>2000
TE	Average	0.9741	0.9798	0.9737	0.9773	0.9738	0.9752
	Std.Dev.	0.0158	0.0101	0.0103	0.0088	0.0103	0.0102
	Var.Coef.	0.0163	0.0103	0.0106	0.0090	0.0105	0.0105
	Median	0.9771	0.9795	0.9736	0.9776	0.9745	0.9759
	Min.	0.9396	0.9610	0.9596	0.9560	0.9519	0.9450
	Max.	1.0066	0.9990	0.9882	0.9970	0.9959	0.9923
	No. of farms	17	17	10	64	35	37

Source: own calculations

Table 4: Scale efficiency in selected size categories in 2010.



Source: own calculations

Figure 3: Scale efficiency with respect to cultivated area in 2010.

Conclusion

In the conclusion we focus on the research question raised in the introduction. That is, we deal with the relationship between farm size and technical and scale efficiency. In particular, is farm size positively correlated with technical and scale efficiency, or can we consider large farms to be more efficient and thus more competitive from this point of view?

The results show that significant differences in the relationship between efficiency and farm size can only be found for technical efficiency in the group of farms with more than 1000 hectares. In other words, farms with more than 1000 hectares are more efficient compared to farms which operate with less than 1000 hectares. The same conclusion can be drawn from the results of the technical efficiency estimate between the years 2005 and 2009 – see appendix.

The results suggest that large farms (especially farms with more than 1000 hectares) seem to be more competitive, at least from a technical efficiency point of view, and thus less sensitive to changes in subsidies. On the other hand, farms with less than 1000 hectares can be sensitive to LFA subsidy degressivity, which is an important message for policy makers with respect to the setting of CAP subsidies for the next programme period.

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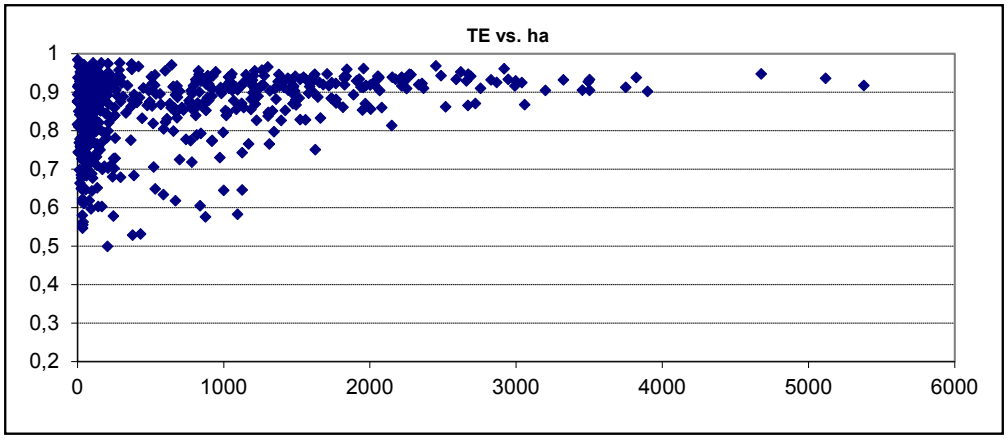
Appendix

Results for technical efficiency in the years 2005 to 2009



Source: own calculations

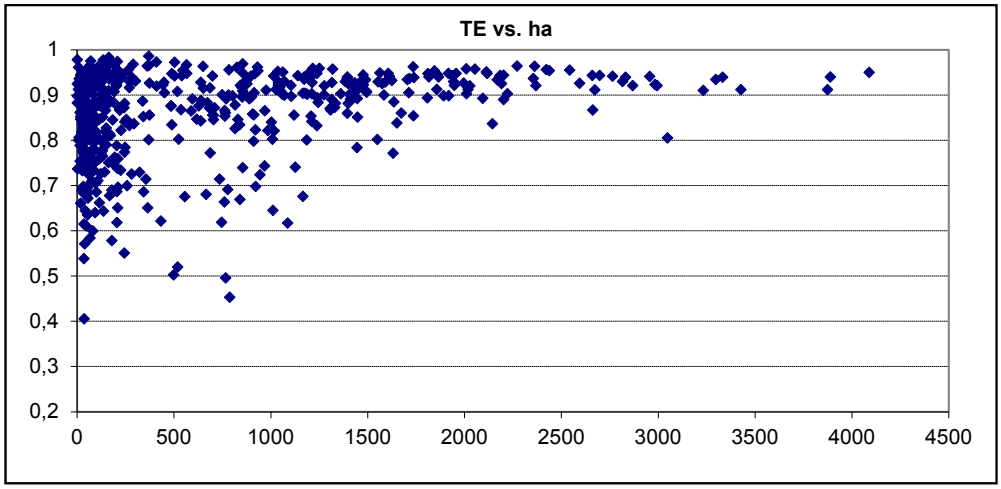
Figure A1: Technical efficiency with respect to cultivated area (ha) in 2005.

	No. of ha	0 - 100	101 - 200	201 - 300	301 - 400	401 - 500	501 - 600	601 - 700
TE	Average	0.8290	0.8519	0.8444	0.8440	0.8551	0.8437	0.8502
	Std.Dev.	0.0962	0.0932	0.1156	0.1272	0.1194	0.1087	0.0818
	Min.	0.5465	0.6021	0.4988	0.5282	0.5308	0.6337	0.6179
	Max.	0.9834	0.9757	0.9756	0.9733	0.9666	0.9550	0.9702
	No. of farms	184	68	39	12	10	14	17

	No. of ha	701 - 800	801 - 900	901 - 1000	1001 - 1500	1501 - 2000	>2000
TE	Average	0.8458	0.8660	0.8655	0.8855	0.9036	0.9192
	Std.Dev.	0.0627	0.0964	0.0756	0.0695	0.0428	0.0292
	Min.	0.7176	0.5756	0.7298	0.5825	0.7501	0.8131
	Max.	0.9161	0.9550	0.9524	0.9650	0.9609	0.9676
	No. of farms	11	24	12	78	40	54

Source: own calculations

Table A1:Technical efficiency in selected size categories (ha) in 2005.



Source: own calculations

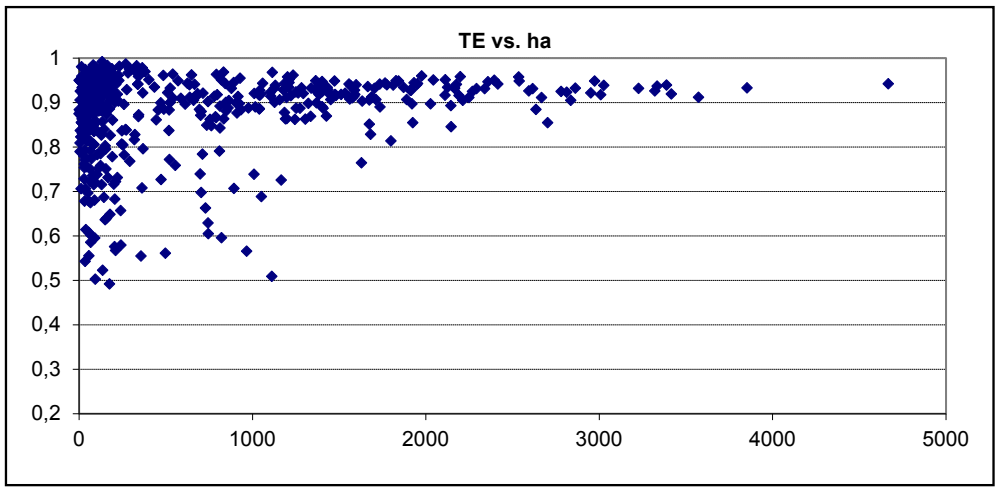
Figure A2: Technical efficiency with respect to cultivated area (ha) in 2006.

	No. of ha	0 - 100	101 - 200	201 - 300	301 - 400	401 - 500	501 - 600	601 - 700
TE	Average	0.8347	0.8636	0.8258	0.8420	0.8457	0.8656	0.8709
	Std.Dev.	0.0986	0.0930	0.1125	0.1154	0.1476	0.1324	0.0757
	Min.	0.4051	0.5781	0.5508	0.6503	0.5024	0.5195	0.6805
	Max.	0.9776	0.9829	0.9739	0.9858	0.9726	0.9724	0.9634
	No. of farms	180	73	33	13	11	13	13

	No. of ha	701 - 800	801 - 900	901 - 1000	1001 - 1500	1501 - 2000	>2000
TE	Average	0.7818	0.8844	0.8505	0.8913	0.9140	0.9258
	Std.Dev.	0.1490	0.0756	0.0830	0.0668	0.0439	0.0318
	Min.	0.4531	0.6689	0.6977	0.6170	0.7710	0.8050
	Max.	0.9552	0.9689	0.9616	0.9588	0.9621	0.9639
	No. of farms	17	19	15	74	34	43

Source: own calculations

Table A2: Technical efficiency in selected size category (ha) in 2006.



Source: own calculations

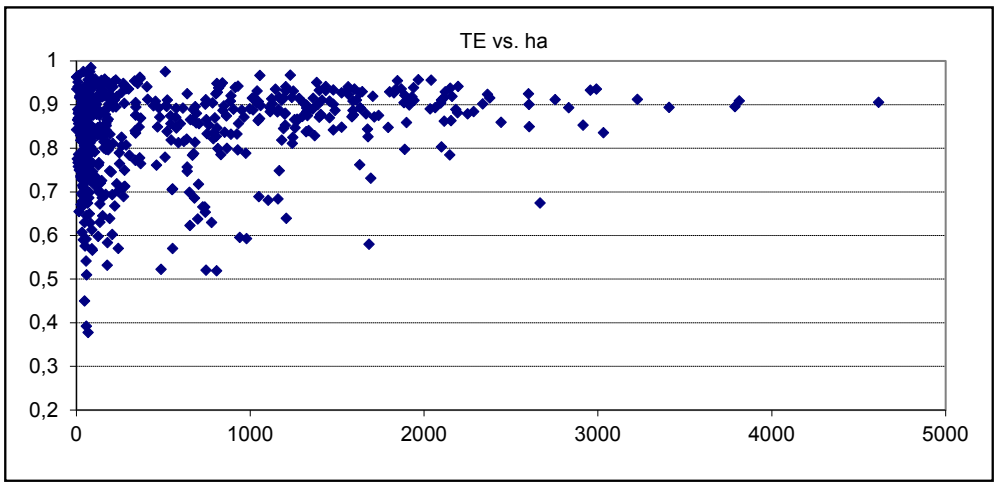
Figure A3: Technical efficiency with respect to cultivated area (ha) in 2007.

	No. of ha	0 - 100	101 - 200	201 - 300	301 - 400	401 - 500	501 - 600	601 - 700
TE	Average	0.8652	0.8755	0.8230	0.8853	0.8516	0.8853	0.9052
	Std.Dev.	0.0958	0.1044	0.1319	0.1165	0.1291	0.0681	0.0595
	Min.	0.5029	0.4917	0.5674	0.5549	0.5612	0.7591	0.7396
	Max.	0.9846	0.9918	0.9871	0.9829	0.9609	0.9641	0.9621
	No. of farms	173	81	27	17	9	11	11

	No. of ha	701 - 800	801 - 900	901 - 1000	1001 - 1500	1501 - 2000	>2000
TE	Average	0.8260	0.8670	0.8644	0.9013	0.9130	0.9252
	Std.Dev.	0.1099	0.1010	0.1143	0.0699	0.0410	0.0238
	Min.	0.6049	0.5960	0.5655	0.5091	0.7647	0.8456
	Max.	0.9634	0.9684	0.9547	0.9679	0.9602	0.9583
	No. of farms	17	15	9	65	38	43

Source: own calculations

Table A3: Technical efficiency in selected size categories (ha) in 2007.



Source: own calculations

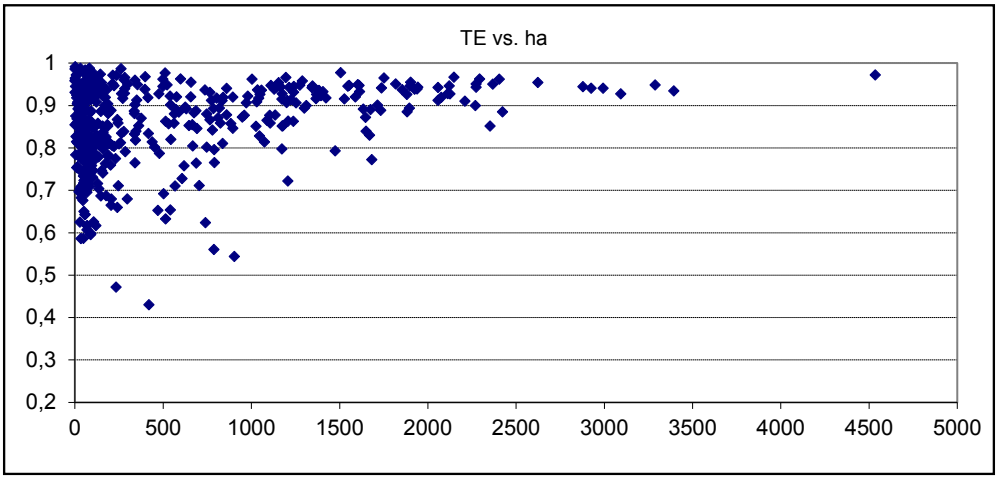
Figure A4: Technical efficiency with respect to cultivated area (ha) in 2008.

	No. of ha	0 - 100	101 - 200	201 - 300	301 - 400	401 - 500	501 - 600	601 - 700
TE	Average	0.8142	0.8323	0.8169	0.8702	0.8392	0.8295	0.8019
	Std.Dev.	0.1121	0.1017	0.1143	0.0708	0.1295	0.0958	0.0901
	Min.	0.3772	0.5315	0.5702	0.7644	0.5222	0.5699	0.6224
	Max.	0.9844	0.9585	0.9562	0.9629	0.9410	0.9751	0.9248
	No. of farms	185	78	31	16	9	17	19

	No. of ha	701 - 800	801 - 900	901 - 1000	1001 - 1500	1501 - 2000	>2000
TE	Average	0.7812	0.8611	0.8234	0.8786	0.8862	0.8881
	Std.Dev.	0.1205	0.0993	0.1171	0.0634	0.0694	0.0514
	Min.	0.5202	0.5190	0.5923	0.6393	0.5795	0.6743
	Max.	0.9109	0.9494	0.9419	0.9671	0.9569	0.9558
	No. of farms	16	19	12	71	41	37

Source: own calculations

Table A4: Technical efficiency in selected size categories (ha) in 2008.



Source: own calculations

Figure A5: Technical efficiency with respect to cultivated area (ha) in 2009.

	No. of ha	0 - 100	101 - 200	201 - 300	301 - 400	401 - 500	501 - 600	601 - 700
TE	Average	0.8458	0.8423	0.8337	0.8883	0.8073	0.8454	0.8493
	Std.Dev.	0.0977	0.0874	0.1237	0.0595	0.1624	0.1078	0.0679
	Min.	0.5861	0.6170	0.4720	0.7650	0.4300	0.6326	0.7278
	Max.	0.9916	0.9740	0.9869	0.9680	0.9621	0.9766	0.9549
	No. of farms	189	65	29	15	10	17	13

	No. of ha	701 - 800	801 - 900	901 - 1000	1001 - 1500	1501 - 2000	>2000
TE	Average	0.8092	0.8853	0.8243	0.9028	0.9158	0.9345
	Std.Dev.	0.1176	0.0382	0.1581	0.0514	0.0458	0.0271
	Min.	0.5601	0.8102	0.5438	0.7219	0.7724	0.8517
	Max.	0.9368	0.9402	0.9221	0.9660	0.9771	0.9722
	No. of farms	13	12	5	47	28	25

Source: own calculations

Table A5: Technical efficiency in selected size categories (ha) in 2009.

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Evaluation of Effectiveness of Investment Projects of Agricultural Bio-gas Stations

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Anotace

Příspěvek je zaměřen na problematiku hodnocení efektivnosti investičních projektů, výstavby a provozu zemědělských bioplynových stanic. Pojednává o významu výroby bioplynu v oblasti zemědělství. Biomasa, ze které se bioplyn vyrábí, je jedním z důležitých obnovitelných zdrojů energie.

V úvodu je část věnována vytvoření pojmotvorné základny z ekonomických a environmentálních literárních pramenů, definování pojmu „investice“, souvisejícího „investičního rozhodování“ a jednotlivých fází realizace investičního projektu. V metodické části jsou uvedeny dynamické techniky vyhodnocování efektivnosti investic.

Praktická část je zaměřena nejprve na základní charakteristiku hodnocených bioplynových stanic, na způsob jejích financování a dosažené nákladově výnosové relace. Těžištěm příspěvku je vyhodnocení provozu a hospodaření vybraných bioplynových stanic ve sledovaném období 2010 - 2013. Efektivnost investice je posuzována pomocí dynamických ukazatelů efektivnosti investic. Všechny čtyři použité ukazatele prokazují velmi příznivé hodnoty provozu stanice z hlediska efektivnosti.

Rovněž tak zjištěnými ukazateli rentability byl potvrzen také pozitivní vývoj hospodaření u všech hodnocených stanic. To plně platí při využití nevratné investiční dotace v rozmezí 25-37% vynaložených pořizovacích nákladů, kterou zemědělské podniky získaly z Programu rozvoje venkova. V případě budování stanic bez uvedené finanční dotace se parametry efektivnosti snižují.

Klíčová slova

Investiční projekt, dynamické metody, ukazatele efektivnosti investic, míra rentability, životní prostředí, obnovitelný zdroj energie, bioplyn.

Abstract

The paper is focused on problems of evaluation of effectiveness of investment projects, building and operation of an agricultural biogas stations. It deals with significance of biogas production in the area of agriculture. Biomass from which biogas is produced is one of important renewable energy sources.

A part of introduction is devoted to creation of term-creating base from economic and environmental literary resources, a definition of the term “investment”, connected “investment decision making”, and particular realization phases of the investment project. In the chapter Materials and methodology, dynamic technologies of investment effectiveness evaluation are introduced and used profitability indicators are delimited.

A practical part is focused at first on basic characteristics of the evaluated biogas stations, on a way of their financing and achieved cost-revenue relation. The mass centre of the paper is the evaluation of operation and management of the selected biogas stations in the monitored period 2010 - 2013. Effectiveness of the investment is evaluated by the help of dynamic indicators of investment effectiveness. All four used indicators show very favourable values of the station´s operation from the effectiveness point of view.

The found out profitability indicators also confirmed a positive development of economy in all evaluated stations. It holds fully in use of non-reversible investment subsidy in a range 25 – 37 % of expended costs which the agricultural enterprises obtained from the Rural Development Programme. In case of building of stations without the mentioned financial subsidy the parameters of effectiveness slightly decreased.

Key words

Investment project, dynamic methods, investment effectiveness indicators, profitability rate, environment, renewable energy source, biogas.

Introduction

According to economic theories, investment is understood as capital assets consisting of estates which are not determined for immediate consumption, but are determined for use in production of consumption goods or other capital goods.

Investment can be regarded from several directions. From the macroeconomical point of view, investments are understood as expenses for purchase of investment goods. Therefore financial investments connected with purchase of financial assets like for example shares or obligations are not ranked among them. Investment expenses of firms are autonomous, it means that they are not dependent on income, so, they can be consider non-elastic towards a product; however, only for short-time considerations. In a long period, investments are dependent on product increments (Brčák, Sekerka, 2010).

Investments in relation to an enterprise are considered also goods which do not serve for immediate consumption, but for production of other goods in the future. Also here a profit deferred in the future holds. From the financial view-point of business investment can be characterized as "one-shot expended sources which will bring financial incomes during longer future period" (Synek, 2007).

Investment decision making is characterized by several significant features, for example:

- long-term character of fixed assets
- time factor with a long-term horizon is taken into account
- it is demanding for exact knowledge of internal and external conditions
- coordination of various participants of the investment process
- capital-demanding operations
- work with really realizable financial income
- an influence of factor of entrepreneurial risk
- view-point of the environment, impact on ecology and infrastructure.

Within looking for solution of strategic considerations, main activities of investment decision making will result and the most important ones are generated. They include planning of capital expenses and financial incomes (to respect a time value of money), taking in account of risk and time, and also a choice of criteria of selection of projects from a view-point of yields and influence on liquidity of the enterprise (Kalouda, 2009).

At present for an enterprise is not possible to monitor only one main aim, but it depends on fulfilment of many aims which blend together. However, a big emphasis is put on financial aims. As the main business aims, effectiveness and financial balance of the enterprise, expressed by market values of the enterprise, investment profitability, and liquidity are considered. Other key aim of the enterprise is obtaining and keeping a share on the market and with this connected satisfying of demand. Also decision making about protection and renewal of the environment should be included into business aims. Within reaching of set aims it is suitable to find a compromise and stem from such a position, so that solution of particular aims would not become exclusive for other aims in other area. It is necessary to strive for a harmony and mutual respecting of every business aim. (Valach, 2010).

An investment project is a special name of project whose subjects are investments, and it is primarily focused on purchase or improvement of the enterprise´s property with the aim to gain economic profit. The investment project is a collection of technical and economical studies used for preparation, realization, financing and efficient operation of proposed investment. In building investments it includes usually also architectonic and ecological studies.

A life cycle of project can be expressed as a series of steps which logically mutually follows. The starting stage is a conception, than practicability, a preliminary planning, a detailed planning, a pilot conception, a subsequent implementation, a test, and a handover into operation follow. A project management in particular stages will enable control over the whole course of the project whereas the division into phases brings easier focus on the main project indicators and the financial expression of a risk. The phases subsequently follow and each of them has a well-founded importance

of occurrence. A successful termination of one phase is a necessity for starting of the next phase.

The own preparation and realization of project can be expressed as a sequence of consecutive four phases:

- Preparation of investment
- Realization of investment
- Introduction of the investment into operation
- Evaluation of effectiveness of the investment operation

The law No. 406/2000 Col., on energy management defines renewable energy sources as usable energy sources whose energy potential is renewed by natural processes; it is dealt e.g. for natural element (sun, wind, water), geothermal energy, and biomass (of plant and animal origin). It is possible to state that a renewable energy source is a source which is in fact unexpended and renewing. A common energy source in the CR is fossil fuels, concretely coal and natural gas. These fuels are ranked among natural sources; however, surely they cannot be considered inexhaustible sources.

Biomass is an organic mass which arises by means of photosynthesis, or a mass of animal origin. In such way marked biomass is usable for energy purposes as a renewable energy source. A substance is of biological origin. For easier imagination it is possible to compare biomass to some "energy can" in which a part of sun energy is deposit (Murtinger, Beranovský, 2006).

Preferences of biomass use are several. It is an energy source which has a renewable character and is connected with smaller negative impacts on the environment. Biomass is inland energy source, therefore it is not possible to import energy from abroad, thereby it contributes to reduction of consumption of imported energy resources. There is no local limitation and managed biomass production contributes to creation of landscape and care of it (Pastorek, Kára, Jevič, 2004).

In an agricultural station, organic materials from agricultural production are processed by fermentation for production of electric and heat energy. The residual product is co called digestate which is used without a rest as an organic fertilizer. This technology enables to use energy aggregated in plants and to return spent mineral substances back into soil. Thereby they create a closed substance circulation. With is activity it also considerably reduce a rise of green-house gases, mainly methane which oxidizes to less harmful CO^2. In such way arisen carbon dioxide is absorbed again by plants.

The aim of paper is to evaluate the adopted and realized investment projects of agricultural biogas stations (further BGS) in an agricultural enterprise.

Materials and methods

The project documentation contains presumed energetic, financial, and environmental contributions and impacts. The stations have been in operation minimally for three years, therefore it is possible to analyse its activity in time series. To evaluate how BGS effectiveness developed, an amount of produced energy, its supply in a public network, and use of heat which as a product of cooling of gas-engine contributes to improvement of energetic balance of the enterprise. The partial aim is, by means of ratio indicators of profitability, to analyse economic contribution for the enterprises..

From the methodological view point, the paper is divided into two parts. Theoretical starting points are realized by creation of term-creating base by study of appropriate professional literature. Data resources were provided by the agricultural enterprises which operates the biogas stations. The groundwork for an analysis of the operation of biogas stations are monthly protocols about gas production in the monitored period, project documentation to realized investments, and other internal resources. Daily and monthly records about gas production are converted on yearly shown values and are monitored in a time series from 2010 when the BGSs were already fully in operation, to December 2013. All data are processed with use of Microsoft Office Excel 2007. Tables and appropriate graphical illustrations of the course of management are created in this programme.

Accounting statements of profit and loss of the BGSs from 2010 to 2013 are the main output resource for the evaluation of effectiveness of the investment. The enterprise files in the accounting particular centres which provide the production mutually for intra-plant prices. One of the single centres is the BGS.

Within evaluation of the given project, dynamic models of evaluation of investment effectiveness are used. The reason is the fact that they take into account a risk and the time factor which cannot be omitted in gaining the investment by building. By decision about investment in the given project of the enterprises implicit cost arise

which increase costs for the investment. Also explicit costs connected with a partial financing by foreign capital arise, as well as inflation affects the investment amount. Dynamical methods have higher explanatory power from a viewpoint of processing of mathematical calculations of basic indicators. In the chapter on processing and results, particular indicators of investment effectiveness indicators are calculated.

$$\text{Net present value (NPV)} = \sum_0^t \left(\frac{CF}{(1+i)t}\right) - IN \quad (1)$$

$$\text{Internal rate of return} = il + \frac{NPVl}{(NPVl - NPVh)} * (ih - il) \quad (2)$$

$$\text{Payback period (PP)} = \frac{IN}{DCF} \quad (3)$$

According to availability of data from the statement of profits and losses of the BGS, only selected profitability indicators are quantified in per cents.

$$\text{Return on sales (RS)} = \frac{\text{profit (EAT)}}{\text{returns on sales}} \quad (4)$$

$$\text{Cost on sales (CS)} = \frac{\text{costs}}{\text{returns on sales}} \quad (5)$$

$$\text{Return on costs (RC)} = \frac{\text{profit (EAT)}}{\text{costs}} \quad (6)$$

where: CF – cashflow, i – interest rate, il – Lower interest rate, ih- higher interest rate, NPVl – NPV at a lower interest rate, NPVh - NPV at a higher interest rate, EAT – profit after taxation, DCF – discounted cashflow, IN - investment

After evaluation and mutual assessment of the above mentioned indicators it is possible to pronounce a qualified conclusion about effectiveness of the investment project.

For the evaluation cost growth is simulated on base of determination of average growth rate of particular variables which enter in revenues and costs of operation of the biogas station. It is dealt with following variables:

- Price of input substrates
- Price of fuels
- Price of purchased electricity
- Price of heat
- Wage costs
- Price of other operational cost

The drop-out of co-generation unit by reason of execution of basic servicing (exchange of filters, oil, setting of the unit) is projected in calculations by decreased revenue for sale of electric energy. The services are carried out approximately after 30 thous. motohours. The particular calculations of the average growth are following. In saved heat the average yearly growth is set by 2.5 % (the average growth of analysed time series of heat price). The purchased electric energy increased on the average by 0.4 % (the calculation on base of time series of prices of electric energy). Wage costs increase yearly by 0.5 % (this growth is calculated from average wages in the selected enterprises. Costs for transport increases in dependence on growth of diesel fuel price which increases on the average by 0.7 % (the calculation is set on base of time series of petrol price from MPO statistics. The last cost is a price of output substrate. In this case, data of UZEI – cost plant survey were used for the calculation. The calculation is based on a share of particular inputs with a view to project increasing costs for growing into the calculation of net current value. In this cost the growth coefficient 2 % yearly was used for the enterprises.

Results and discussion

The Czech Republic in approval of new biogas station follows a methodical direction of the Ministry of Environment. The main purpose of this methodical direction is to bind the appropriate authorities of the state administration in the area of environment to unified procedure in permitting and approval of biogas stations before putting in operation, and to optimize conditions of their operation from the environment point of view. The methodical direction is determined above all for official of the state administration and operators of stations for security of qualified approval process and for elimination of problems with placement of biogas stations (Švec, 2010).

At present, biogas stations processed mainly slurry and other agricultural products. Some operators of these stations grow purposefully crops suitable for processing into biogas, e.g. maize. Production of electricity generation is majority and a by-product is arising heat. In total 487 biogas stations was in operation on the territory of the Czech Republic to the 31st July 2013. The Agrarian Chamber of the CR states that the biggest number of BPSs is agricultural, 317, further BGSs within sewerage plant, their number is since 2008 the same 97, 55 BGSs on dumps, 11 industrial BPSs, and 7 communal. Building of new agricultural BPSs has growing trend in the monitored period.

From resources of the Czech Biogas Association it is possible to find out that the total electricity generation from biogas reaches 1 089 GWh for the year 2013. Agricultural biogas stations are classified in the Czech Republic into three groups according to installed power: up to 250 kW, up to 550 kW and more than 550 kW.

Biogas stations do not product only electricity and heat, but just also digestate which has a significant value as fertilizer for agricultural land. Use of digestate as an organic fertilizer has important role because thanks to this agricultural enterprises avoid use of mineral fertilizers (Lijo and at al., 2014).

Some authors point out a fact that big concentration of biogas stations together with a big amount of used digestate can lead to pollution of surface and underground water (Hermann, 2013).

Characteristics of investment projects

Chosen agricultural enterprises realized a BGSs project on own parcels where the businesses operate their agricultural activity (plant and production). The production and subsequent sale of electric energy (eventually use of waste heat) can be understood as a new resource of incomes for a guaranteed purchase price for a lifetime of the project (20 years) from the start of operation. At the same time, realization of BGSs increases a share of renewable sources in the CR and also decreases consumption of primary (non-renewable) energy source, and thereby it also decrease exhalations connected with production of electric energy and heat. BGSs building invokes diversifications of activities within agricultural enterprises with a possibility of significant strengthening of economic potential of the agricultural enterprises.

Enterprise A

The enterprise A is situated in 435 m above sea level in Plzeň region. A BGS fermenter has a volume 3816 m3, uses units with the installed electric power 716 kW (heat power 823 kW) of mark TEDOM. The enterprise deals with both the plant and animal production with acreage of managed area 1987 ha.

Enterprise B

The Enterprise B is placed in 460 m above sea level in the South-Moravian region. It uses two fermenters with capacity 2500 m3 and defermenter with capacity 1400 m3. Further it uses co-generation unit (combined production of heat and power) with the installed electric power kW (heat power 789 kW) of mark JENBACHER. The enterprise deals with both the plant and animal production with acreage of managed area 2876 ha.

Enterprise C

The enterprise C is located in 605 meters above sea level in the South-Bohemian region. For fermentation process it uses a fermenter with capacity 4325 m3. A co-generation unit has an installed electric power 535 kW (heat power 568 kW) of mark DEUTZ AG. The enterprise in its activity deals with both the plant and animal production with acreage of managed area 2416 ha.

Enterprise D

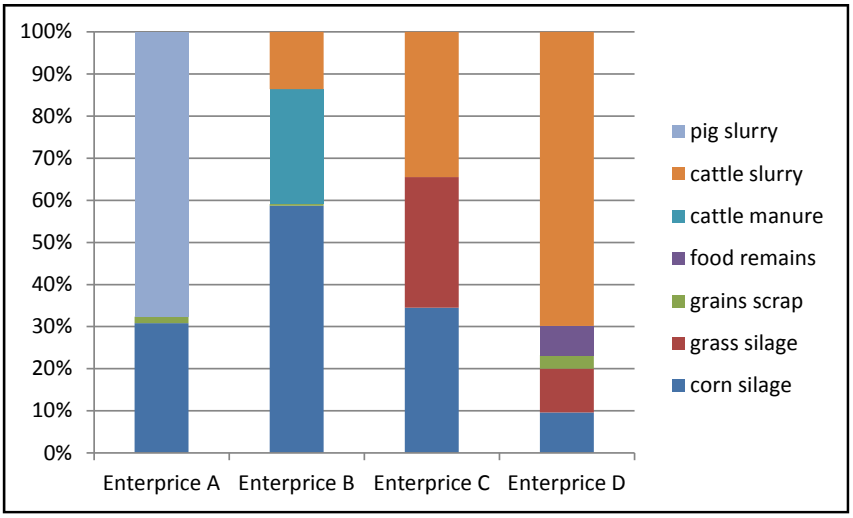
The enterprise D is situated in 465 meters above sea level in the region Hradec Králové. For the fermentation process it uses fermenters with capacity 2025 and 2285 m3. A co-generation unit has an installed electric power 549 kW (heat power 566 kW) of mark MAN Nutzfahrzeuge AG. The enterprise in its activity deals with both the plant and animal production with acreage of managed area 2219 ha.

Security of input substrates

As already mentioned, all inputs in particular PGSs comes from their own production. Also the entire fermentation process and with that connected production of electric energy depend on composition of particular input substrates. Because BGS is a long-term investment, it is necessary to secure suitable input raw materials for all lifetime of the BGS. The following Graph 1 introduces for particular BGSs a proportion of input raw materials which are used within the fermentation process (values for 2012).

From the graph 1, differentness of used inputs in particular agricultural enterprises is obvious. From a view-point of division into animal and plant inputs in the enterprise A animal inputs prevails – the main input substrate is pig slurry (it creates more than 70 %) which is completed with silage maize. In the enterprise B the situation is opposite – the main input substrates are silage maize with a share exceeding 60 %. The enterprise C uses 2 plants and 1 animal input. Maize silage creates 34 %, grass haylage 32 %, and remaining 34 % is cattle slurry. The enterprise D uses in large quantity animal inputs – a dominant input is cattle slurry which represents 70 % of annual inputs, and further it is completed with silage maize, grass haylage, deeding remains and cereal meal.

Results of the research are in harmony



Source: Enterprises´ data processed by author

Graph 1: Structure of input substrates for particular enterprises (2012).

with conclusions of authors Mužík, Abrham (2013) who state that it shows that use of biomass is energetically effective just in those cases when biomass is energetically used where it rises (the best when a producer and user of biomass is one entrepreneurial person). In the papers evaluated agricultural biogas stations meet this requirement because all input raw materials come from the own production of enterprises.

Walla and Schneeberger (2006) state that use of green electric power from energy plants. Lucerne is on ecological farms the most efficient energy crop-plant. In the evaluated stations in the enterprises B and C raw materials of plant origin and in enterprises A and D the basic raw material are wastes from animal production and not purposefully grown energy plants.

Financing of investments in particular enterprises

Particular evaluated enterprises used for financing of BGS investment subsidies from the Rural Development Programme of the CR. The maximal permissible amount of subsidy amounts to 40 % for purposefully expended costs connected with BGS building. The particular enterprises achieved following subsidies:

In the enterprise A subsidies for BGS create 25 % of investment cost value. The total investment in BGS in this enterprise was 86 600 thous. CZK. The amount of subsidy amounted to 21 992 thous. CZK. The enterprise used for financing own sources in amount 13 226 thous. CZK, the remaining financial part vas covered by a loan.

In the enterprise B the subsidies for BGS create 27 % of investment costs. The total investment in BGS was in amount 94 800 thous. CZK. The amount of subsidy was 25 500 thous. CZK. At the same time the enterprise used for financing its own sources in amount 4 300 thous. CZK, a remaining part of investment was covered by a loan.

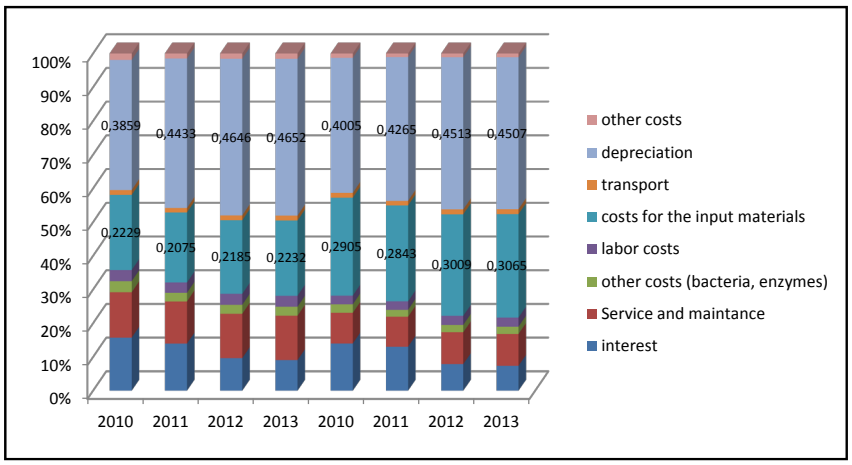
In the enterprise C, subsidies for BGS represented 28% of investment cost value. The total investment in BGS in this enterprise was in amount 59 970 thous. CZK. The allotted amount of subsidy for this enterprise was 17 000 thous. CZK. This investment was partly financed by own sources in amount 3500 thous. CZK and the remaining means were obtained by the enterprise in form of loan.

In the enterprise D the subsidies for BGS create 37 % of investment cost value. The total investment was in amount 76 993 thous. CZK. The amount of subsidy for this BGS amounted to 28 252 thous. CZK.

All costs and revenues connected with the operation of biogas station the plant register separately from management of the whole enterprise, therefore in calculations authors started above all from profit and loss statement of BGS. The monitored period is from 2010 to December 2013.

Structure of project operating costs

In particular enterprises the structure of cost items does not differ significantly which is obvious in the following Graph 2.



Source: Enterprises´ data processed by author

Graph 2: Structure of operating costs in enterprises B, C (2010-2013).

A significant part of BGS financing is creating by a bank loan for which interests have to be paid. The interest item moves in the total cost structure in particular enterprises in a range 13 – 9 % in the first year of operation and gradually the share of this cost item decreases. The most significant part of costs is created by the own depreciations of BGS. Particular technological parts are, according to accounting, ranked in other depreciation groups. The building part of BGS is included in a depreciation group 4 with a depreciation time 20 years while technological system belong in a depreciation group 2 with a depreciation time 5 years (Mužík, Abrham, 2006).

From a view-point of biogas station, costs for the input material (substrate) in BGS are very important. Here in particular enterprises, there is a relatively wide range of share in the total costs. It very depends on a kind of input material (slurry x maize) and their representation in feeding rations in BGS. Shares of the cost item for input material moves in range 22 – 35 % of the total costs arisen in BGS.

A service creates 9 – 15 percents of total costs, particular service acts run approximately after 30 thous. hours of operation (change of oil, seal) and after 60 thous. hours of operation it is necessary to carry out a general engine repair (setting, change of basic components).

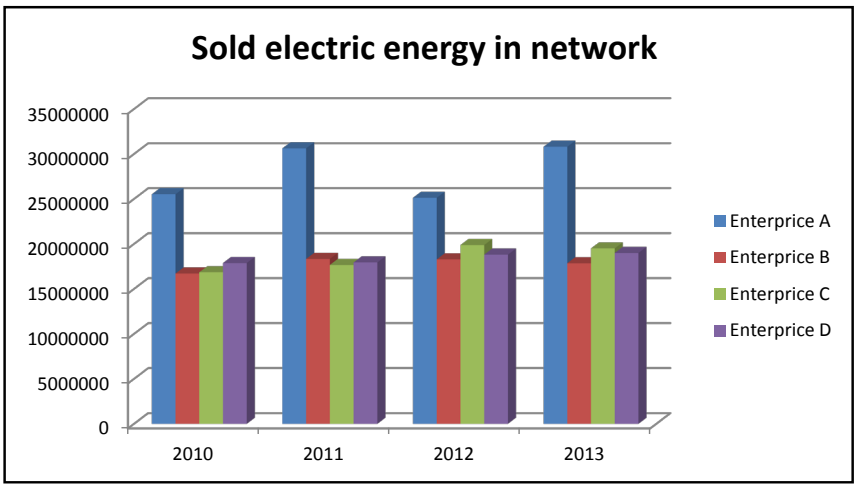
Remaining items of type of other costs, transport, labour costs create only a minimal part of the total costs.

Revenues structure in project realization

The main part of revenues from BGS operation is represented by annual invoice payments for supplies of electric energy in a distributional electric system. The revenues can have a form of savings in its purchase from an external supplier (a form of green bonuses), or are realized by direct sale of these energies in the network (purchase price). A standardized operation of co-generation unit is 8100 h/year (Kazda, 2009). All analyzed enterprises use the green bonuses regime. Other possibility is a use of waste heat for use in neighbouring municipality, or own use within the enterprise. From BGS operation view-point, waste components arise in the fermentation process – digestate or fugate (in this case it depends on state) which can be further used as a fertilizer according to the Law No. 156/1998 Col., on fertilizers. Also the digestate has to be used according to the ordinance No.474/2000 Col., on fertilizers. And last but not least the Government Regulation No. 262/2012 Col., on determination of vulnerable areas and action programme. This regulation sets particular vulnerable areas according to cadastral territories, use of fertilizers in this area, storage of nitrogen substances in the vulnerable areas, change of grown crop-plants, farming on steep agricultural land and so on.

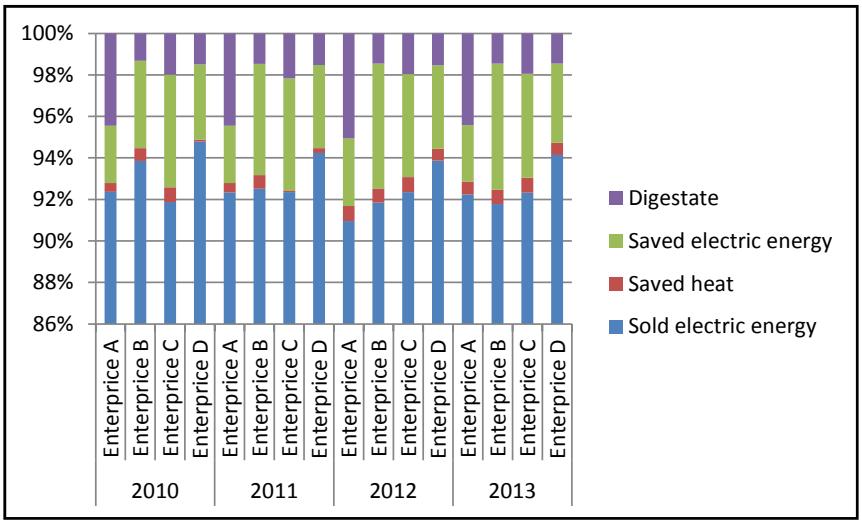
The following Graph 3 shows amount of revenues only for sold electric energy in the network in particular enterprises in the period 2010 – 2013 on base of underlying data from BGSs.

As already mentioned, the sale of electric energy is the main of BGS incomes. Other possibility is in case of the green bonus saving for purchase of electric energy, use of waste heat, eventually use of sale of digestate as a fertilizer. In the following Graph 4, a structure of all BGS revenues is introduced.



Source: Enterprises´ data processed by author

Graph 3: Sold electric energy in network (CZK, 2010 – 2013).



Source: Enterprises´ data processed by author

Graph 4: Revenues structure of BGSs (2010-2013).

From the revenue structure view-point, in all enterprises it is obvious that revenues for sale of electric energy in the network create 91 – 85 % of BGS revenues. In the enterprise A a significant part is represented by revenues from digestate (use as a fertilizer) in a range 4 – 4.5 % of BGS revenues. The saved electric energy (by use of electric energy from the own BGS) creates 3 – 6 % of revenues of the enterprises. The use of heat in these enterprises shares in the total BGS revenues only in 0.3 – 0.4 %. Just the use of waste heat from BGS is a very significant attribute for efficient use of the total BGS potential.

Evaluation of effectiveness of biogas stations (NVP, IRR)

In calculation of NVP, two variants are introduced; the first counts on receiving of subsidy after one year of operation on base of real values (Table 1), and the second variant shows NVP in case of failure of subsidy (Table 2). This paper counts on a discount rate 5.6 %.

A prediction of financial flows is compiled on base of presumptions mentioned in the chapter Materials and methods.

Variant 1	NVP	IRR
Enterprise A	57 179 052	14.094%
Enterprise B	27 045 787	11.392%
Enterprise C	53 471 239	16.650%
Enterprise D	33 235 266	11.554%

Source: author

Table 1: NVP and IRR for selected BGSs with receiving of investment subsidy.

Variant 1	NVP	IRR
Enterprise A	36 754 811	10.473%
Enterprise B	4 743 073	6.438%
Enterprise C	38 759 601	12.616%
Enterprise D	4 983 568	6.749%

Source: author

Table 2: NVP and IRR for selected BGSs without receiving of investment subsidy

The net present value (NPV) for the selected BGSs in all cases resulted positive, even i case of failure of subsidy. In the lifetime 20 years the internal rate of return (IRR) moves for the first variant in a range 11 – 16 % (it is dealt with a variant when the subsidy for BGS of the enterprise is paid off after one year of operation). The second variant is failure of subsidy for BGS; in this case results of NVP and IRR considerably decreased (NPV is in range 6 – 12 %). The payback period (PP) is in the first variant for the particular enterprises following:

The enterprise A has the payback period 7.2 years in the variant 1 (with subsidy), the enterprise B 9.8 years, the enterprise C 6.5 years and the last enterprise D 9.6 years. According to Mužík and Abrham (2006) the payback period in these investments up to 10 years with recognized subsidy acceptable. The PP up to 5 years is than very good. Gebrezgabher et al. (2010) deals with economic analysis of biogas stations in the Netherlands. By the help of linear programming they simulated scenarios influencing the amount of net present value and the internal rate of return in dependence on chosen input substrates, amount of electric energy, digestate, and waste heat. In this case the internal rate of return reached a value approximating 20 %.

Profitability indicators of BGS

The rate of cost profitability was calculated according to methodology of cost and return calculation of biogas stations in agricultural enterprises (Poláčková, 2013).

Manganelli (2013) in its study draws attention to economic advantages from use of biogas co-generation power station fuelled by biogas from wastes in cattle breeding and other waste materials arising from the same production chain in the area of Campania (Italy) with an intensive animal production. Economic results analyzed in the paper in biogas stations in the enterprises A and D confirmed in accord with the author suitability of biogas production from wastes

Enterprise A	2010	2011	2012	2013
Rate of cost profitability	32.45%	23.57%	9.12%	28.06%
Return on sales	23.17%	18.26%	8.20%	20.84%
Cost on sales	71.40%	77.46%	89.88%	74.27%
Return on costs	40.06%	29.10%	11.26%	34.64%
Enterprise B	2010	2011	2012	2013
Rate of cost profitability	30.72%	20.42%	26.78%	24.37%
Return on sales	22.27%	16.31%	20.13%	18.74%
Cost on sales	72.50%	79.87%	75.15%	76.87%
Return on costs	37.93%	25.21%	33.07%	30.09%
Enterprise C	2010	2011	2012	2013
Rate of cost profitability	47.12%	22.70%	41.30%	39.37%
Return on sales	29.79%	17.73%	27.35%	26.49%
Cost on sales	63.22%	78.11%	66.23%	67.29%
Return on costs	58.17%	28.03%	50.98%	48.60%
Enterprise D	2010	2011	2012	2013
Rate of cost profitability	45.41%	33.07%	33.75%	65.05%
Return on sales	28.97%	23.67%	25.14%	36.33%
Cost on sales	71.03%	77.14%	80.38%	64.36%
Return on costs	40.78%	30.69%	31.27%	56.44%

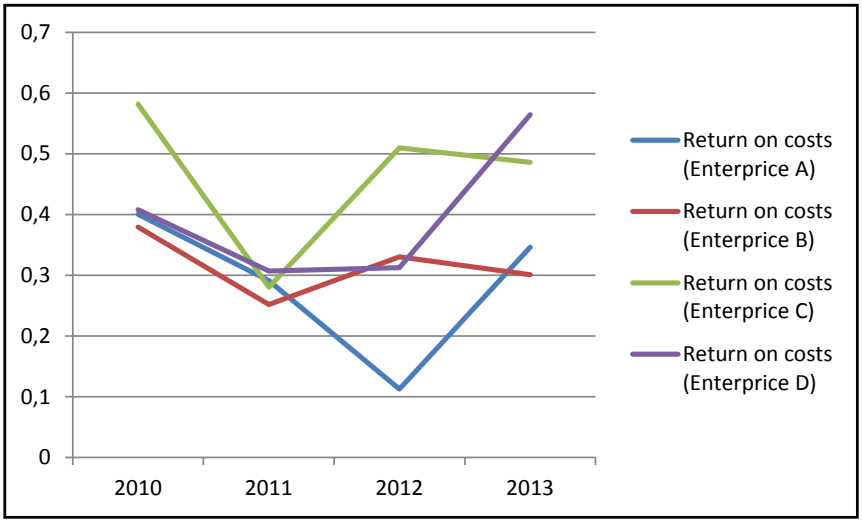
Source: Enterprises´ data processed by author

Table 3: Results of evaluated indicators (2010-2013).

in animal production. The first evaluated indicator is the return on costs (see the Graph 5). These indicators express how many hellers of profit falls on 1 CZK of costs. From the graph swings are obvious in particular enterprises. The steadiest BGS from this indicator viewpoint is BGS of the enterprise B where the return on costs moves in a range 28 – 39 %).

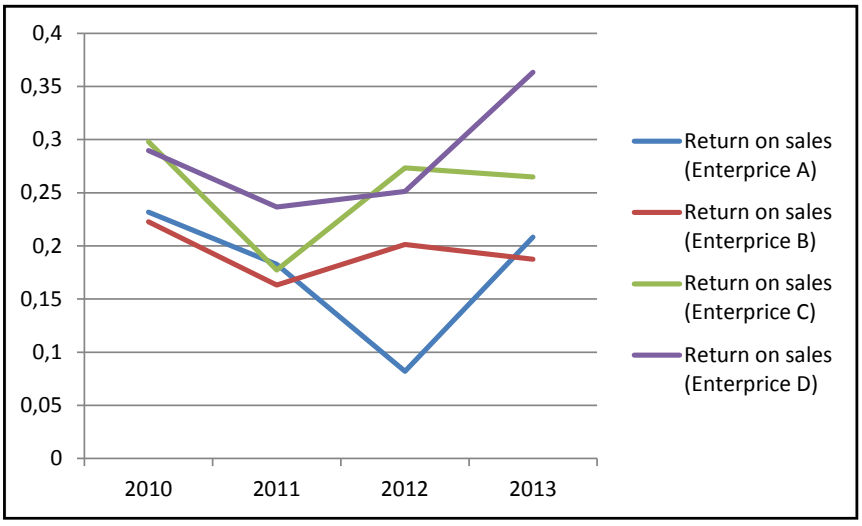
Other significant indicator of business effectiveness is return on sales (see the graph 6) which can be marked also as profit margin. For calculation of return on sales, the net profit of BGS is given in relation with the value of revenues for associated production (electric energy, heat, digestate). In the monitored period, this indicator moves in a range 8 – 35 %. A fall in 2012 in the enterprise A was caused by a drop out of a co-generation unit by reason of repairing which projected in the amount of revenues for sold electric energy. In the enterprise B and C, the development of revenues on sale is relatively steady moving in a range 20 – 28 % (20 – 28 hellers fall on 1 CZK of revenues).

The rate cost profitability moves in particular BGS moves in range 10 – 65 % in the monitored period. In 2010 – 2011, the values are relatively steady without significant swings in particular BGSs. After 2012, these indicators significantly increased



Source: Enterprises´ data processed by author

Graph 5: Development of return on costs indicators for particular enterprises (2010-2013, in %).



Source: Enterprises´ data processed by author

Graph 6: Development of cost on sales indicators for particular (2010-2013, in %).

in the enterprises A and D. This jump increment can be explained by that consumption of input raw materials slightly decreased (enterprises started to use enzymes for better fermentation and they also started to use more waste heat).

Authors Hrůza and Stober (2009) state that agricultural biogas station can bring many effects in the economic system of agricultural enterprise, however, it depends mainly on good communication between the investor and the designing firm.

In the paper analyzed results of evaluated biogas stations in a longer time period confirm the mention presumption on base of wider and longer-range investigation than in one investment project which most authors evaluates in their studies.

Conclusion

A result of the realized investment project is a building and operation of biogas stations in agricultural enterprises where input raw materials are above all maize silage, grass silage, and cattle slurry. The necessary components come from own production of the enterprise. The operation of biogas station contributes to the agricultural enterprise to a stabilization of economic situation by securing a regular and at the same time guaranteed source of incomes.

Revenues on BGS operation in the analyzed enterprises shares in the total revenues on operation activity in a range 27 – 17 % and creates a significant part of operating revenues the enterprise. At the same time a biogas station represents a financial pillow in case of a more significant volatility of product prices of animal and plant production on the market, or in case of bad revenues. Purchase prices of electric energy are guaranteed for the whole lifetime of the project and create an income certainty for agricultural enterprises. The annual operating characteristic is from a view-point of supplied power steady. In a trouble-free operation it is affected only by regular short-term service shut-downs of the co-generation unit (a change of filters, oil, spark plugs and so on). A more significant fluctuation of power or long-term shut-downs are than often caused by breach of operation regulations, especially dosage, composition and quality of input substrate.

Investment into biogas stations supports diversification of activities towards non-agricultural activities – a sale of electric energy, use of waste heat, increase in hygiene of animal bedding, and remains-less processing of feeds. At the same time the BGS operation satisfies also tight conditions regarding the environment.

The realization of biogas stations in the area of agriculture has large preferences for enterprises from both the viewpoint of use of own input raw materials of plant production, and the processing of wastes from the animal production. Also such waste raw materials from biogas stations as digestate can be used in agricultural operation. The enterprise separates the arisen waste to fugate, which is further used for reutilization in the plant production, and a separate which serves for bedding of dairy cows. The fugate is a resource of nutrients of organic origin for the plant production.

The revenues structure in particular BGSs shows that over 92 % of revenues create sale of electric energy in the network. Other revenues on BGS operation arise by use of waste heat (in this case the analyzed enterprises have considerable reserves in use possibilities), or digestate as a fertilizer.

For investment evaluation, dynamic indicators of investment evaluation were used – the net present value and the internal rate of return. On base of results in particular enterprises with BPS we can state that investments are acceptable for the enterprises (ceteris paribus). In all evaluated BGSs the net present value was positive, even in case without receiving subsidy for BGS building. The internal rate of return moves in the first variant (variant with subsidy) in a range 11 – 16 %. According to the payback period indicator, all evaluated BGSs got below 10 years (according to Mužík and Abrham (2006) it is dealt with acceptable values).

At present, biogas stations are already an integral part of entrepreneurial activity of a large number of agricultural enterprises. The input substrate can be products both of the animal and the plant production (ideally a combination). Considering that it is necessary to think about the future permission of these operations regarding the character of activity – to permit for processing of complementary activities (processing of manure, slurry and so on.). Regarding the animal production a biogas station represents a certain rate of competition (decision-making whether to use crop-plants as an input substrate in the biogas station or as feeding for animals).

On base of the analysis of operation and results in the paper evaluated biogas stations it is unambiguously proved that agricultural biogas

stations represent permanent and certain source of financial means for agricultural enterprises, which operate them, and contribute in this way to the financial stability of these enterprises. This results is confirmed also by other studies from other countries, e.g. Gregersen (2002), Mittal (1997) when a positive influence of biogas stations in light of characteristics of decentralized energy source, a better use of wastes, redistribution of nutrients was proved and they significantly partake in solution of problem in the environment area.

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Quantitative Differences among Normal and Knowledge Texts on Agriculture Waste Processing

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Anotace

Cílem článku je identifikovat rozdíl mezi vzdělávacími texty psanými běžnou formou a texty znalostními, které byly vytvořeny záměrným použitím metod znalostního inženýrství. Výzkumný vzorek tvoří 60 dokumentů – vzdělávacích textů z oblasti zpracování zemědělských odpadů, které byly autory převedeny do znalostní podoby. Nad sadou indikátorů, které se používají pro hodnocení didaktických textů, byly formulovány pracovní a operační hypotézy, jejichž platnost byla testována pomocí párového t-testu. Ukázalo se, že znalostní forma vzdělávacích textů vykazuje statisticky významně (α = 0,05) nižší koeficient celkové obtížnosti, když je při srovnatelném množství faktických a technických informací složen z významně většího počtu jednoduchých vět spojených v souvětí reprezentující znalost. Na základě významně větší frekvence vybraných identifikátorů je pak možné oba typy texů odlišit i formálně, na čemž je možné založit další výzkum: automatizované rozpoznávání typu vzdělávacího textu a měření obsahu znalostí, které jsou v něm uvedeny.

Klíčová slova

Zemědělské vzdělávání, znalostní a informační systémy, zemědělské odpady, literární styl, znalostní jednotka, celková obtížnost textu.

Abstract

The objective of this work is to identify the differences among educational texts written in two styles: normal educational text and their knowledge form. The research sample consists of 60 documents – educational texts on agriculture waste processing – converted by the authors into the knowledge form. Over the set of indicators used for evaluating the educational texts, we formulated working and operational hypotheses and validated them using the paired sample t-test. The results show that the complex text difficulty rate of knowledge texts is significantly (α = 0.05) lower than of the normal texts. They present the same amount of information logically divided into more simple sentences merged to complex sentences. Based on the difference in frequencies of selected identifiers we are able to distinguish the literary styles. The further research aims at an automatic recognition of the text styles and measuring the amount of knowledge inside the text.

Key words

Agriculture education, knowledge and information systems, agriculture wastes, literary style, knowledge unit, complex text difficulty rate.

Introduction

Classification of literary styles of texts is a common issue solved by many researchers from more points of view. Cortina-Borja and Chappas (2006) quantified the literary style of various forms of media, including the new ones (broadsheet and tabloid newspapers, technical periodicals and television news scripts). It allowed them to investigate the richness of vocabulary exhibited in these texts under the proposition that the writing style usually varies depending on the targeted readership or audience. Graham et al. (2012) state that in literature, there is an established set of techniques that have been successfully leveraged in the statistical analysis of literary style, most often to answer questions of authenticity and attribution. In their work, they suggest that the progress made and statistical techniques developed in understanding the visual processing

as it relates to natural scenes can serve as a useful model and inspiration for visual stylometric analysis.

In connection with the analysis of the literary styles of the documents, there is another issue worth solving: how to measure (ideally through quantitative characteristics) information content of the documents. This issue is really important in education, because it can influence the learning outcomes of the educational process (D. Newton, L. Newton, 2009). Duric and Song (2012) or Asaishi (2011) dealt with the analysis of educational texts. The aspects that were evaluated and measured included, among others, the extent of having the textbook equipped from the didactics point of view, the extent of the difficulty of the text, the analysis of terms, the extent of the information density, and so on. Just these authors inspired us to carry out the research presented in this paper.

In education, the main focus is put on the transfer of knowledge. We feel the ability of measuring the knowledge content in educational texts or textbooks as one of the critical factors in evaluation of the quality of the textbooks. On the other hand, according to our best knowledge no such metrics for measuring the knowledge content in the text (knowledge density, number of pieces of knowledge, etc.) have been developed and published. The objective of this work is to compare quantitative indicators and parameters of two types of texts: normal text without any corrections, and knowledge text created using the methods of Knowledge Engineering. In particular, the knowledge unit as the representation of knowledge in natural language is used. When the differences in quantitative indicators are identified and described, we can formulate more advanced hypotheses on the influence of the indicators on measuring the knowledge content of the text as an input for further research.

In this work we continue in our research on determining the quantitative characteristics of normal and knowledge texts. Previously (Rauchová et al., 2014), we tested the further presented methodology (see Materials and methods) and anticipated the quantitative characteristics of the text, which could be of the largest potential to distinguish among the text types. As we found, it is worth dealing mainly (but not exclusively) with the following indicators (see Materials and methods for their definition):

- semantic difficulty rate;
- syntactic difficulty rate;
- complex text difficulty rate;
- technical and factual information per words;
- number of concepts.

Apart from the previous analysis on micro-samples of the texts (Rauchová et al., 2014), other authors (e.g. McCrory and Stylianides (2014) or Miller (2011)) support our arguments for choosing this set of the indicators as well. The objective of the current work is to use statistically significant samples of homogeneous texts on agriculture waste processing and prove or disprove the following working hypotheses:

H1.0: The complex text difficulty rate (T) is higher for Normal text than for Knowledge text.

H2.0: The density of technical and factual information per word (i) is higher for Normal text than for Knowledge text.

H3.0: The average number of sentences per complex of sentences (V_a) is higher for Knowledge text than for Normal text.

H4.0: The number of chosen word concepts is higher for Knowledge text than for Normal text.

Materials and methods

Knowledge texts in general

In this work, we understand "knowledge text" as a specific form of the text, which contains knowledge in an explicit form. Based on our previous research (Dömeová, Houška et al., 2008), we see production rules and their advanced version, knowledge unit, respectively, as the most suitable form to represent explicit knowledge in the text. Formally, we suggested to record knowledge unit as (Dömeová, Houška et al., 2008)

$$KU = \{X, Y, Z, Q\}, \quad (1)$$

where X stands for a problem situation,

Y stands for the problem being solved in the problem situation X,

Z stands for the objective of solving the elementary problem,

Q stands for a successful solution of the elementary problem (result).

Even though there is no unique way to create sentences based on the production rules (Kendal, Creen, 2007), we can always express the knowledge unit in the following textual form (Dömeová, Houška et al., 2008): "*If we want to solve an elementary problem Y*

in the problem situation X in order to reach the objective Z, then we should apply the solution Q."

Quantitative characteristics of texts

In this part, we present the most commonly-used metrics characterizing different aspects of the texts (e.g. difficulty, communication ability, etc.) in quantitative indicators. Further on, the following parameters are used.

Complex text difficulty rate (Arya, Hiebert, Pearson, 2010)

$$T = T_s + T_p \tag{2}$$

where T_s is the syntactic difficulty rate,
T_p is the semantic difficulty rate.

Syntactic difficulty rate (Arya, Hiebert, Pearson, 2010)

$$T_s = 0.1\frac{N^2}{U \cdot V} \tag{3}$$

where N is the number of words,
U is the number of verbs,
V is the number of sentences.

Semantic difficulty rate (Hrabí, 2012)

$$T_p = 100\frac{P}{N} \cdot \frac{P_1 + 3P_2 + 2P_3 + 2P_4 + P_5}{N} \tag{4}$$

where P_1 is the number of common terms,
P_2 is the number of technical terms,
P_3 is the number of factographic terms,
P_4 is the number of figures,
P_5 is the number of recurring concepts,
P is the total number of terms in the text,
N is the total number of words in the text.

The following indicators are taken from (Hrabí 2012).

Coefficient of density of scientific and factual information per noun

$$h = 100\frac{P_2 + P_3 + P_4}{P} \tag{5}$$

Coefficient of density of scientific and factual information per word

$$i = 100\frac{P_2 + P_3 + P_4}{N} \tag{6}$$

Average number of adverbs per sentence

$$ADV_A^V = \frac{ADV}{V} \tag{7}$$

where ADV is the number of adverbs (adverbs of time, place, manner and cause),
V is the number of sentences.

Average number of adverbs per complex of sentences

$$ADV_A^S = \frac{ADV}{S} \tag{8}$$

where ADV is the number of adverbs (adverbs of time, place, manner and cause),
S is the number of complexes of sentences.

Hűbelová (2010) has used some basic formulas for describing the structure of text, e.g. average number of sentences per complex of sentences and average number of complexes of sentences per sentence could be one of them.

Average number of sentences per complex of sentences

$$V_A = \frac{V}{S} \tag{9}$$

where S is the number of complexes of sentences,
V is the number of sentences.

Average number of complexes of sentences per sentence

$$S_A = \frac{S}{V} \tag{10}$$

where S is the number of complexes of sentences,
V is the number of sentences.

Research sample and statistical methods used

In total, the research sample consists of 120 documents divided into two groups. 60 documents are written in a standard format for educational texts (normal texts), 60 documents contain the text of the same content, but rewritten into the knowledge format (knowledge texts). Normal texts are taken from educational or professional literature on agriculture waste processing (see the complete list at **http://pef.czu.cz/~houska/Agris_2014/Sample.pdf**) and represent one half of each pair. The other half of the pairs is represented with knowledge form (see above for its general form) of the texts,

which have been translated using the procedure presented in Houška and Rauchová (2013). An example of such pair follows:

Original text taken from a textbook on the industrial waste processing (see Enviregion, 2014, in Czech, translated by the authors):

„*The waste arisen from industry production differs in comparison with the one arisen from households in more properties. It differs in the composition influenced with the kind of the production. It can often contain elements, which are of the hazardous character for people as well as for the nature (toxic, explosive, flammable, etc.). That is the reason for special manipulation for such waste. Individual productions generate waste of different properties and thus there is no unique procedure for processing it. Waste from the chemical productions is often really dangerous and has to be modified before processing. Metallurgy also produces a large amount of dangerous waste. Food productions generate waste that could be transformed into a fertilizer and used in agriculture. Building industry can often recycle the waste in order to be re-used for the production of building materials or for building the houses.*“

Its knowledge form (the original text modified by the authors according to (1)) can be presented as follows:

“*If we consider the waste arisen from industry production and describe its properties, then it differs from the households one in more characteristics influenced with the source of the waste. If it contains elements denoted as hazardous for people or nature (toxic, explosive, flammable, etc.), then we should manipulate with the waste carefully. When we consider the industrial waste and describe its processing, we should bear in mind that each production generates a different kind of the waste, and thus there is no unique way of processing the waste. If dangerous waste is processed, the manipulation procedure should be described in detail in order to prevent the consequences to the environment, e.g. using the modification of the waste from chemical production aimed at the reduction of the content of the toxic metals, such as cadmium, nickel, lead, etc. When we deal with the waste processing and aim at exploiting the maximum value obtained from the waste, then we can e.g. transform the food production waste into fertilizers, building production waste into building material, etc.*”

The complete research sample (all pairs of normal and knowledge texts in Czech) is available at: **http://pef.czu.cz/~houska/Agris_2014/Sample.pdf.**

For the purposes of semantic analysis of the sample, the texts were pre-processed manually in order to allow smooth identification of the key parameters for the analysis. The notation was as follows:

- concepts (**in bold**),
- factographic terms (underlined),
- common terms (highlighted),
- figures (underlined),
- technical terms (underlined),
- verbs (underlined) and
- recurring concepts (*in italics*).

Furthermore, the texts were pre-processed for syntactic analysis, too. We distinguished:

- simple sentences (single underlined) and
- complex sentences (double underlined).

We use the indicators of descriptive statistics, such as mean, variance, standard deviation, etc. to identify basic differences among the variables presented above for normal and knowledge texts. Furthermore, we use the paired sample t-test to confirm or reject the operational hypotheses on the equivalency of individual variables for normal and knowledge texts. Using the paired version of the t-test, we respect the natural dependence among the items in both sets, where the knowledge texts were directly derived from the normal ones. See Wetcher-Hendricks (2011) for the description of these methods in details. All calculations are processed using the statistical software Statistica, version 12.

Results and discussion

First we calculate basic descriptive statistics for all partial variables, separately for normal and knowledge texts, see Table 1.

Inspired by the working hypotheses formulated in Introduction (H1 – H4) and data in Table 1, we aim at testing the following operational hypotheses.

H1.1: There is no difference in the mean value of the number of words between Normal text and Knowledge text.

H1.2: There is no difference in the mean value of the number of verbs between Normal text and Knowledge text.

	Normal text					Knowledge text				
Variable	Mean	Minimum	Maximum	Variance	Standard deviation	Mean	Minimum	Maximum	Variance	Standard deviation
N	249.8	161	311	1064.1	32.62	255.7	194	335	1098.0	33.1
U	26.1	8	41	67.9	8.24	25.6	10	43	63.4	8.0
S_s	7.5	2	12	8.5	2.91	3.7	0	11	6.3	2.5
$S_c^{(2)}$	4.6	0	9	6.8	2.61	4.1	0	9	5.4	2.3
$S_c^{(3)}$	2.2	0	5	2.2	1.49	2.7	0	7	2.8	1.7
$S_c^{(4)}$	0.5	0	2	0.6	0.77	0.8	0	4	0.9	1.0
$S_c^{(5)}$	0.2	0	1	0.2	0.40	0.4	0	2	0.3	0.5
$S_c^{(6+)}$	0.1	0	1	0.1	0.30	0.3	0	3	0.4	0.6
S_c	7.6	2	13	11.2	3.34	8.1	2	15	9.0	3.0
V_A	2.4	0.4	3.3	0.3	0.54	2.7	2	4.4	0.2	0.5
P	2.7	0	6	3.3	1.83	9.5	2	17	10.4	3.2
P_1	67.2	39	94	183.9	13.56	66.6	47	92	121.1	11.0
P_2	12.4	0	75	104.3	10.21	11.2	0	27	36.7	6.1
P_3	3.8	0	14	9.7	3.11	3.8	0	14	9.7	3.1
P_4	4.5	0	18	10.5	3.24	4.5	0	18	9.8	3.1
P_5	10.3	1	19	18.4	4.29	10.32	1	19	18.4	4.3

Note: S_s … number of simple sentences;
$S_c^{(i)}$ ..number of complex sentences consisting of i simple sentences.
Source: own processing

Table 1: Basic descriptive statistics for normal and knowledge texts.

H1.3: There is no difference in the mean value of the syntactic difficulty rate between Normal text and Knowledge text.

H1.4: There is no difference in the mean value of the semantic difficulty rate between Normal text and Knowledge text.

H2.1: There is no difference in the mean value of the coefficient of density of scientific and factual information per noun between Normal text and Knowledge text.

H2.2: There is no difference in the mean value of the coefficient of density of scientific and factual information per word between Normal text and Knowledge text.

H3.1: There is no difference in the mean of the number of simple sentences between Normal text and Knowledge text.

H3.2: There is no difference in the mean of the number of complex sentences with 2 sentences between Normal text and Knowledge text.

H3.3: There is no difference in the mean of the number of complex sentences with 3 sentences between Normal text and Knowledge text.

H3.4: There is no difference in the mean of the number of complex sentences with 4 sentences between Normal text and Knowledge text.

H3.5: There is no difference in the mean of the number of complex sentences with 5 sentences between Normal text and Knowledge text.

H3.6: There is no difference in the mean of the number of complex sentences with more than 5 sentences between Normal text and Knowledge text.

H3.7: There is no difference in the mean of the number of complex sentences in total between Normal text and Knowledge text.

H3.8: There is no difference in the mean of the average number of sentences per complex of sentences between Normal text and Knowledge text.

H4.1: There is no difference in the mean of the number of chosen words between Normal text and Knowledge text.

H4.2: There is no difference in the mean of the number of common words between Normal text and Knowledge text.

H4.3: There is no difference in the mean of the number of technical term words between Normal text and Knowledge text.

H4.4: There is no difference in the mean of the number of factographic terms between Normal text and Knowledge text.

H4.5: There is no difference in the mean of the number of figures between Normal text and Knowledge text.

H4.6: There is no difference in the mean of the number of recurring concepts between Normal text and Knowledge text.

Note: Working hypotheses and operational hypotheses do not form a hierarchy. For instance, there is no intention to understand hypotheses H4.1 – H4.6 as the particularization of the hypothesis H4.0. They are only of the same kind of the analysis (i.e. semantic difficulty of the text).

The following Table 2 shows the results of the paired t-test for dependent samples and the decision on whether we reject the above-presented null hypotheses, or not.

As indicated by Table 2, both forms of texts differ significantly in the following aspects:

N … number or words, $N(\mathrm{KT}) > N(\mathrm{NT})$;

T_S … syntactic difficulty rate, $T_S(\mathrm{KT}) < T_S(\mathrm{NT})$;

T_P … semantic difficulty rate, $T_P(\mathrm{KT}) < T_P(\mathrm{NT})$;

S_S … number of simple sentences, $S_S(\mathrm{KT}) < S_S(\mathrm{NT})$;

$S_c^{(4)}$ ..number of complex sentences containing 4 simple sentences, $S_c^{(4)}(\mathrm{KT}) > S_c^{(4)}(\mathrm{NT})$;

$S_c^{(5)}$ ..number of complex sentences containing 5 simple sentences, $S_c^{(5)}(\mathrm{KT}) > S_c^{(5)}(\mathrm{NT})$;

V_A … number of complex sentences, $V_A(\mathrm{KT}) > V_A(\mathrm{NT})$;

P … number of simple sentences per complex sentence, $P(\mathrm{KT}) > P(\mathrm{NT})$.

Variable	Type of text	Mean	Standard deviation	t-test value	P value	Hypothesis	Validity α = 0.05
N	normal	249.8000	32.62	-2.0493	0.044884	H1.1	rejected
	knowledge	255.6667	33.13				
U	normal	26.1167	8.24	0.6404	0.524364	H1.2	not rejected
	knowledge	25.5833	7.96				
T_s	normal	28.0115	25.94	4.149494	0.000108	H1.3	rejected
	knowledge	13.5023	10.10				
T_p	normal	22.0048	9.96	2.277690	0.026384	H1.4	rejected
	knowledge	19.7780	7.35				
h	normal	20.9395	10.22	1.2690	0.209409	H2.1	not rejected
	knowledge	20.2580	8.26				
i	normal	8.27834	4.88	1.7473	0.086172	H2.2	not rejected
	knowledge	7.63884	3.19				
S_s	normal	7.5167	2.90	9.7706	0.000000	H3.1	rejected
	knowledge	3.6667	2.50				
$S_c^{(2)}$	normal	4.5833	2.61	1.7810	0.080057	H3.2	not rejected
	knowledge	4.0833	2.31				
$S_c^{(3)}$	normal	2.2167	1.48	-1.9285	0.058608	H3.3	not rejected
	knowledge	2.6500	1.68				
$S_c^{(4)}$	normal	0.4833	0.77	-2.8013	0.006872	H3.4	rejected
	knowledge	0.7833	0.92				
$S_c^{(5)}$	normal	0.2000	0.40	-2.2560	0.027792	H3.5	rejected
	knowledge	0.3500	0.54				
$S_c^{(6+)}$	normal	0.1000	0.30	-1.8352	0.071522	H3.6	not rejected
	knowledge	0.2500	0.62				

Source: own processing

Table 2: Statistical analysis with the paired sample t-test.

Variable	Type of text	Mean	Standard deviation	t-test value	P value	Hypothesis	Validity α = 0.05
S_c	normal	7.5833	3.34	-1.8112	0.075194	H3.7	not rejected
	knowledge	8.1167	3.00				
V_A	normal	2.3930	0.54	-4.2878	0.000068	H3.8	rejected
	knowledge	2.7281	0.47				
P	normal	2.7000	1.82	-14.0022	0.000000	H4.1	rejected
	knowledge	9.5167	3.22				
P_1	normal	67.2167	13.55	0.6034	0.548555	H4.2	not rejected
	knowledge	66.5833	11.00				
P_2	normal	12.3833	10.21	1.3313	0.188226	H4.3	not rejected
	knowledge	11.2333	6.05				
P_3	normal	3.7966	3.11	0.3308	0.741982	H4.4	not rejected
	knowledge	3.7797	3.10				
P_4	normal	4.5167	3.24	0.0000	1.000000	H4.5	not rejected
	knowledge	4.5167	3.12				
P_5	normal	10.3167	4.29	-0.2346	0.815359	H4.6	not rejected
	knowledge	10.3167	4.29				

Source: own processing

Table 2: Statistical analysis with the paired sample t-test (continuation).

As more of the parameters shown above are correlated (e.g. if the number of complex sentences is higher for knowledge texts, we can assume that the number of words is also higher for knowledge texts, etc.), we visualize the comparison using box plots for the selected ones only (see Figure 1).

By applying the same approach to confirming the validity of the original working hypotheses H1.0 – H4.0 on the differences in characteristics among normal and knowledge texts, we obtain the results presented in Table 3.

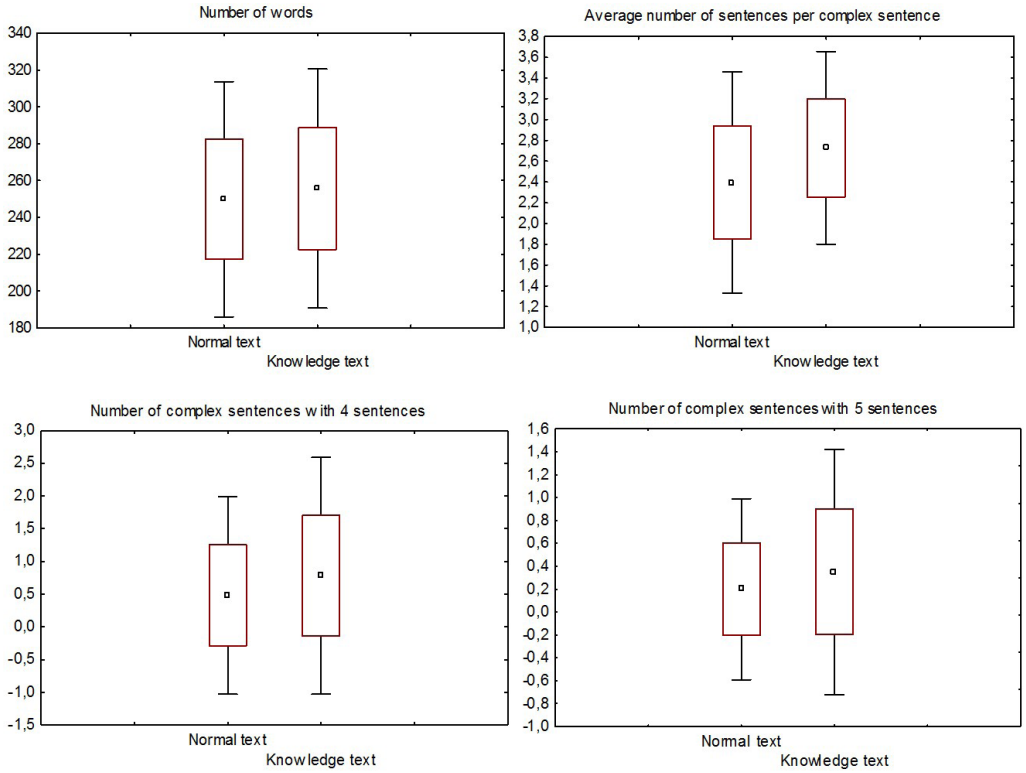
Except the H2.0 hypothesis on the differences in coefficients of density of technical and factual information between normal and knowledge texts, all working hypotheses are rejected for $\alpha = 0.05$. Our comments and the comparison with the works of other authors follow.

H1.0: There is statistically significant difference in the complex text difficulty rate between normal and knowledge texts. Normal texts achieve higher value than the knowledge ones.

At the first glance, it does not make sense. The authors, who are dealing with measuring the difficulty of texts in textbooks (e.g. McCrory, Stylianides (2014) or Miller (2011)), also show the dependence between the amount of knowledge in the text and the complex text difficulty rate as "the higher is the amount of knowledge in the text, the higher is the difficulty of the text". Explanation can be found in the way of calculating the complex text difficulty rate T as the sum of syntactic difficulty rate T_S and semantic difficulty rate T_P, see Eq. (2-4). Based on the rejected validity of the operational hypotheses H1.3 and H1.4 (both T_S and T_P values are significantly lower for knowledge texts than for normal texts), it is natural that the value of the complex text difficulty rate T is also lower for knowledge texts.

H2.0: There is no statistically significant difference in the coefficient of density of technical and factual information between normal and knowledge texts.

In contrast to our preliminary results (Rauchová et al., 2014), we have not confirmed the assumption on the differences between the texts in that characteristics. It is natural that the coefficient of density of scientific and factual information per noun h is independent on the style of the text. The number of nouns is always similar to the number of the terms in the text (see Eq. (5)). The main discrepancy between the preliminary research and the current results is caused by the coefficient of density of scientific and factual information per word i. Obviously, the variance played an important role in our preliminary research (see mean values and standard deviations for normal and knowledge texts in Table 2 for the parameter i) and roughly influenced our estimations.



Source: own processing

Figure 1: Box plots for selected parameters of normal and knowledge texts.

Variable	Type of text	Mean	Standard deviation	t-test value	P value	Hypothesis	Validity $\alpha = 0.05$
Complex text difficulty rate	normal	50.078	29.532	4.67358	0.000018	H1.0	rejected
	knowledge	33.333	13.823				
Coefficient of density of technical and factual information	normal	20.849	10.188	1.28765	0.202894	H2.0	not rejected
	knowledge	20.172	8.280				
Average number of simple sentences per complex sentence	normal	2.393	0.544	-4.2878	0.000068	H3.0	rejected
	knowledge	2.728	0.472				
Number of chosen word concepts	normal	2.700	1.825	-14.002	0.000000	H4.0	rejected
	knowledge	9.517	3.223				

Source: own processing

Table 2: Statistical analysis with the paired sample t-test (continuation).

H3.0: There is statistically significant difference in the average number of simple sentences per complex sentence between normal and knowledge texts. Knowledge texts achieve higher values than the normal ones.

This result is natural. We decompose the knowledge texts based on a formal model of the knowledge unit and its language form, respectively, see Eq. (1). The sentence always consists of two simple sentences expressing both antecedent and consequent parts of the unit at minimum. It is sometimes necessary to explain some part of the knowledge unit in more detail; as a result, the number of simple sentences becomes greater. This goes in line with mainstream literature on knowledge management or knowledge engineering. All authors, whose works we have studied, understand knowledge as enhanced data or information. This idea is really common nowadays and more applications, e.g. in agriculture (Rydval et al., 2014) or project management (Mochida, 2011) are based on it. Obviously, more words and simple sentences are required in order

to express knowledge than a statement containing information or even data only.

H4.0: There is statistically significant difference in the number of chosen word concepts between normal and knowledge texts. Knowledge texts achieve higher values than the normal ones.

In contrast to operational hypotheses H4.2 – H4.6, which concentrate on common terms, facts, technical terms, etc., the H4.0 hypothesis works with words typical for language expressions of knowledge units, mainly connectives (if, when, to, then, in order to, etc.). Here we can prove that even if there is no difference in the content of the statement (hypotheses H4.2 – H4.6 were not rejected), it can play an important role when electronic educational documents are assigned with metadata (Šimek et al., 2012), because there is no need to accompany the change of the text style with the change of the metadata. On the other hand, the formal structure of the knowledge text is too unique for the statistical analysis to be able to distinguish among normal and knowledge texts.

Conclusion

In this paper we analysed a relevant sample of educational texts on agriculture waste processing in order to investigate the differences among their normal and knowledge form. Compared to normal text, the knowledge text is characterized with sentences of more words (in average), higher occurrence of complex sentences to express the complete knowledge as well as relatively higher number of simple sentences per the complex sentence (again, in average). Particular word concepts and the intensity of their occurrence in the knowledge text allow us to differentiate both forms of text.

Several parameters, which can be used for distinguishing the texts, could serve for the purposes of further research on classification of general text as normal text or knowledge text and calculating the rate of correspondence of general text to knowledge text, respectively. In literature, we can find many kinds of analyses on document type classification (popular, narrative, scientific, etc.) or sentiment analyses of the content of documents (see e.g. Feldman, 2013 for systematic review of the current state in this area). Our results allow us to define a new type of such analysis.

Another important issue for further research is the readers' point of view. Even though we can measure and calculate that the complex difficulty of knowledge texts is significantly lower than of the normal one, we have to ensure that the readers' opinion will be in line with this theoretical assumption. Thus we are carrying out the experiment on perceiving the differences among the texts by human readers – practitioners working in agriculture and being responsible for agriculture waste processing. When these two connecting questions are answered, we will be able to evaluate the practical impacts of our theoretical findings achieved in this work.

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Supporting a Regional Agricultural Sector with Geo & Mainstream ICT – the Case Study of Space4Agri Project

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Abstract

Agriculture is a global issue nowadays. At the European level, it is a sector, in which we are investing many resources. In particular, the Agri-Food sector plays a central role in the policies of the European Commission and the Horizon 2020 research and innovation program, as well as being the main theme of Expo 2015 that will be held in Milan, Lombardy. In the Lombardy region, the farmers represent 2% of the entire population, cultivating about 80% of the agricultural land. Increasing needs to develop a common body of knowledge shared at the regional and national level so as to make it possible to effectively monitor cropping systems, water stress and impacts of climate changes affecting more frequently the territory, are becoming more and more urgent. In this context, the project Space4Agri (S4A) intends to support the regional and local needs in terms of management of the agriculture sector, by designing and developing an information and knowledge based platform for managing geospatial and mainstream information by making it accessible over the Internet by standard communication technologies (Geo&Mainstream ICT). This platform has been designed to allow data workflows integrating i) spatial data and observations, ii) non-spatial information available from existing agronomic databases, iii) data collected in the field by farmers, agronomists and volunteers using mobile applications, iv) data collected by unmanned aerial sensors, and/or data produced by researchers as a result of applying scientific analysis on high quality remote sensing data. Foreseen results of the Space4Agri project and from other similar ongoing research activities may significantly spur the socio-economic development of Europe and create new growth opportunities for companies, public administrations, students and citizens.

Key words

Agriculture, Geo & Mainstream ICT, Space4Agri, Lombardy.

Introduction

Agriculture is a global issue nowadays. Two principal factors are influencing the agricultural sector; one is an economist's view that agriculture is a key pro-poor strategy for economic growth (Batchelor et al., 2014, Charvat et al., 2014a). The second is a concern for food security, based on the recognition that natural resources are limited, farm sizes are getting smaller, populations are increasing, and that climate change and water scarcity threaten the security of basic food production (Batchelor et al., 2014). There is broad agreement that agricultural productivity needs to improve. The introduction of modern technologies to improve crop yield, provide information to enable better in-field management decisions, reduce chemical and fertilizer costs through more efficient application, permit more accurate farm records, increase profit margin and reduce pollution. In other words, farm with precision to optimize inputs and outputs. Even though technology has the potential to help alleviate the problem facing future generations, an integrated approach is needed to promote its use among farmers (Seelan et al., 2003). The ways in which agriculture should be developed remain hotly debated (Batchelor et al., 2014). At the European level, it is a sector, in which we are investing many resources. In particular, the Agri-Food sector plays a central role in the policies of the European Commission and the Horizon 2020 research and innovation program, as well as being the main theme of Expo 2015 - Feeding the planet energy for life, which will be held in Milan, Lombardy. The Lombardy region is Italy's leading agricultural

area; the farmers represent 2% of the entire population, cultivating about 80% of the agricultural land (Acutis et al., 2014). Modern agriculture has a major impact on the environment (Charvat et al., 2014a). Farms and pastures can cause erosions, desertification, chemical pollution and water shortages, these risks need to be monitored and managed in an effective and efficient way (Lackóová et al., 2013). One way for an improved sustainable agriculture is the application of geoinformatics. Agro-geoinformatics, a branch of geoinformatics, is critical for agricultural sustainability, food security, environmental research, bioenergy, natural resource conservation, land use management, carbon accounting, global climate change, health research, agricultural industry, commodity trading, economy research, education, agricultural decision-making and policy formulation. Agro-geoinformatics, is the science and technology about handling digital agro-geoinformation, such as collecting, processing, storing, archiving, preservation, retrieving, exploring, transmitting, accessing, visualizing, analysing, synthesizing, presenting, and disseminating agro-geoinformation (Han et al., 2012). Agro-geoinformation, can play a key role in the agricultural decision-making and policy formulation process. Recent advances in geoinformatics have created new opportunities to apply agro-geoinformation for agricultural management, monitoring, and planning (Kaivosoja et al., 2014). Geospatial irrigation data that is detailed, comprehensive, consistent, and timely is needed to support studies tying agricultural land use change to aquifer water use and other factors (Brown et al., 2014).

Within this frame, the Space4Agri (S4A) project aims at developing innovative methodologies for the integration of earth observations into monitoring activities of the agricultural sector in Lombardy (http://space4agri.irea.cnr.it/it). The objective of S4A is to answer the needs from a regional and national level for the agro-food sector to support in an efficient and effective way the planning and management of cropping systems, providing information on water stress and impacts of changing climate affecting more frequently the territory. In this context, the project intends to design and develop an information knowledge platform for managing geospatial and mainstream information based on standard communication technologies (Geo & Mainstream ICT). The S4A project consists of seven work packages (WP): WP1, examining the state of art of the user and system needs. WP2, WP3, and WP4 are the core of the project covering the three main technological and scientific areas SPACE, AERO and IN-SITU, respectively. The first focuses on the data analysis performed on remote sensing, (extraction of crop information data acquired by Earth Observation systems). The second aims at designing and developing software interface for flying planning and control of Unmanned Aerial Vehicles (UAV or drones), and finally the third develops a system for both acquisition of in-situ data and sharing and dissemination of all the data created relevant for the project. The interaction of these three WPs will allow integration of:

- Satellite data for monitoring of the environment and the territory (SPACE).
- Aeronautical technologies, such as a UAVs or drones, which will be more precise in monitoring and promoting the understanding of the agro dynamics at the local scale (AERO).
- Smart technologies and methodologies to capture, collect and exchange information via sensors or through reports from operators in the agricultural sector (IN-SITU).

WP 5 will test the methodologies developed within WP2, 3, and 4. WP 6 will evaluate the economic impact of these developed technologies on the Lombardy region and finally, WP7 is in charge of project's dissemination and divulgation activities.

Very few public bodies, in Italy, maintain an active SDI with a portal to make in situ data available routinely; among them meteorological data are the most common type of data published by, for example, Emilia Romagna (ARPA_EMR), Lombardy (SIAR_L, and ARPA_L), Tuscany (ARPA_T), Puglia (SIAR_P), Veneto (ARPA_V) and the Ministry of Agriculture (Ministero delle Politiche Agricole Alimentari e Forestali).

Within the S4A project, WP4 has the objective of developing smart technologies to validate and calibrate products derived from satellite data or acquisitions by drones and or to support the collection of in-situ observations regarding crop status and development as well as alert situations in Lombardy. This information is useful in the ordinary management of agriculture, and in case of alert resulting from stress conditions or diseases of crops. The data will come

from in-situ sensors (such as infrastructure of agro-meteorological stations), or will be collected through special applications (App), the so-called „human sensors", i.e. operators in the field. Among these operators, in addition to farmers, volunteer users may also be involved, as individual citizens or students cooperating in the project. According to the latest experiences of citizen science, nowadays spread globally, many volunteers actively contribute to scientific research. Furthermore, data collection by citizens was reported with a higher frequency comparing to data collected by public bodies (Charvat et al., 2014b).

The present article will describe the results achieved so far in building the S4A information and knowledge platform supporting the following objectives of IN-SITU (WP4):

1. To design and implement a Spatial Data Infrastructure (SDI) for the management and sharing of images and products obtained from the processing of remotely sensed data. Additionally, measurements from the sensors, data from existing databases, and agronomic data from in-situ observations acquired by the actors of the agricultural world using smart technologies developed within the project itself.
2. To provide information specific to the user profile (public, administration) and location (farmer) on regional level based on analysis performed on data collected and managed by S4A SDI.

Materials and methods

General Uses Cases of the Space4Agri information and knowledge platform

This section gives an overview of the three use cases based on experts' knowledge of the domain that have been a foundation for the design and implementation of the S4A information and knowledge platform. The use cases represent the roles of users and the flow of data starting from acquisition by meteorological stations, sensors on satellites or drones, and experts in the field, to further processing to yield new valuable information, and dissemination by communication channels to targeted stakeholders. The three proposed use cases have been modelled and are described in the following text.

Use case 1. Distribution of authoritative agro meteo information to target users

Figure 1 schematically represents the workflow of how data from heterogeneous sources are collected, processed, and transformed for allowing the regional operator and the decision maker, to efficiently visualize and analyze them in order to provide end users (the public and farmers), with synthetic relevant information on ongoing agro-meteo and crop conditions in the form of bulletins. The dissemination channel must select and send the personalized information using the most suitable means (emails, web portal, and/or sms) that is relevant to each target user. The workflow is assembled by a starting phase of data collection by different sources as meteorological stations, satellites, and in-situ by experts and farmers through smart applications installed on their mobile devices. This information is integrated into SDI and processed by experienced researchers/analysts. The outputs of the analysis is turned into knowledge by experts and provided to the decision makers who may exploit it for taking decisions on the policies for the agro sector, and may identify and communicate personalized relevant information to the stakeholders, the public and farmers.

The use case fosters the application of Smart technologies for both collecting in-situ observations (qualitative and quantitative) performed by experienced operators using mobile devices and publishing them in real time on the Internet; it also considers disseminating personalized information to stakeholders based on their interests, type of crops they cultivate, and context, region where their estate is located and current season. Remote observations can be used for the identification of anomalies of crop conditions due, for example, to abiotic and biotic factors (Hatfield, Pinter, 1993; Qin, Zhang, 2005; Bhattacharya, Chattopadhyay, 2013). Satellite data can be analysed in conjunction with field observations and data acquired by meteorological station networks to produce additional spatially distributed information on crop development (crop phenology), crop status and, with the support of crop growth models, yield forecast (Nouvellon et al., 2001; Doraiswamy et al., 2004). The final goal of this use case is the provision of the relevant personalized information that is currently under-utilized or not publicly available to farmers and the public through newsletters, bulletins or other means of communication and practices.

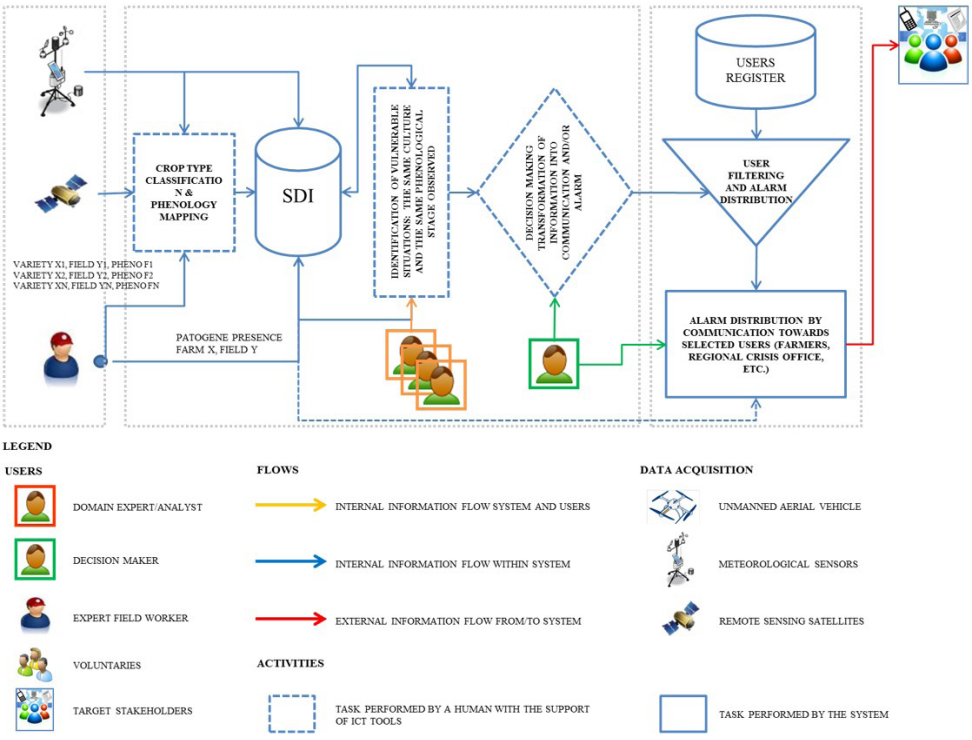

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Figure 1: Schematic representation of the workflow representing the use case 1 (the legend applies all use case diagrams).

Use case 2. Generation of information on anomalous states of the crop

Figure 2 represents the workflow of how the data are collected, processed, analysed and transformed for the dissemination of information on anomalous states of the crops. As described in the use case 1 the workflow is assembled by a starting phase of data collection. The crop typology (Fontanelli et al., 2014) and stages are detected by remote observations through the computation of indicators and/or in-situ observations collected by volunteers (Voluntary contribution by students, citizens). The observations of critical conditions (stress/late season crop) in agricultural areas of the Lombardy region trigger an alert map that is published in S4A SDI thus highlighting that something anomalous might be ongoing. The regions affected by the anomaly shown on the alert map are more closely analysed by experienced researchers/ analysts. The output of the analysis can provide either knowledge on the actual ongoing situation or uncertainties that may require further in-situ investigations at a local scale in specific regions, possibly by planning flights of UAVs or field surveys, in order to verify if something anomalous is actually occurring. Both knowledge and advices to perform further investigations are delivered via communication channels to the decision makers so that they may take decisions in the early warning phases and send alerts to the stakeholders on the current critical situation or guide operators in the field to check the status of the crops.

Use case 3. Knowledge based forecast of potential critical situations

The workflow schematically represented in figure 3 shows how data are collected, processed, analysed and transformed for communication of knowledge-based forecast of potential future critical situations. As described in the previous use cases the workflow is assembled by a starting phase of data collection by Meteorological station, satellites, and by experts. Additionally observations from drones can be included if available. These observations of a critical condition (stress/late season crop) are cross analysed by the expert with respect to the specific season drivers (meteorological and agro-practises) to foresee the possible evolution of a critical situation. The output of the analysis is converted into maps on a possible evolution of the critical situation of the crops in specific areas, and is distributed via communication channels, to the decision makers. The final stage is a filtering and dissemination

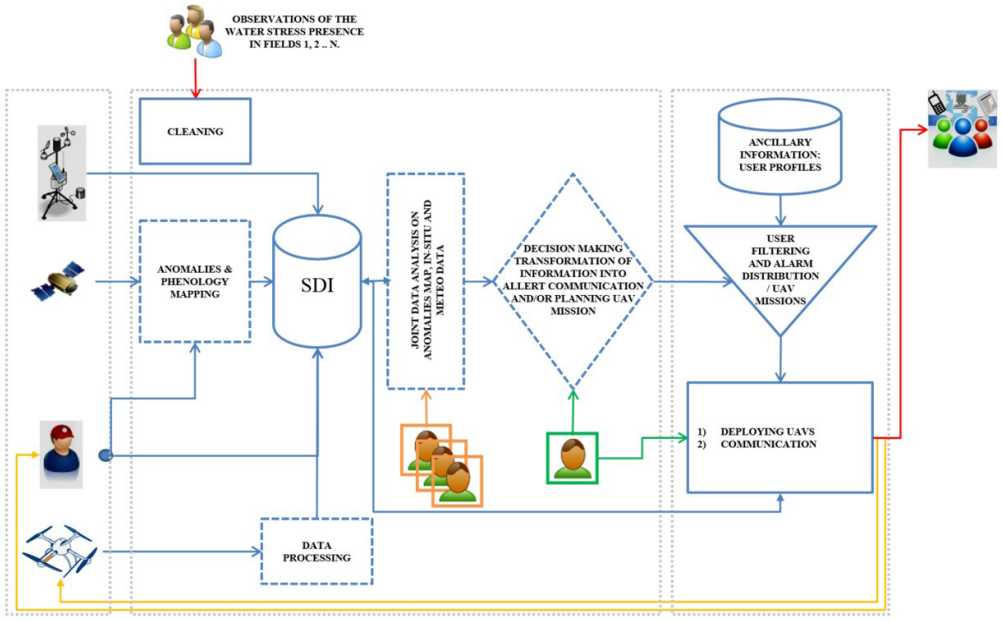

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Figure 2: Schematic representation of the workflow representing the use case 2.

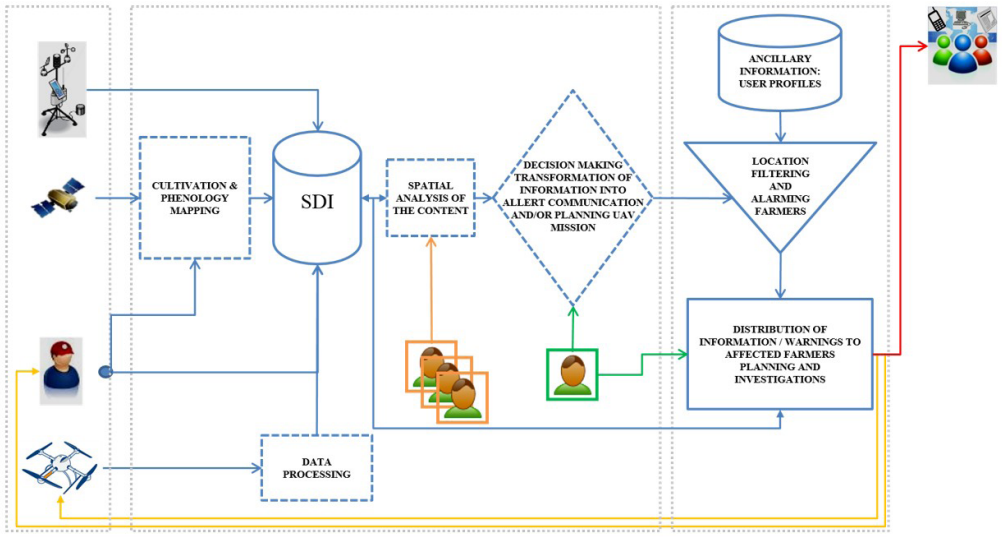

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Figure 3: Schematic representation of the workflow representing the use case 3

of the forecasts and distribution of possible advices on how to prevent the crisis to target stakeholders.

Architecture of the S4A information and knowledge based platform

The overall architecture of the S4A platform is depicted in figure 4, encompassing also representations of applications developed or deployed and configured to the project needs.

S4A Core Methods component

The core of the platform consists of three basic layers defined in the computer software developments. **Application layer** is an abstraction layer reserved for communications protocols and methods designed for process-to-process communications in the Internet model. **Domain layer** is the part of the program that encodes

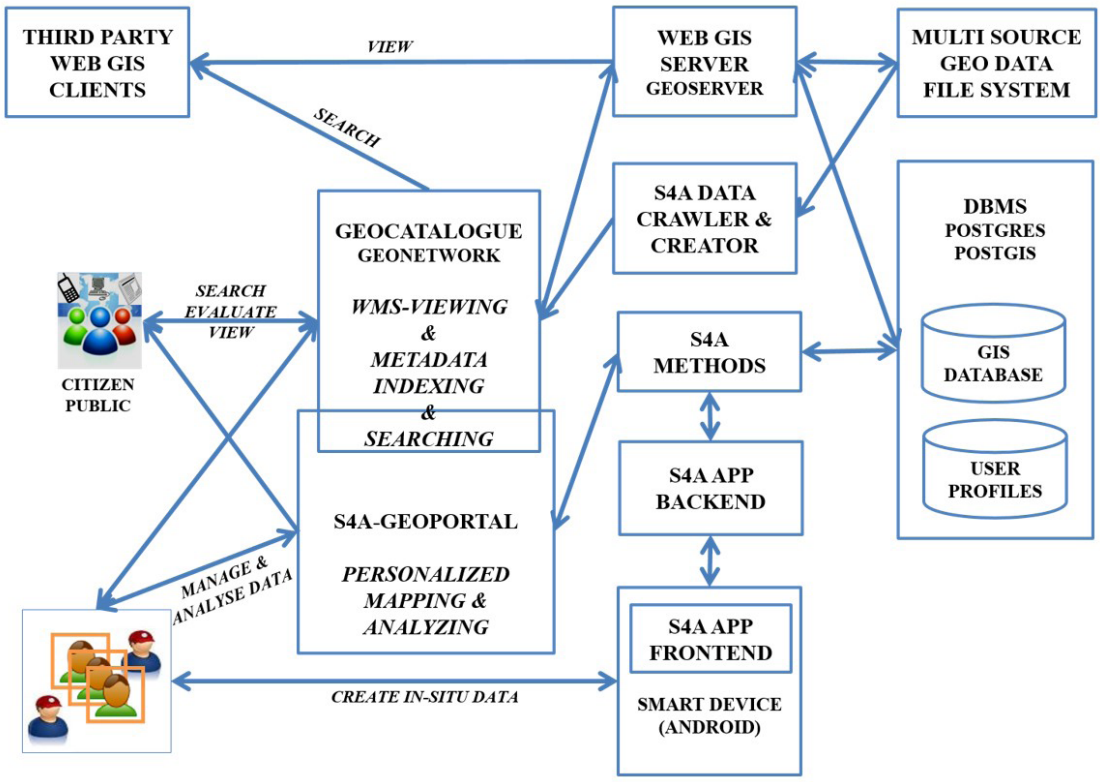

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Figure 4: Main components of S4A information and knowledge based platform.

the real-world business rules that determine how the data can be created, displayed, stored, and changed. **Data access layer** is a layer of a computer program which provides simplified access to data stored in persistent storage of some kind, such as an entity-relational database. Web service component allows users applications (e.g. S4A mobile application) interacting with the core layers in a standardised REST (Representational state transfer) manner. REST has become a popular method for publishing **Web services** as a Web-friendly alternative to SOAP, which is primarily focused on defining and addressing web resources (like documents and images) and for managing their representations (Riva, Laitkorpi, 2009). **Web layer** encompasses end-user applications allowing human interactions with the platform through the World Wide Web system with a web browser. The core components of the platform are being implemented with Java programming language.

Web GIS server component

In order to provide a straightforward and standardized way of handling different sources of the geospatial data, a Web GIS server application has been incorporated into the platform architecture. Common set of functionalities for a Web GIS server can be dissemination of maps, query, search, feature editing, transformation, advanced geoprocessing, delivery of Web Services (OGC, REST), in a customizable and scalable way and with acceptable performance measures (Fu, Sun, 2010). Requirements originating from the use cases include management and publication time series of geospatial raster (Remote Sensing images, or outputs from data analysis) and vector (agriculture, meteo data) datasets. Additionally various spatial analysis are requested as well as statistical representations of time-series raster data of vegetation, meteo and other indexes (NDVI, EVI, NDFI). An important component of the S4A platform is a database management system (DBMS). Since the most data relevant for the project are georeferenced, a GIS database has been defined as a system component. GIS database allows handling and integrity of spatial data with consistent DBMS through spatial data formats and functions definitions and all this in high performance with high data

volumes (Fu and Sun, 2010). In order to accomplish the requirements on S4A Web GIS server component, we have used GeoServer opensource software, which is designed to ensure interoperability by publishing data from any major spatial data source using open standards (Giannecchini, Aime, 2013). Relevant geospatial data are being published on S4A GeoServer instance from the data server devoted to remote sensing experts from the institutes involved in the project. Currently products of remote sensing data as phenology classification maps of vegetation indexes are made available as raster data layers for viewing (WMS – Web Map Service) and downloading (WCS – Web Coverage Service) (Fig. 5).

Vector data of agricultural parcels and observations collected by the smart mobile application are stored in the a GIS database described in the next section and exposed via GIS server in the web, this available for viewing (WMS) and downloading (WFS – Web Feature Service) from within any OGC compliant GIS clients (Fig. 6).

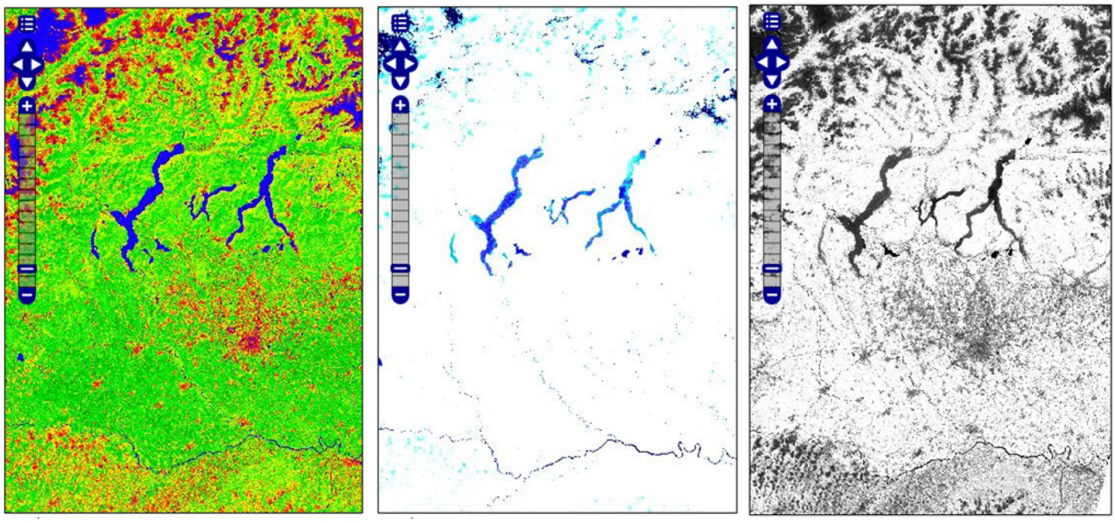

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Figure 5: Raster data published on the web as vegetation and meteo indexes maps via OGC WMS.

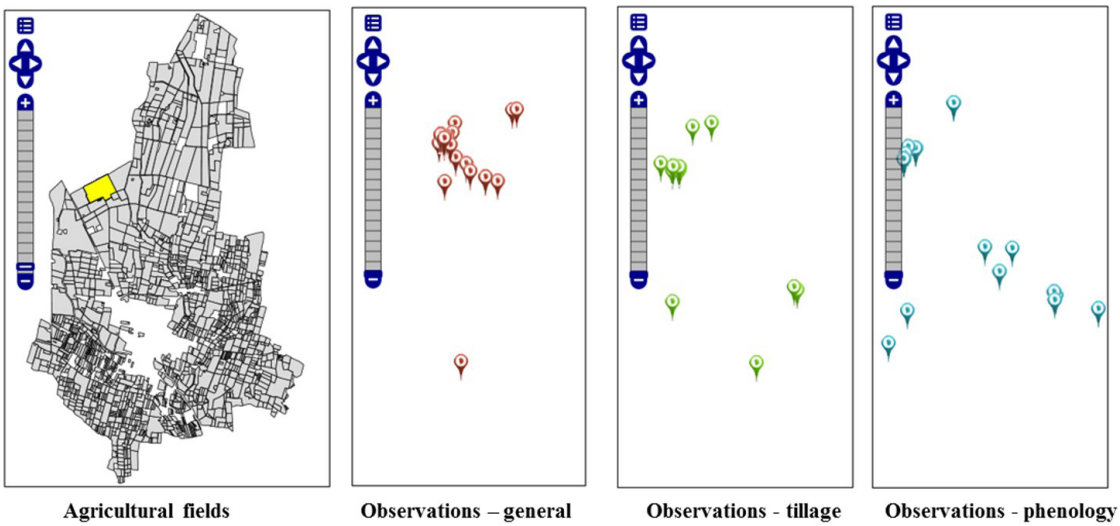

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Figure 6: Vector data published on the web as map features via OGC WMS.

DBMS and S4A database model

The underneath GIS database has been implemented using PostgreSQL, which is an opensource object-relational database management system (ORDBMS) with an emphasis on extensibility and standards-compliance. Additionally, it allows to manage geographic objects through its extension – PostGIS, which is opensource and freely available to download and install. PostGIS adds extra data types (geometry, geography and others) to the PostgreSQL database. It also adds functions, operators, and index enhancements that apply to these spatial data types. These additional functions, operators, index bindings and types augment the power of the core PostgreSQL DBMS, making it a fast, feature-plenty, and robust GIS database management system (Obe, 2011).

The database model is built on six basic concepts and relationships among them (Fig. 7) modelled as follows: an agricultural field (S4A_FIELD_FEATURETYPE), which represents a piece of territory delimitated by boundaries with information about a tillage status on it (S4A_FIELD_TILLAGE) with an aggregation of information about a culture type cultivated (S4A_FIELD_CULTURE), phenological stage of the respective culture (S4A_CULTURE_PHENOLOGY) and geospatial reference of geometry based on existing data about agricultural parcels provided by SIAR Lombardy (SIARL_AGRI_PARCELS). S4A_CULTURE_PHENOLOGY package is defined as a list of culture types with crop stages, each one with its own timestamp. It can have a geospatial reference of a point type or be associated to a field.

In-situ observations modelled for mobile application can be of three types: (1) General observation of any kind of information related to the project context or beyond; (2) Observation of a phenological status of a particular crop and (3) observation of tillage on a particular field. General observation is modelled by the feature type S4A_OBSERVATION shown in figure 8. Observations collected by expert users are assigned to a field based on coordinates and spatial relation to the fields' boundaries. On the other hand the observations collected by volunteers are represented as points features acquired in the field.

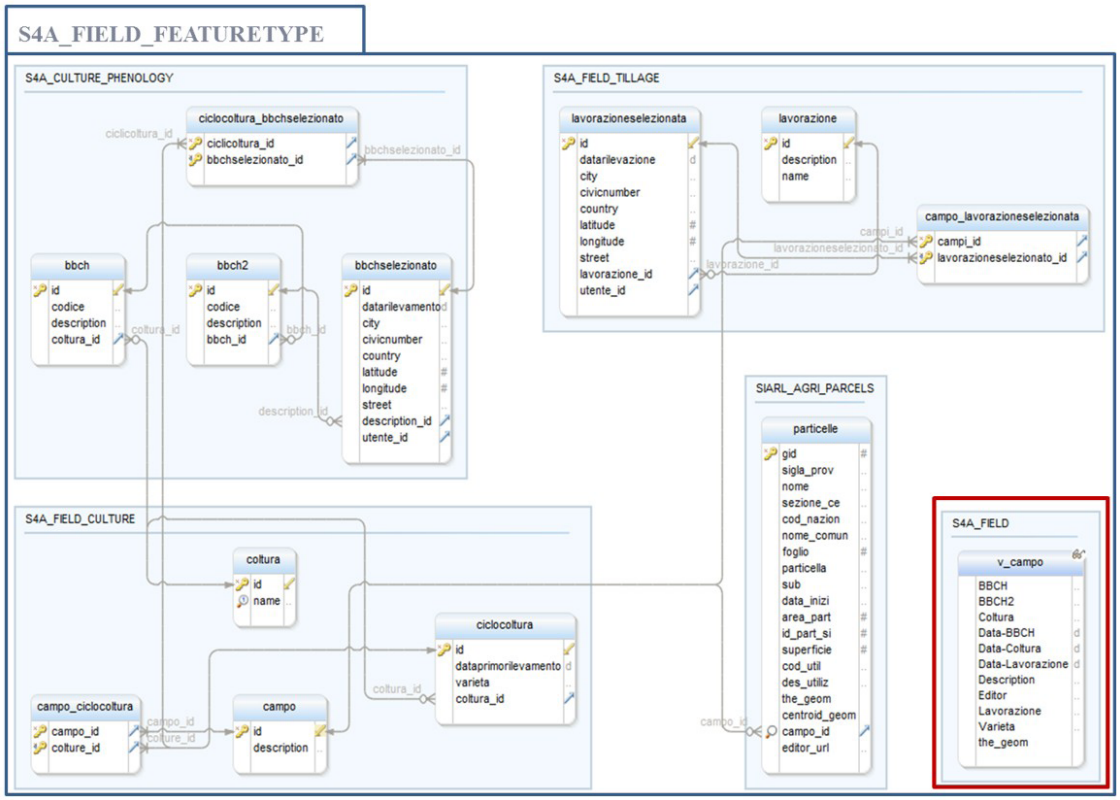

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Figure 7: Model of the S4A_FIELD_FEATURETYPE aggregating information about culture, phenology, and tillage .

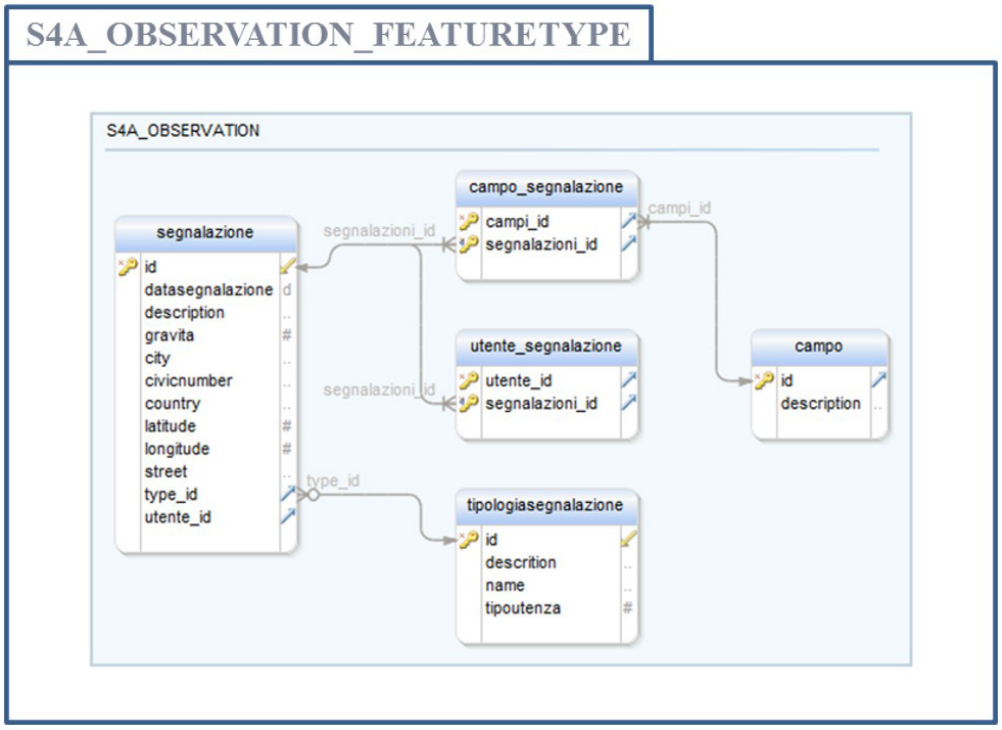

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Figure 8: Model of the S4A_OBSERVATION_FEATURETYPE covering both expert and volunteer users.

Space4Agri mobile app

Another component integrated into the S4A platform architecture is a mobile application, which provides an interface for users collecting in-site data. A mobile app is a computer program designed to run on smartphones, tablet computers and other mobile devices. The one implemented in S4A has been developed for Android platform. It allows registered users to create information in the form of a free text description, and/or photograph of the land. Additionally, categorized information to specify the crop type, phenological status and field tillage can be collected. The crop status has been implemented on a base of an agronomic ontology - BBCH (Dal Monte et al, 2010).

Geocatalogue

The geocatalogue indexes and maintains metadata records of S4A spatial data and thus allows searching for desired information sources about a specific semantics the user is interested in. This facility is offered to ease the selection based on a data fitness of use, obviously when the volume will be huge. GeoNetwork opensource software has been used to implement the described functionality. The metadata is created for each dataset published as a WMS layer with Web GIS server described above, extended by theme specific information and made available via publicly available web portal. Geocatalogue application embeds also a geospatial data viewing functionality, which is provided to the user. In this manner, the data can be searched, elaborated and used.

S4A Geoportal

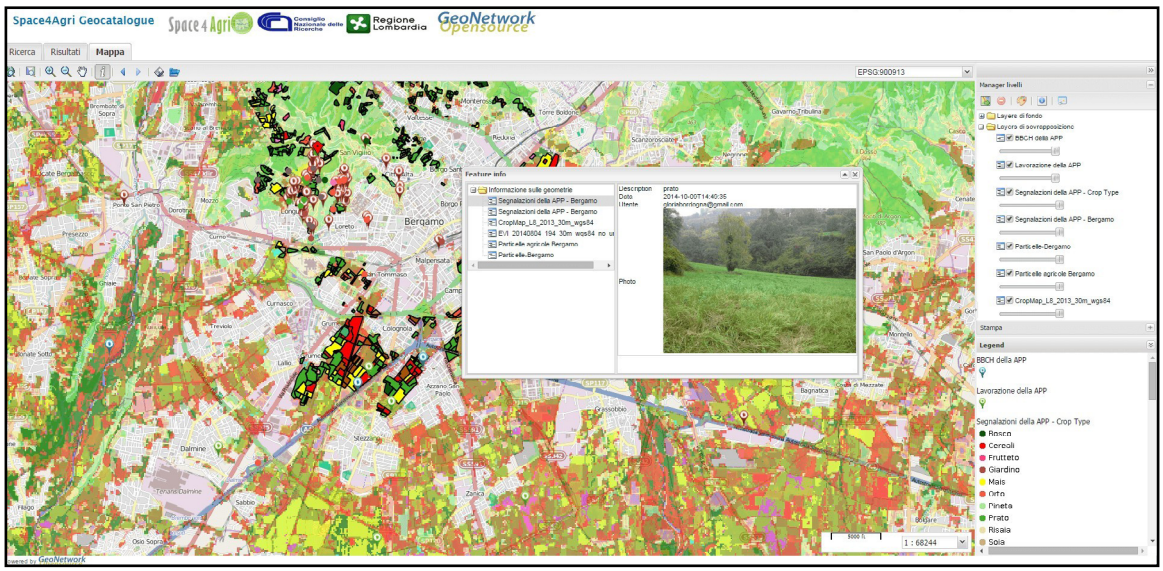
An important component from the user perspective, which is currently in the development phase, is a personalized geoportal application. The geoportal will in addition of advanced functionalities as e.g. time-series data elaboration, data downloader tool, provide a personalized way to access the relevant data based on information stored in user profiles database. Authorised users will be able to visualize the content (e.g. agricultural parcels, or field observations, thematically related datasets) linked to their account at the initial login into the geoportal. Geoportal is being developed within the same framework as the core S4A methods components in order to ensure efficiency in communication to the core methods. Naturally, methods and functionalities available from the currently existing open source solutions (e.g. GeoNetwork and GeoServer) will be incorporated into new developments.

Results and discussion

S4A platform is the result of innovative combination of three components of the technical-scientific domain: Technologies Aerospace, Earth Observations and Geo & Mainstream ICT.

The first three main ICT results achieved in the projects at the current state are the following:

1. An Integrated data platform for publishing and serving S4A geospatial data products: this is implemented through the Geoserver toolkit and actually manages a) vector layers of the cadastral parcels of the estates of the farmers involved in the project located in 14 distinct municipalities; b) raster images of indicators which are resulting from remote sensing data analysis, such as NDVI (Normalized Difference Vegetation Index), EVI (Enhanced Vegetation Index), Chlorophyll concentration, NDFI (Normalized Difference Fraction Index); c) geotagged free text reports, possibly associated with a photograph, d) geotagged phenological categorizations of the crops' stages based on BBCH taxonomy; and e) geotagged categorizations of tillage observed in fields, generated through the Smart APP by Volunteers and Farmers. This platform is compliant with OGC web services (WMS, WFS, WCS and CSW) and thus all layers listed above can be discovered and served to any OGC compliant application with use of CSW, WMS, WFS and WCS interfaces. The main originality of the S4A lies in the integration of authoritative information (e.g. SIARL data), research information (CNR/IREA remote sensing products) and volunteers' information (collected by S4A app) in an integrated data platform.
2. A catalogue service to search for specific thematic layers served by the S4A platform with embedded geospatial data viewer to display results of search in an overlay mode in order to facilitate correlations analyses between indicator maps and in-situ field observations, textual reports and fields' practices.
3. A final important result of the project is the smart app currently available for mobile devices powered by Android, which allows the collection of in-situ observations related to i) field condition and management (tillage dates and agronomic practices), ii) crops (type, varieties and phenological stage in BBCH scale) and iii) conditions indicating the presence of the parasite. The application, currently in the prototype beta version, will be made available to the operators of a public administration, farmers, researchers, students and the public who want to be involved in the project activities.



Source: own processing

Figure 9: S4A integrated data platform presentation layer for data discovery and use deployed on GeoNetwork opensource and connected with GeoServer via OGC interfaces.

Conclusion

The S4A project is in its halftime, thus the results represent the prototype solution, which can be used for the technology transfer in the real implementation in the regional or national agricultural sector. Nevertheless, beta version of the S4A platform components is running and currently in the testing phase. One of the following steps in this respect will be to introduce the S4A platform and particularly the S4A APP to voluntary farmers and students of agricultural high schools in the region as potential representatives of volunteers in order to provide a test-bed of the S4A products as well as support educational process.

Additionally, the remote sensing experts discovered advantages of having their data published through an SDI, thus they tend to provide more data for publishing almost on a daily basis. As an example, instead of searching for data in the file system of the data server (e.g. IREA data server has capacity 100TB and more than 90% is used), they may use an SDI catalogue to search and OGC services to use the data directly in their tools (e.g. GIS clients as QGIS) that the use on a daily base.

The S4A project has shown already quite high potential of integrating the geo and mainstream ICT into a common platform, while developing a complex information system for a specific domain, e.g. agricultural sector.

The data available through the S4A platform may significantly support regional administration, which is distributing funds among farmers, in the verification process. Farmers' declaration versus analysed status resulting from a combination of heterogeneous data sources as remote sensing products, in-situ observations collected by mobile devices and monitoring data acquired from UAV missions. The final score may bring significant savings of public sector expenses as well as join forces together in order to enhance the current situation in agricultural sector, and not only there.

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Open Land Use Map

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Anotace

Open Land Use Map je iniciativa, která byla spuštěna v rámci projektu Plan4business a která bude dále rozšířena v rámci projektu SDI4Apps. Tato služba si klade za cíl vytvořit mapu využití půdy s celosvětovým pokrytím. Úvodní mapové podklady budou tvořit data Corine Land Cover, Global Cover a Open Street Map. Přispěvovatelé, především dobrovolníci, budou moci měnit geometrii vzhledů jevů a přiřadit aktuální využití půdy dle klasifikace HILUCS. Podrobnější datové sady budou využívány ke zvýšení úrovně podrobnosti open Land Use Map. Výsledkem bude báze otevřených dat, která budou dostupná v různých formátech a pro uživatelem vybrané území. Tento článek popisuje technické a obchodní aspekty aplikace Open Land Use Map včetně integračních a harmonizačních nástrojů, plán udržitelnosti a aplikace doplňující celou platformu.

Klíčová slova

Integrace dat, využití půdy, otevřená data, obchodní plán, udržitelnost, INSPIRE.

Abstract

Open Land Use Map is an initiative that has been started by the Plan4business project and that will be extended as part of the SDI4Apps project in the future. This service aims to create an improved worldwide land use map. The initial map will be prepared using the CORINE Land Cover, Global Cover dataset and Open Street Map. Contributors, mainly volunteers, will able to change the geometry and assign up-to-date land use according to the HILUCS specification. For certain regions more detailed datasets, if available, will be used as an update of the Open Land Use Map. The product is treated as Open Data and users will be able to download the data in a specified format and for a selected area. The paper introduces the technical and business aspects of Open Land Use Map app including the integration and harmonisation tools, sustainability plan and apps that accompany the entire platform.

Key words

Data integration, land use, open data, business model, sustainability, INSPIRE.

Introduction

"Land use and land management practices have a major impact on natural resources including water, soil, nutrients, plants and animals." (Hart, 1996). The term land cover is often mistakenly used instead of the term land use. Kannegieter (1998) uses land use as a combined data theme including land use and land cover. However, their actual meanings are quite distinct. Land cover refers to the surface cover on the ground. The INSPIRE Directive (European Parliament, 2007) defines land cover as "physical and biological cover of the earth's surface including artificial surfaces, agricultural areas, forests, (semi-)natural areas, wetlands, water bodies." (INSPIRE, 2012). Land use is defined as "territory characterised according to its current and future planned functional dimension or socio-economic purpose (e.g. residential, industrial, commercial, agricultural, forestry, recreational)." (INSPIRE 2012)

On the one side, there are global mapping initiatives for land cover mapping (e. g. CORINE Land Cover, Africa Cover, Global Cover) and voluntary initiatives such as Geo-WIKI for updating global Land Cover Maps. The idea of collecting spatial data by citizens is described by Goodchild (2011). Heipke (2010) explains the basic technology needed for crowdsourcing geospatial data, discuss the underlying concepts including quality issues and give some examples for this novel way of generating geospatial data.

On the other hand, there are no global initiatives for land use mapping. The only sources of land use are heterogeneous and scattered data from local and regional levels. Cerba (2008) describes in detail the aspects of heterogeneous spatial data. The problem of land use data heterogeneity was the main challenge for the Plan4business project. This EU co-funded project aimed at harmonising and integrating spatial planning data sets so they can be used for cross boarder information and analysis services. Charvat et al. (2013) explains why there is a need to harmonise data. Müller (2013) presents some of the interoperability issues of land use data.

The work started in the Plan4all project by defining the land use application schema which was then used for the INSPIRE Data Specifications on Land Use (Camerata et al., 2011). The Plan4business project developed a platform that can serve to users as a catalogue of land use and planning data such as transport infrastructure, regional plans, urban plans and zoning plans. The platform represents not only a central access point for integrated, harmonised and thus ready-to-use formatted data, it moreover offers rich analysis and visualisation services via an Application Programming Interface (API) and an interactive web frontend. As a result, a large data pool of integrated land use and open data was created.

The Plan4business platform offers not only data but also tools and apps for different user groups:

- data providers - planning authorities, engineering bureaus and researchers who provide data into the platform using the Plan4business tools,
- data curators - who perform integration and quality assurance,
- clients and data brokers - who will be hosting and exploiting the Plan4business platform and its apps.

The Plan4business platform is twofold. On the one side, there is an Open Data Platform which is accessible for free and contains mainly open data. On the other side, in order to keep the platforms sustainable, there will be a Commercial Platform which revenue will be generated via on-demand and subscription services to different customer groups ranging from environmental and planning authorities and companies to banks and real estate companies and developers.

The Plan4business developments and results serve as a basis for another EU co-funded project Uptake of Open Geographic Information Through Innovative Services Based on Linked Data (SDI4Apps). SDI4Apps will exploit the integration tools and the Open Data Platform developed in Plan4business for one of its pilot applications – Open Land Use Map. This application is focused on land use data collection through voluntary participation, data integration, harmonisation and visualisation.

Objectives

Land use data, urban and regional planning data sets were not aggregated so far, and thus it was very laborious to use them for any other purpose than for printing or simple publishing by the authorities that collected them. Creating time series or comparative analyses on these data sets was not yet possible; researchers, spatial planners and professionals from the real estate world and other disciplines, such as insurance industry, investors, or market-relevant activities related to urban development have a growing stake in such capabilities.

There is neither global nor European initiative for mapping land use on local and regional levels. The INSPIRE land use represents scattered resources of various quality and with limited coverage in Europe. The CORINE Land Cover (CLC) is land cover map, not land use map. Moreover, the map is too generalised for regional and local purposes. The Urban Atlas is only for major European cities and does not cover rural areas and remote suburbs of cities.

The needs for a European land use map were expressed during the collection of requirements within the Plan4business project. The voluntary approach is the only way how to perform the collection of data with minimising the costs. The intention of Open Land Use Map is to start support voluntary initiative for open land use

mapping. The initial work was already done in Plan4business and the initiative currently continues under the SDI4Apps project.

Materials and methods

The work is divided into the next steps:

- Define data model for land use mapping based on the Hierarchical INSPIRE Land Use Classification System (HILUCS).
- Transfer existing data and build initial land use map as a combination of different sources:
  - Land use from Open Street Map,
  - Land cover datasets (CORINE Land Cover, Global Cover) which include information on land use,
  - National information sources such as cadastral data in the Czech Republic.
- Make Open Land Use Map publicly available.
- Deploy SDI4Apps mobile and desktop interface for updating of Open Land Use Map.
- Deploy harmonisation tools for updating of Open Land Use Map using existing available open data.

The Open Land Use Map will become freely available for download and accessible through OGC interfaces, but also through Application Programming Interfaces (API) developed within SDI4Apps.

The Open Land Use Map will use the following available global data sources:

- European and global land use and land cover data including CORINE Land Cover, Urban Atlas, Global Cover, Africa Cover;
- Land Use Data from Plan4business and other projects;
- Regional, local, spatial and urban plans of the SDI4Apps partners;
- Publicly available land use data.

Sustainability of the Open Land Use Map

The main aspect of all emerging initiatives is to secure their sustainability. The idea is not only to build an open data set for land use but also to offer a set of added value commercial services. From the business model point of view, there will be two main platforms with the following pricing:

Open Data Platform (ODP) – a data hub containing open data, management and harmonising tools, open applications (e.g. Open Land Use Map). All the services will be available for free with no restrictions. Any party can access the data pool and make commercial or non-commercial apps based on these data. The use of the data must be in line with data licences.

The non-profit ODP will have the following sources of financing in order to keep it sustainable:

- In-kind contributions - sponsorships of companies contributing to the system maintenance, server infrastructure, update and upgrade.
- Future project contributions – there is a number of future projects (e.g. Smart Open Data, SDI4Apps, Open Transport Net, FOODIE) for which the portal can serve for their purposes. The projects would not only use the data but they would also feed the platform with new data. These projects could contribute to the system maintenance, server (cloud) infrastructure and new tools development.
- Advertisement - the hub will offer space for advertising.
- Public funding from the side of organisations who don't want to build their own infrastructure or who would like to support the Open Data Platform.
- Other contributions.

Commercial Platform (CP) – a data hub containing restricted data and commercial apps and tools. The restricted data hub includes all data that cannot be included in the ODP. The CP will be used for commercial applications and in line with data licences. Restricted data will be either not available for download or there will be a possibility to download the data only for a certain group under given conditions and in line with data licences. The incomes will be composed of:

- Advertisement with the focus on concrete user groups (e.g. real estate businesses).
- Data hosting for public and private bodies who don't want to make data freely available, but they need to publish their data.
- Profits from the commercial apps.

- Payments from the project partners for the infrastructure utilisation.
- Payments from third parties accessing the CP or offering the commercial apps in other counties and regions.

Figure 1 shows these two platforms, associated apps and tools and the potential users.

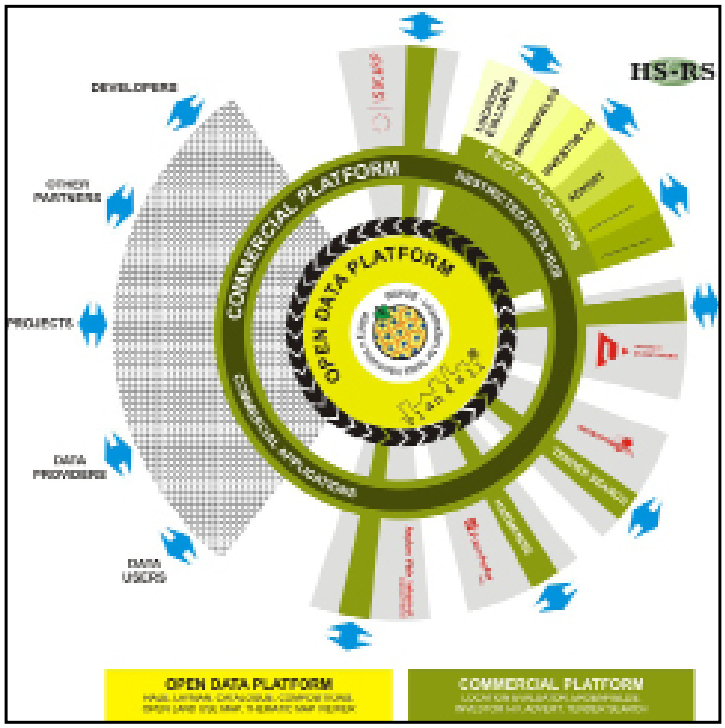
Technology Description

The Plan4business system is realised through a composition of three engine layers, namely the integration layer (1), the storage layer (2) and the analysis layer (3) (Figure 2). The layer's tasks are either to harmonise (1), store and provide (2), or visualise and analyse (3) data related to urban plans (Templer et al., 2013).

The integration engine's task is to transform spatial data sets based on a set of schema mapping instructions. Examples for mapping instructions are reclassifications of land use nomenclatures, spatial coordinate transformation and assigning object types from the source data to a target schema. The integration engine has been realized as a web service based on the Humboldt Alignment Editor (HALE) software stack. HALE, which has been started during the Humboldt project (Fichtinger at al., 2011), provides the functionality to perform interactive mapping of geospatial schemata. HALE's user interface has been adopted in order to allow for performing the mapping process online. Therefore, a step-by-step wizard guides the user through the mapping process and asks to map the source entity types to a pre-determined target schema. The latter is a simplified subset of the INSPIRE Data Specification on Land Use. Besides spatial coordinate transformation and retyping of entities and attributes, re-classification of land use categories is one of the core aspects in the land use domain (Figure 3). Re-classification can be realized through mapping -tables connecting a source classification to one or more classification categories of HILUCS.

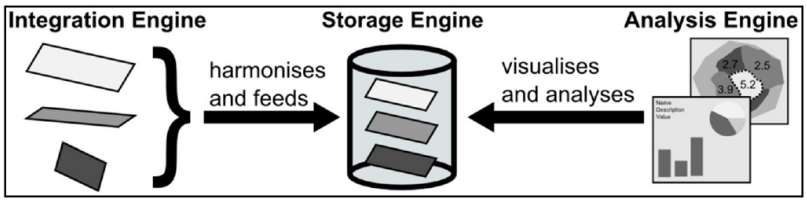
Once the schema mapping is finished it may be executed, published and shared with other users.

Applying the mapping instructions to the source data uploads the resulting transformed data to the storage engine. The latter is a combination of two separated data bases following the relational paradigm on the one hand and the graph paradigm on the other. The main component of the storage



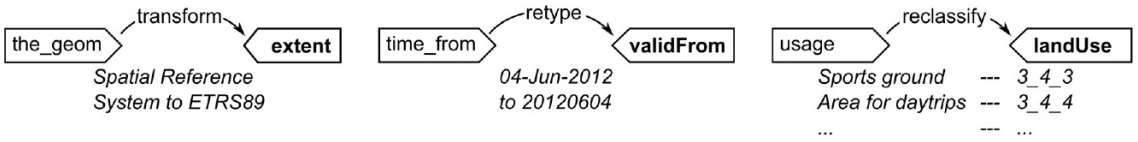
Source: own processing

Figure 1: Open Data and Commercial Platforms and associated tools, apps and users.



Source: Templer et al. ,2013

Figure 2: Composition of the three core engines; integration engine for data harmonisation, storage engine for data storage and provision, analysis engine to visualise and analyse harmonized data.



Note: The bold attribute names belong to the target schema INSPIRE Data Specification on Land Use..

Source: own processing

Figure 3 - Exemplary mappings for spatial, temporal and thematic attributes.

engine is the relational data base. Although the relational paradigm has been carried out successfully for many years, it lacks in performance when it comes to more complex queries that require a lot of table joins. Thus, we have supplemented it with a graph data base that runs particular use cases. Both, the relational data base and the graph data base, can be managed via the web portal. This allows for storing, deleting or updating transformed data sets. The data is either accessible as INSPIRE compliant files (e.g. Geography Markup Language) or via SQL.

The analysis engine encapsulates data access and represents a base for an extensible collection of analysis and visualisation apps. (Ježek, 2013). The solution has been developed within the Plan4business project with the aim of automated spatial planning data automation. This could be used for the implementation of the INSPIRE specifications on land use, which is a challenging task in many countries (Jaroszewicz et al., 2013).

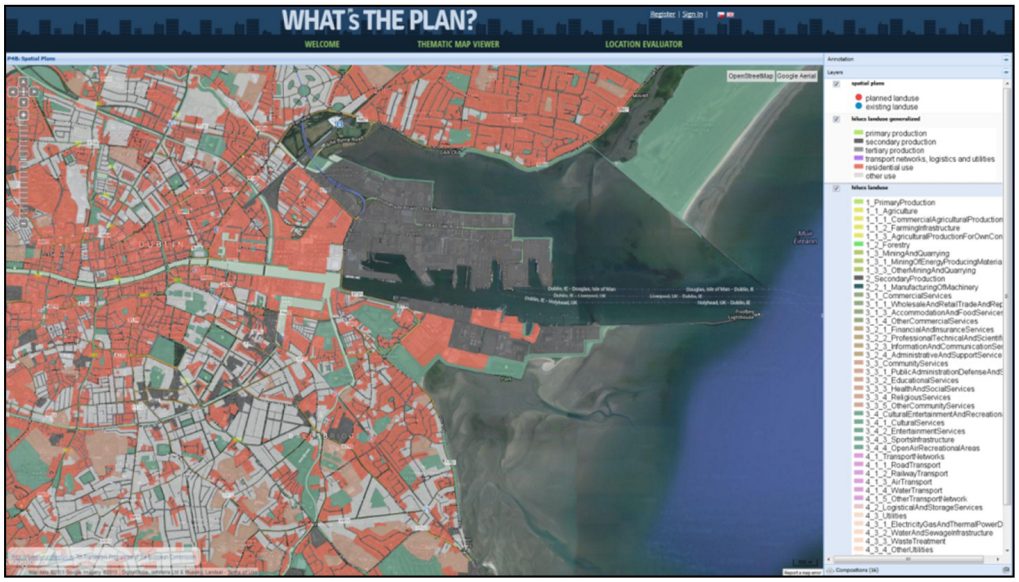
Results and discussion

This section presents the end-user apps built on top of the analysis engine, such as Brownfields (an app for brownfield advertisement), Embed Map (embedding an interactive map window with user defined maps into user's website) and Advert (placing an advert for selling real estates). The Plan4business platform and the apps are available at www.whatstheplan.eu. The apps combine the data harmonized through the integration engine with open data available from various sources. As an example the Thematic Map Viewer and the Location Evaluator apps are described in more detail.

The Thematic Map Viewer (Figure 4) enables to navigate through thematic maps and results of predefined analyses from local to European level. Based on the level of zoom in a certain area a list of thematic maps is dynamically offered to the user. The user can then select one of the thematic maps, display it in the map viewer and analyse it in an interactive manner.

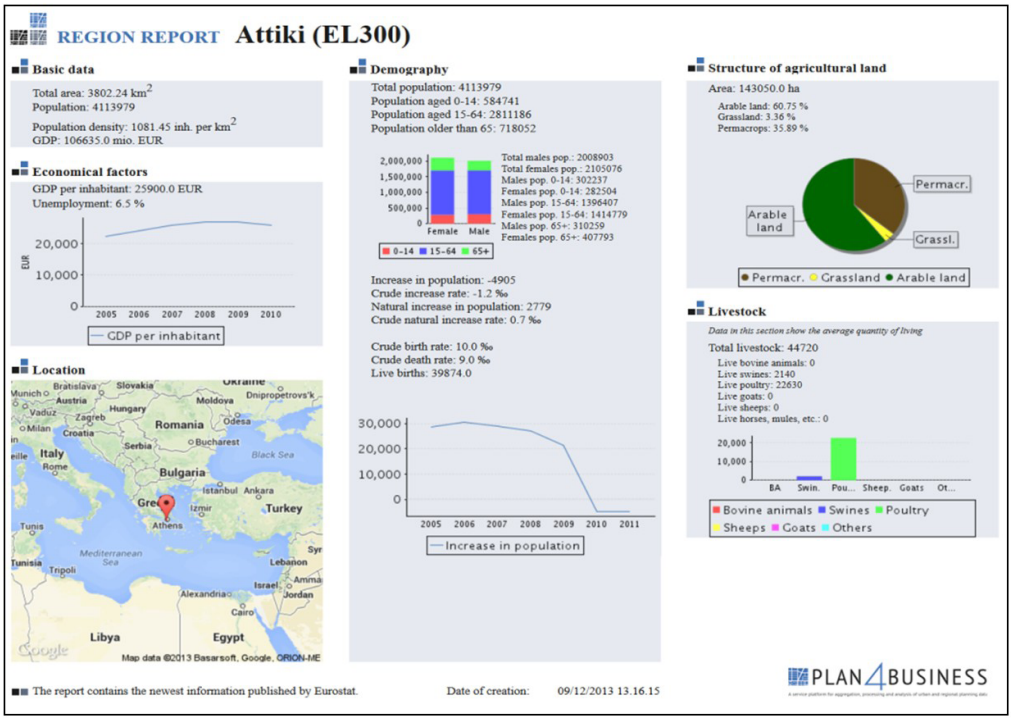
The Location Evaluator is an app for user friendly access to data from various sources including statistical, analytical and cadastral information. User can generate a comprehensive report about a region in Europe (Figure 5), a municipality or a point of interest in selected countries through navigation in a map.

Another app that will be enhanced within the SDI4Apps project is the already mentioned Open Land Use Map.



Source: own processing

Figure 4: Thematic Map Viewer.



Source: own processing

Figure 5 - Report generated by the Location Evaluator.

Conclusion

The current situation with data availability and compliance to commonly used standards differ from country to country. But in general, most data from the public sector are not published in a standardised and machine readable form. This makes collection, integration and update of data rather difficult.

The Plan4business project developed a solution that can help to overcome this situation and enable effortless land use and other data integration. The solution is fully Open Source and can be

extended to any region in the world including African countries.

The results of the Plan4business project offer the first complete solution for users. The solution will be extended with additional data sets as well as further functionalities and applications to support different user communities. The SDI4Apps project will build on top of the Plan4business achievements and extend the platform with additional apps and tools including the Open Land Use Map.

The authors presented the technological solution for data integration, how to make the system sustainable in the future and the methodology for setting up the Open Land Use Map built on top of this platform. The Open Land Use Map has a great potential in various specialisms including forestry, agriculture, spatial planning and other environmental applications.

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Monitoring of Integrated Accounts Rendering and Non-Financial Information Disclosure to Agricultural Holdings (on the Basis of the Volgograd Region)

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Anotace

Článek popisuje kvalitu a spolehlivost vytváření reportingů velkých zemědělských podniků a úplné zveřejňování finančních a nefinančních reportingů. Tento dokument zveřejňuje výsledky dlouhodobého sledování a výzkumu prováděného na katedře účetnictví a auditingu na Volgogradské státní zemědělské univerzitě, stejně jako strategii výsledky reportingů Volgogradské oblasti - integrovaného rozvoje venkovských oblasti. V závěru jsou vytvořena doporučení pro vytváření integrovaných zpráv, kterými se upravuje proces účetnictví zemědělských podniků – vytváření reportingů.

Klíčová slova

Public rendering reporting, souvisle integrovaný reporting, monitoring, zemědělskopotravinářský komplex, účetnictví kvalitní reporting, koncept integrovaného podávání zpráv, zveřejňování nefinančních informací, úplnost hlášení informací zájemcům, doporučení pro reporting, reporting hodnotící kritéria.

Abstract

The article describes the quality and reliability of the public reporting rendering by large agricultural holdings and full disclosure of financial and non-financial information reporting. The results of long-term monitoring and research carried out at the Department of Accounting and Auditing of the Volgograd state agrarian university as well as the Strategy for integrated development of the rural areas of the Volgograd region results were given here. Recommendations for the coherently integrated reporting adapting in the accounting process of agricultural enterprises were made.

Key words

Public reporting rendering, coherently integrated reporting, monitoring, agri-industrial holdings, accounting reporting quality, concept of integrated reporting, disclosure of non-financial information, completeness of reporting information interested users, recommendations for reporting, reporting evaluation criteria.

Introduction

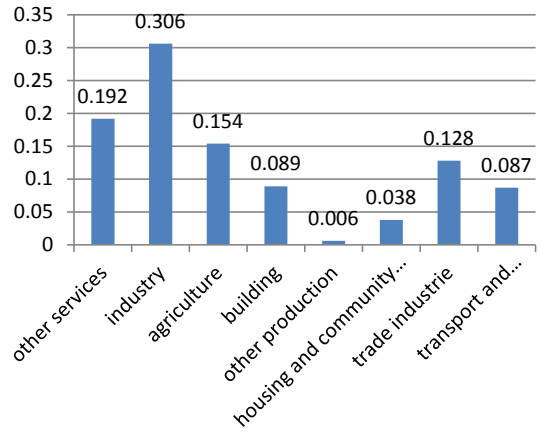
In current economic environment the ability to accomplish information with high accuracy is the most important factor of each company. For data and information processing, it is important to use technological innovations so the firm become more competitive. In recent years a development of automatic systems in agriculture gained increased interest, which lead to the fact that researchers were concerned about the development of rational and adaptable systems based on behavioural approach (Sørensen, et al., 2010). For traditional systems the output (report) is usually created in the form of the documents and the forms. The structure of the current output reports is pre-defined and the farmer obtains the reports periodically where only the data changes. In 2009, the EU funded a project named FutureFarm which would bring a new model and prototype of a new information system for reporting. In their study Sørensen et al. (Sørensen et al., 2010) define and analyse the system boundaries and identify relevant decision processes for farm management information system. Related study of Lawson et al. (Lewis, T , 1998) examined the potential benefit for introducing farm information systems management. The research project FutureFarm

continues with the identification of the content of the "process" entities of the information flow model which represent the usage processes of the information, and of the "information" entities which represent the data elements (Sørensen et al., 2010/1). The collection of the data for agricultural management system is solved for example by Steinberger et al., 2010. Software architecture for farm management information systems in precision agriculture concerns Nikkila et al. (2010). According (Papula, Volná, 2012) must create the proper structure of the report (Sneidere, Vigante, 2014). Schneider is engaged in legislation issues of disclosure and information and generated reports. Problems connected with reporting,audit farms and rural development are also discussed in the works of Lakhtionova (2011), Serrano-Cinca (2013), Demortain (2011).

The scientists of the Volgograd state agrarian university carried out the work on developing the «Strategy for the integrated development of rural areas of the Volgograd region and the effective functioning of the agricultural sector in the WTO, taking into account socio-economic, climatic features» (Strategy for the integrated development of rural areas. 1.2.2014). Under the state contract they carried out the monitoring of the largest region agricultural holdings qualified rendering, accuracy, transparency of accounting and completeness of disclosure of non-financial information in it (social development, ecological safety, etc.). (Melikhov, 2014; Tseplyaeva, Balashova, 2012).

Volgograd region is one of Russia's largest producers of agricultural products (in Russia - 10th place, in the Southern Federal District - 3rd place) having favorable conditions for stable and progressive development of the agricultural sector in the context of globalization. In the gross regional product increased from 203.2 billion rubles in 2006 to 498.9 billion rubles in 2011, the share of agricultural production was 15.3% (Figure 1). In 78.1 billion got in 2012 the share of agricultural products in the crop production was 62.1% (48.5 billion rubles), livestock production had 37.9% (29.6 billion rubles). The relative share of the area in agricultural production in Russia in 2012 amounted to 2.4%. For the processing of results was also used from Shaposhnikova, Murtazayeva (2009); Skiter (2014).

Increasing of the information transparency and large agricultural companies' openness for all stakeholders is an important factor in the stability of the business and makes a substantial contribution into the socio-economic development of the Volgograd region. Growth in the value of agricultural holdings, reduce of the risks while investing and public confidence in the performance of the largest companies increase largely depend on how open and truthful companies disclose their achievements and problems, the strategy and its implementation, used resources and contribution to the people's, technologies', regions', etc. development. The set of public reporting (financial and non-financial) is one of the mechanisms to ensure transparency



The Volgograd region's position in production of agricultural and food industry main goods types in Russia in 2012	
Grain production	9
Sunflower seeds production	7
Vegetables production	2
Potatoes production	29
Livestock and poultry for slaughter production	19
Milk production	22
Eggs production	21
Vegetable oil production	8
Animal fat production	36
Dairy production	41
Bread production	24

Source: Strategy for the integrated development of rural areas of the Volgograd region and the effective functioning of the agricultural sector in the WTO, taking into account socio-economic, climatic features

Figure 1. The relative share of industries in the Volgograd region in the gross regional product structure, in 2012.

and reliability (Zubova, 2013; Bychkov et al., 2012).

Under the current conditions in Russia problem of the agrarian formations reporting quality, prepared according to IFRS or GAAP, international standards of integrated reporting is urgent, but it is important to note that the agribusiness in the Russian Federation should be integrated in the IFRS system by 2016...2018. The list of the public companies at the moment includes not all agricultural holdings (as FZ-208 „On the consolidated financial reporting"). Voluntary formation of reporting according to IFRS does not develop very intensively due to: the high cost of adaptation to international standards; shortage of personnel; agricultural holdings management concerns to represent public reporting (the lack of willingness to disclose material information to competitors) (Federal law on accounting, 8.2.2014). The objects of the research are the largest integrated agroformations of the Volgograd region, which are able to solve the problem of overcoming the disparity in prices for products and services, to change organizational - production structure of activity, to solve the issues of technical rearmament and economic equality between producers and service. Such structures reporting should be of another level and qualities. For processing data were used international standards described in Dalmazzone (2011), De Haan (1999), Schröter et al. (2014), Weber (2007).

Research purposes and aims

In 2012...2013 there were major changes in the international accounting standards in Russia:

1. The publication G4 version of the Guide to reporting on sustainable development GRI; (GRI-G4_Guidelines-report , 18.1.2014)
2. The International Standard integrated reporting was published (Towards Integrated Reporting, 1.2.2014 and Consultant project of the international structure, 18.12.2013).
3. The National Concept for the development of public non-financial reporting in the Russian Federation and the publication of a new version of the Code of Corporate Governance is getting ready.

This study was carried out to determine the ways of reporting quality perfection in the new conditions and to improve the overall level of corporate reporting development. The main objective of the research is the integrated analysis of the Volgograd region largest agricultural companies reporting and assessment of their transparency level for creating the conditions for the corporate reporting qualitative evolution.

The main objectives of the research are:

- the large agro-industrial enterprises reporting quality examination of (including non-financial);
- identifying and disseminating best practices in reporting;
- drawing up of corporate reporting ratings.

The research model and methods were approved by the board of the Faculty of Economics. The Working Group and Executives were approved: the Chief of the Department of Accounting and Auditing, the teaching staff, post-graduate students, students in the master's program and students of economic direction.

During the research the Volgograd region agricultural holdings accounting records in 2012 were studied (integrated reports, traditional annual reports and non-financial reports, including reports on sustainable development), as well as other materials on reporting posted on the official corporate websites. 16 major agro-industrial enterprises, including agricultural holdings, enterprises of agricultural segment of large public companies, processing enterprises of Agricultural Industrial Complex were included into the survey sample.

Materials and methods

The research was carried out in three stages. At the first stage the Working Group carried out the reporting survey in accordance with the procedure.

In the second stage the Expert Group made a spot-checking of the survey results; and the verification of preliminary results: the got data was sent to all the companies with the purpose of reconciliation.

In the third stage the survey results were summarized.

The reporting survey was carried out according to six criteria, each of which corresponds to a set of parameters and indicators. Two sets of criteria were used: the quality of accounting information and the quality of reporting.

The criteria selection was largely based on:

- the implementation of international standards: Guidelines GRI, version G3.1;

- draft of the International Standard Integrated Reporting;
- public reporting systems availability in the companies, allowing to prepare annual reports systematically and properly;
- registration of requests to the main companies stakeholders' reporting information (potential reports readers);
- reporting usability.

Such a criterion selection allows to reveal both best practices in terms of compliance with international best practices of corporate reporting (including integrated) and agricultural holdings reporting „bottlenecks" (Figure 2).

Integrated reporting concept

In the future 6-10 years all Russian large agricultural holdings will move to the preparation of integrated reports or reports SD: either because of the desire to meet corporate reporting modern international standards, or performing exchanges listing and regulatory requirements, both national and international ones. IR-reporting concept is shown in Figure 3.

In the modern conditions of the Volgograd region agricultural holdings operation agroformations business model changes significantly due to the globalization of the economy, the development of production and marketing technologies, increasing the agricultural raw materials products consumption (meat, dairy products and juice), environmental and social problems of modern agriculture. In this section the fundamental importance for the formation of the market value of the agricultural holding (Group of companies) acquired the form of reporting, which could represent intangible assets (innovative developments, new products, business-processes, automated accounting and control systems), the holding company investment potential for foreign investors and for internal management decision-making. A single form will allow to disclose consequent information that enables to detect inconsistencies between the financial, non-financial and management information. Over the period of 2010-2013 the International Integrated Reporting Council (IIRS) was created, which published for discussion a consultation project on the concept of the International Integrated Reporting (Zubova, 2013).

Need for the project and the concept has arisen because of a lot of types of the companies' internal and external reporting, which are formed for the management, financial market participants, tax authorities, banks (it is of a different size, structure and nature), which leads to loss of time and financial resources in search for relevant information. The system of coherently and integrated reporting is important for investors, as the traditional annual reports do not create an integrated view of the business due to the lack of information for decision-making regarding whether there are business opportunities and risks.

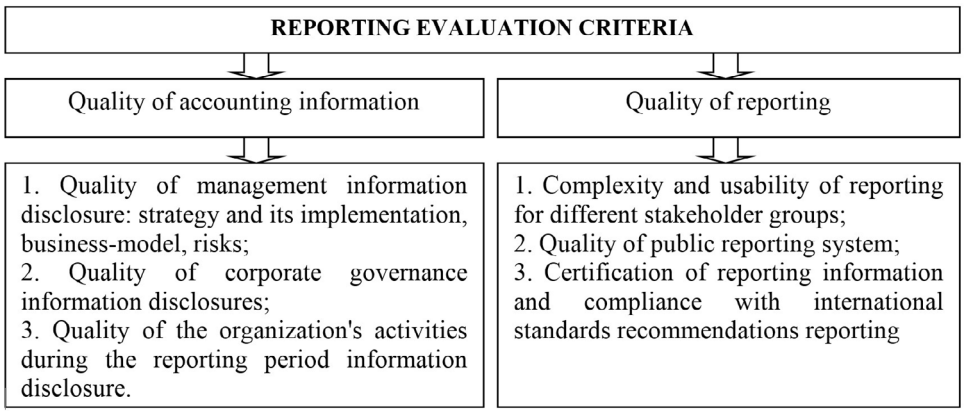


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Figure 2: Criteria for reporting information quality and agricultural holdings reporting

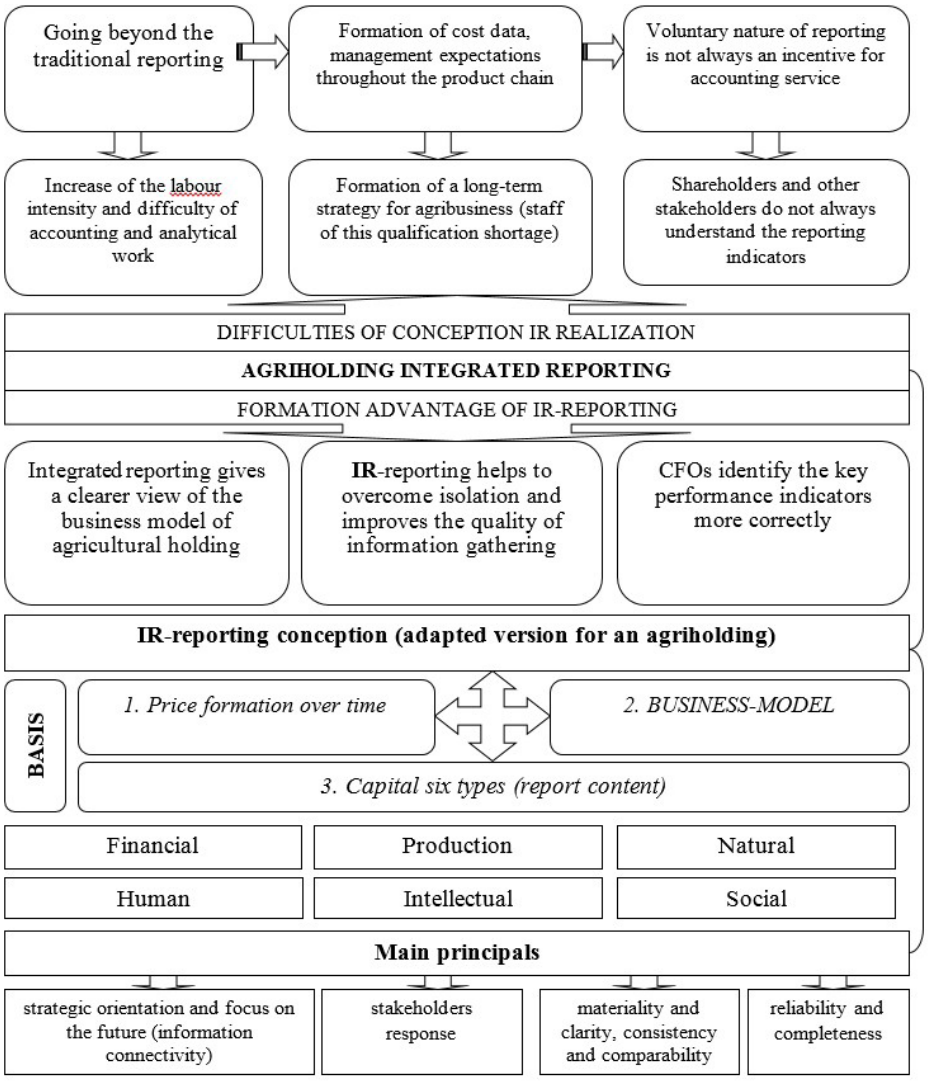

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Figure 3: Advantages and the complexity of the integrated reporting concept on the basis of its components in the agricultural holdings accounting practice.

Results and discussion

In this section, we represent the most important results of the agricultural holdings in the Volgograd region public reporting research

According to the Table 1, the level of the agroindustrial enterprises in the Volgograd region reports compliance with IFRS is not very high - 37.5%, 18.7% of agricultural holdings prepare reports in accordance with the Guidelines for reporting on sustainable development The Global Reporting Initiative (G3.1), and 25 % of companies make reports in accordance with the Draft International Standard for integrated Reporting. We assume that in the near future, Russia will expand the scale of the use of these two international standards (IR and GRI) in connection with existing global trends, as well as in connection with changing the national regulatory framework. Table 2 summarizes the results of a survey of enterprises managers, CFOs and chief accountants.

Agricultural enterprises are potentially ready for the transition to modern types of reports for the period of 2014 ... 2017: integrated reporting plan to generate 56% of the respondents, and sustainable development - 38% of companies.

Enterprises list	Compliance with IFRS	Compliance with the Management for sustainable development (GRI)	Compliance with IIRC (IR-reporting)	Compliance with RAS	Internal audit reports
Holding company "Helio-Paks"	+	-	+	+	+
LLC "Vipoyl" (Holding "Vipoyl)	+	-	+	+	+
Agricultural holding "Novoanninskiy"	-	-	-	+	+
Agribusiness "Zarya" (holding "PomidorProm")	-	-	-	+	-
CJSC "Krasnodonskoye" (Mriya "Kopitaniya")	+	+	+	+	+
LLC "Gorodishchenskaya Poultry"	-	-	-	+	-
LLC "Poultry Kamyshinskaya"	-	-	-	+	-
CJSC "Agrofirm Vostok"	-	-	-	+	+
Agricultural holding "Agro Invest"	+	+	-	+	+
Agro Holding "Volgograd"	-	-	-	+	-
Agricultural holding "Geteks"	+	-	-	+	+
Agricultural holding "Terra-Invest"	-	-	-	+	-
Group of companies "Agricultural holding"	-	-	-	+	-
Agro Holding Ltd. "Nagavskoe"	-	-	-	+	-
LLC " Agricultural holding Povolzhje"	-	-	-	+	-
JSC "Gardens of Pridonye"	+	+	+	+	+

Source: own processing

Table 1: Compliance of agriholdings in the Volgograd region public reporting .

All in all - almost all of them (99%) plan to disclose information in the reports on the activities in the field of sustainable development. The companies plan to do it fully, producing integrated reports or „two-volumes“ (traditional reports and reports on SD).

We can note that the quality of reporting improves the transition to integrated reporting, the presence of systems for public reporting companies (more than 30% of businesses tend to create it), and the key stakeholders involvement in the preparation of reports, 38% of companies understand their importance.

In the Table 3, we give the data disclosure on certain groups of parameters (the disclosure of risks, corporate management, etc.). Thus, the disclosure (~ 57%) of the company‘s strategy is of a high level. A number of parameters (business model, stakeholder involvement, user requests and reports, etc.) are at the average level (~ 56%). It can be assumed that due to the neglecting the requests for reporting information, the information is not claimed and of little value, it is prepared and placed as „wasted.“

Enterprises list	Transition to IR-reportings	Reporting will consist of two volumes (financial and non-financial)	Reports with included information on sustainable development	Public reporting system implementation	Involvement of key stakeholders
Holding company "Helio-Paks"	+	-	+	+	+
LLC "Vipoyl" (Holding "Vipoyl)	+	-	+	-	+
Agricultural holding "Novoanninskiy"	+	-	-	-	-
Agribusiness "Zarya" (holding "PomidorProm")	+	-	-	-	-
CJSC "Krasnodonskoye" (Mriya "Kopitaniya")	+	-	-	+	+
LLC "Gorodishchenskaya Poultry"	-	+	-	-	-
LLC "Poultry Kamyshinskaya"	-	+	-	-	-
CJSC "Agrofirm Vostok"	-	+	+	-	-
Agricultural holding "Agro Invest"	+	-	+	+	+
Agro Holding "Volgograd"	-	+	-	-	-
Agricultural holding "Geteks"	+	-	-	+	-
Agricultural holding "Terra-Invest"	-	+	-	-	-
Group of companies "Agricultural holding"	-	+	-	-	+
Agro Holding Ltd. "Nagavskoe"	-	+	-	-	-
LLC " Agricultural holding Povolzhje"	+	-	+	-	-
JSC "Gardens of Pridonye"	+	-	+	+	+

Source: own processing

Table 2: Planned activities to improve the quality of agriholdings in the Volgograd region reporting for 2014…2017.

We refer the following to poorly disclosed accounting information (18.7%):

- Disclosure of risk information;
- Data on corporate management (information on the relationship performance of companies and the remuneration of top management).

It is also important to note that specific information about the state of the business and the companies' prospects supporting the strategy's implementation (target and forecast figures, indicators dynamics comments of, etc.) discloses in 25% of cases.

The information disclosure level increase on these aspects will enhance the level of companies' information openness and transparency. However, it is not the fact that it would increase greatly the usefulness of the reports. The key stakeholders' queries examine only 31%. In general, the information which is required by regulators, or the information, which the company stakeholders (such as shareholders) are mostly interested in, is disclosed well.

Enterprises list	Disclosure of the company's strategy information	Business-model description	Disclosure of risks information	Data on corporate management system	Interaction with stakeholders
Holding company "Helio-Paks"	+	+	+	-	+
LLC "Vipoyl" (Holding "Vipoyl)	+	-	-	-	-
Agricultural holding "Novoanninskiy"	+	+	-	-	+
Agribusiness "Zarya" (holding "PomidorProm")	-	-	-	-	-
CJSC "Krasnodonskoye" (Mriya "Kopitaniya")	+	+	-	+	+
LLC "Gorodishchenskaya Poultry"	-	-	-	-	-
LLC "Poultry Kamyshinskaya"	-	-	-	-	-
CJSC "Agrofirm Vostok"	+	-	-	-	-
Agricultural holding "Agro Invest"	+	+	+	+	+
Agro Holding "Volgograd"	-	-	-	-	-
Agricultural holding "Geteks"	+	-	-	-	-
Agricultural holding "Terra-Invest"	-	-		-	-
Group of companies "Agricultural holding"	-	-	-	+	-
Agro Holding Ltd. "Nagavskoe"	-	-	-	-	-
LLC " Agricultural holding Povolzhje"	+	-	-	-	-
JSC "Gardens of Pridonye"	+	+	+	-	+

Source: own processing

Table 3. Disclosure of individual parameters characterizing the management quality control in the agricultural holdings reports.

Analyzing the current practice and the concept of forming a coherently integrated reporting of the Group companies, we consider that its implementation in the accounting process is the competitive advantage of agroindustrial enterprises. In this case, the traditional financial reporting is added by the disclosures of the social, environmental, managerial, organizational matters. In the given concept it is recommended to disclose nature protection activities costs, reserves, showing the impact of climate change on their activities, describing the agribusiness main risks, key personnel, the level of business processes automation, etc.

The largest Agricultural Industrial Complex enterprises in the Volgograd region pay enough attention to the environmental activities information disclosure (environmental protection, modern sewage treatment plants, the calculation of deviations, the influence of environmental regulations, investment , skills) - 56 % of the sample. Aspects of social activity are represented in 43% of the non-financial reports rendering. It is interesting

Enterprises list	Ecological activity	Social activity	Investment and innovative activity	Personnel policy (health, work conditions)	Production organization
Holding company "Helio-Paks"	+	+	+	+	+
LLC "Vipoyl" (Holding "Vipoyl)	+	+	+	-	-
Agricultural holding "Novoanninskiy"	+	+	+	-	-
Agribusiness "Zarya" (holding "PomidorProm")	-	-	-	-	-
CJSC "Krasnodonskoye" (Mriya "Kopitaniya")	+	+	+	+	
LLC "Gorodishchenskaya Poultry"	-	-	-	-	-
LLC "Poultry Kamyshinskaya"	-	-	-	-	-
CJSC "Agrofirm Vostok"	-	-	-	-	-
Agricultural holding "Agro Invest"	+	+	+	+	+
Agro Holding "Volgograd"	-	-	+	-	-
Agricultural holding "Geteks"	+	-	+	-	-
Agricultural holding "Terra-Invest"	-	-	-	-	-
Group of companies "Agricultural holding"	+	-	+	-	-
Agro Holding Ltd. "Nagavskoe"	-	-	-	-	-
LLC " Agricultural holding Povolzhje"	+	+	-	-	-
JSC "Gardens of Pridonye"	+	+	+	+	+

Source: own processing

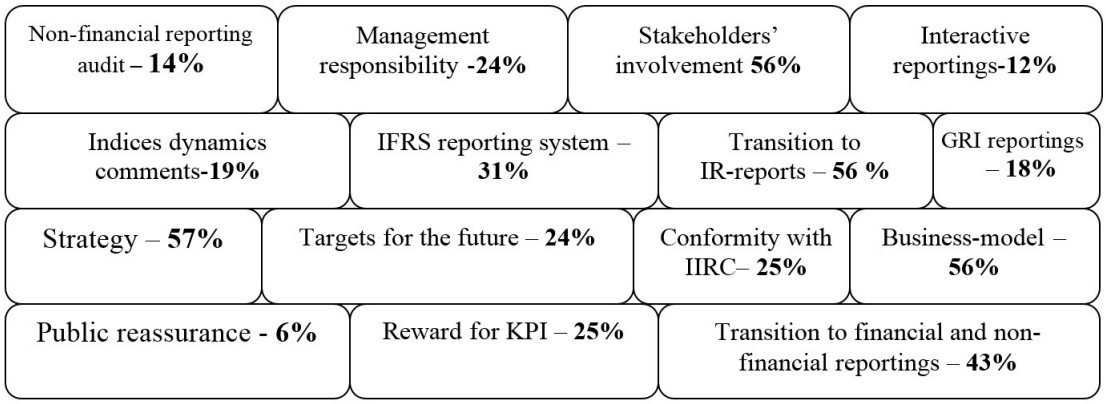
Table 4. Level of non-financial information disclosure in the Volgograd region agriholdings reporting.

that investment and innovation activity is widely represented (~ 57%): agricultural holdings describe the mechanisms of the investments, calculate their liquidity and return, reveal innovative products and business processes. The personnel policy and the production organization information disclosure are not so popular - 25 % and 19 %, respectively (Table 4).

Conclusion

The figure 4 shows the main key performance indicators that were obtained from the results of the monitoring.

In conclusion, we can say that about 43% of agricultural holdings are planning to release „two-volumes", i. e. two reports: the annual traditional and non-financial (sustainability report, social report, ecological, etc.). Only 18 % prepare annual reports that include varying degrees of information on sustainable development. Integrated reports are prepared by 4 agriholdings (25%). Third of holdings (38%) are planning to prepare reports (integrated or non-financial) in accordance with the Guidelines GRI. Slightly



Source: own processing

Figure 4. Analysis of key performance indicators.

less than half of holdings (42%) prepare electronic reports posted on the sites. The report users' reliance to the accounting information is largely based on the provided information confirmation by an external independent person. There are no problems with the reliability of financial information (the company complies with the legislation), and the accuracy of the non-financial information (production, human, environmental and other data) can cause users' great questions, as only 14 % of companies carry out the audit of non-financial reporting. All agricultural holdings have the conclusion on the financial audit. 10 % of the companies have the conclusion of the internal control and audit. Conclusion on non-financial audit (assurance of non-financial information) is not available.

The sense of reports' public assurance is to confirm the representatives of the main stakeholders (potential readers of the report) in materiality and completeness of the given accounting information, as well as the company's response to their requests and suggestions.

Conclusion regarding the public verification is represented by 2 companies, i.e. 6% of the companies have the verification from their stakeholders that the useful for them information is placed in the reports. The auditor's opinion on the involvement of stakeholders and the company responses during the reporting period isn't submitted; the auditor's opinion regards the significance of the given data - 5 holdings.

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Simulation and Prediction of Water Allocation Using Artificial Neural Networks and a Spatially Distributed Hydrological Model

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Abstract

Lake Koronia is located in the North part of Greece and is protected by the Ramsar Convention of wetlands. A deficit in the water balance has been presented at the last twenty years due to the excessive water consumption for agricultural uses. This research is an attempt to simulate water flow with MIKE SHE model in order to observe how the water is allocated in the study area. The results of water flow module used for the estimation of Lake's water balance for 4 hydrological years (2008-2012). Furthermore the Artificial Neural Networks (ANNs) was used for the prediction of water flow in two sub-catchments. The coefficient correlation (R) was found for Bogdanas (0.9) and Kolxikos (0.86). The Root Mean Square Error (RMSE) and the Mean Absolute Percentages Error (MAPE) were also calculated in order to evaluate the quality of the ANNs results.

Key words

ANNs, MIKE SHE, water allocation, water balance, wetlands, Lake Koronia.

Introduction

Wetlands are important natural environmental systems providing many benefits for e.g. natural habitat for wildlife, water filtration and supply, microclimate modification etc. They also contribute to socio-economic benefits in human's life with direct and indirect benefits as tourism, aesthetic values, domestics need, agricultural uses, fisheries, hunting etc (Alexander and McInnes, 2012). During the past decades many of these ecosystems experienced ecological stress due mostly to human activities and high demand of water consumption (Alexander and McInnes, 2012; Singh et al, 2010).

Wetlands are unique ecosystems that need specific approaches in order to assess the ecological balance (Zalidis et al., 2004). The distribution of water amount is highly affected by the climatic conditions (Nazarifar et al., 2012). The MIKE SHE model is developed from Danish Hydraulic Institute (DHI) and is a physically-based spatial distributed hydrological model that incorporates many environmental parameters and physicals processes of hydrological cycle (Thompson et al., 2004, Wang et al., 2012). The application of the model covers a wide range under different case studies in water management with efficient results. Some of these applications with consistent results are related to groundwater management (Demetriou, Punthakey, 1999), simulation of overland flow in a flashy mountainous stream (Sahoo et al., 2006) and impacts of land use changes (Im et al., 2009). Simulation of the water balance with MIKE SHE is able to be done in wetlands presenting an integrated fully-distributed approach (Thompson et al., 2004; Rahim et al., 2012). Estimations of water balance using future climatic scenarios were developed with MIKE SHE; from the results they concluded that the estimation of current and potential future climate conditions could be useful tool in wetland management (Singh et al., 2011).

Artificial neural networks (ANNs) are mathematical models, and the main structure of neural networks is based approximately on the human's brain which is filled by neurons and synapses (Parsinejada et al., 2013). ANNs can "learn" through training processes, following the pattern of a procedure developing a functional relationship between the data and produce solutions to problems (Parsinejada et al., 2013; Mishra and Singh, 2013; Gallo et al., 2014). Myronidis et al. (2012) proposed a method to predict trends of droughts with a combination of ARIMA/ANN using the parameters of precipitation and lake's water level. Chattopadhyay and Rangarajan (2014) due to the excessive groundwater irrigation especially

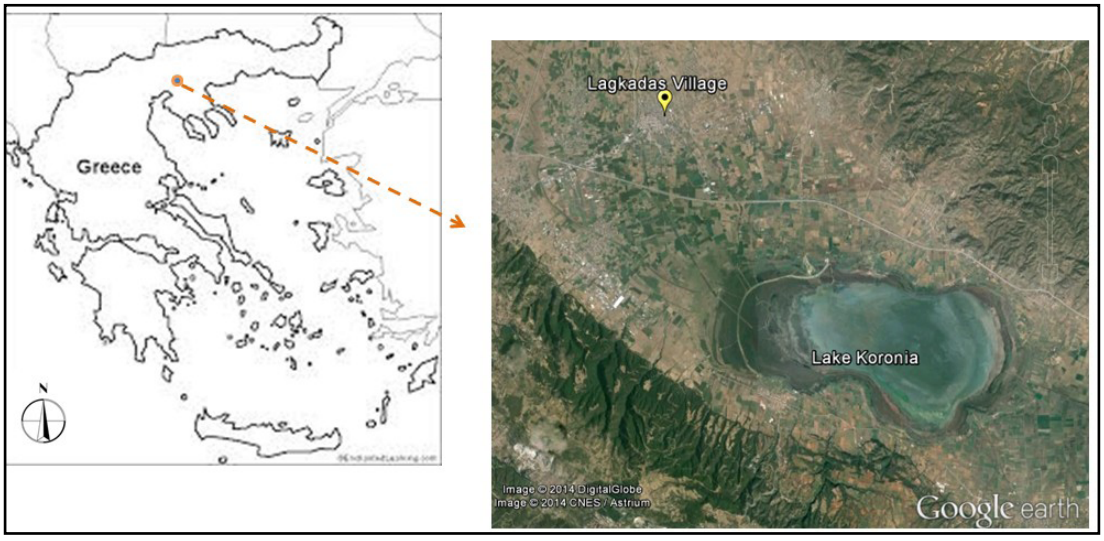
for agriculture uses developed a non-linear model with ANN to predict water level in shallow aquifer. They concluded that ANNs can efficiently demonstrate the seasonal variability forecast and also proposed this method as monitoring tool of groundwater sustainability. Gallo et al. (2014) used the ANNs in order to forecast future amounts of pollutant emission under different scenarios. The neural networks in their assignment were able to predict efficiently future amounts of air pollution in a short term. They concluded that the air pollution influenced by the meteorological conditions.

The aim of this study is to develop a simulation process with the MIKE SHE model in order to observe how the water is allocated in the catchment of Lake Koronia. We also used the water balance tool of MIKE SHE model to estimate the water balance for the hydrological years 2008-2012. The results of MIKE SHE water flow were used for the training of ANNs in order to predict the values of water flow. This method could be used to forecast the amounts of water flow and future amounts of water budget. For the training of ANNs we used the mean monthly rainfall data as input value and monthly water flow of Bogdanas and Kolxikos sub-catchments as output for the period of 1/6/2008-30/6/2013. The back propagation method was used for the training of the network and the sigmoid function as the activation function of each neuron. The known water flow data of MIKE SHE model will be used for the evaluation of output results of ANNs with a test facility after the training process. The development of these methods could be valuable tools in the ecological restoration of the Lake Koronia through the better understanding of the conditions that affects it.

Materials and methods

Lake Koronia belongs to the Mygdonia basin and is located in North Greece in the Region of Central Macedonia (N 40° 41', E 23° 09'). The catchment of Lake Koronia occupies an area of ~ 782 km² and is protected by the Ramsar Convention of wetlands (Figure 1). The last few years a deficit in water balance is present due mostly to the excessive irrigation for agricultural uses. Until 1985 the area of the lake was 45- 49 km² with an average depth of 5 m. In 1995, the lake surface area was 30 km² and the maximum depth 1 m. In the summer of 2002, the lake dried up completely. The restoration of Lake Koronia is considered a great challenge (Mylopoulos et al., 2007; Michaloudi et al., 2009).

In this study we used the MIKE SHE model in order to estimate the water balance for 4 hydrological years (2008-2012) in a shallow lake with semi-arid climate conditions. The model domain grid cell size selected at 250 x 250 m². For the elevation relief in the study area we used contours of 20 m digitized in ArcGIS. The hydrological network was provided from the Management Agency of Lakes Koronia-Volvis. The study area was separated into 10 sub-catchments according to the main streams flow and the topographic elevation. Meteorological data



Source The figure of Greece obtained from EnchantedLearning.com and Lake's Koronia from Google earth

Figure 1: The study area, Lake Koronia.

with long time series are unavailable due to the lack of data within the study catchment (Mylopoulos et al., 2007). In the past many meteorological stations were operated for small periods (5-8 years). Today meteorological stations are located outside the study catchment and only one is active inside the catchment of Koronia. The station is located in Lagkada village, at an elevation of 87 m and supervised by the National Observatory of Athens and the Municipality of Lagkadas (Figure 2). We used the monthly rainfall data (mm) in time series related for the period from 1/6/2008 to 30/6/2013.

For vegetation and land use cover we used the Corine 2000 maps. In order to estimate the actual evapotranspiration (ET) we calculated the reference evapotranspiration (ET_o) in monthly rate (mm) with a modified method of Hargreaves–Samani (HS) proposed from Droogers and Allen (2002). The equation of ET_o is described as:

$$ET_o = 0.0013 \cdot 0.408Ra \cdot (T_{avg} + 17.0) \cdot (TD - 0.0123 \cdot P)^{0.76} \quad (1)$$

Where: T_{avg} is the mean temperature (℃), TD is the Tmax-Tmin temperature (℃), P is monthly precipitation amount (mm), Ra is the extraterrestrial radiation given from the table in FAO (Food and Agriculture Organization) in unit of MJ m^{-2} day^{-1}. Ra is multiplied by 0.408 in order to convert to ET (mm). The constant numbers (0.0013, 17, 0.0123 and 0.76) was valued and estimated according to the IWMI (International Water Management Institute) Climate Atlas with efficient correlation results compared with the method of Penman–Monteith (Droogers, Allen, 2002).

For the project of Koronia Lake the calculation of overland flow developed with the method of finite difference. The estimated value of manning number for overland flow according the existing land cover conditions in the area with short vegetation is estimated at 30 $m^{1/3}/s$ (DeBarry, 2004, DHI, 2012). The Unsaturated Zone (UZ) was calculated with the 2-layer Water Balance as the more indicated method for the shallow groundwater table (Dai et al., 2010). Soil data was obtained from HWSD (Harmonized World Soil Database) and used in the model as polygon file. According to HWSD five are the main types of soils the area (Calcaric Fluvisols, Calcaric Regosols, Chromic Luvisol, Dystric Cambisol, Eutric Cambisol).

Source: own processing. The data from the meteorological station of Lagkadas were used to run MIKE SHE model and ANNs.

Figure 2: The hydrological network and the sub-catchments of Lake Koronia Catchment.

These types present different soil texture according to USDA (United States Department of Agriculture) classification covered by loam, clay, sandy and mixture of them. We categorize the soils according to their texture and the estimation of properties for each soil type was defined from the literature presented in Table 1.

The Saturated Zone (SZ) was calculated with the method of linear reservoir as a more appropriate due to the lack of data in the area but also because it is a useful tool for shallow lakes (Wang et al., 2012, DHI, 2012). Lake Koronia consists of a shallow aquifer with a depth of 40-60 m and a deeper at 450 m (Mylopoulos et al., 2007). Although the depths of reservoirs have a conceptual meaning we estimate the depths according to the volume of water (formation thickness x specific yield). We used the same values for the initial depth and as threshold of interflow and base flow reservoirs (Table 2). Furthermore the parameters of the time constant cannot be physically observed and they are mainly used as calibration values. A fair estimation of these parameters could be obtained from the hydro-geologic conditions and the literature review from previous studies (DHI, 2012).

In order to have more consistent results we used the utility of the hot start period for the first two years (1/6/2008-30/6/2010) as a "warm-up period" in order to provide the initial conditions and hydrological properties for the main simulation (Signh et al, 1999). The final simulation period was 1/6/2008-30/6/2013 using the hot start period of the first two years.

Precipitation is one of the main parameters, which contributes to the enrichment of aquifers. In our study we tried to combine the results of simulation water flow from MIKE SHE model with the precipitation amount in a monthly time step. The aim of this process is to train an ANN in order to predict future values of water flow in two sub-catchments (Bogdanas and Kolxikos) using the monthly amount of precipitation. We used the Neural Works Predict tool with a set of rainfall data for the period 1/6/2008-30/6/2013 as the input

	Clay loam	Clay to clay loam	Loam to Loamy sand	Loamy sand	Clay Loam to loam
Water content at saturation (cm^3) (Rawls et al., 1982; Chan, Knight, 1999)	0.43	0.45	0.42	0.41	0.42
Water content at field capacity (m^3) (Hignett, Evett, 2008)	0.34	0.35	0.15	0.14	0.26
Water content at wilting point (m^{-3}) (Hignett, Evett, 2008)	0.15	0.17	0.10	0.06	0.11
Hydraulic conductivity (m/s) (Mylopoulos et al., 2007, Batu, 1998)	1,00E-07	1,00E-09	1.3e-007	1.3e-006	2.8e-007

Source: own processing

Table 1: The soil properties for the different type of soils in the study Catchment of Lake Koronia.

	Interflow Reservoirs	Base flow Reservoir 1	Base flow Reservoir 2
Specific Yield (Mylopoulos et al., 2007)	0.08	0.08	0.08
Initial Depth (m)	4.8	18	36
Bottom Depth (m)	60 x 0.08 = 4.8	225 x 0.08 = 18	450 x 0.08 = 36
Time Constant (days) (Wang et al., 2012, Thompson et al., 2014)	40	120	250
Threshold Depth (m)	4.8	18	36
Percolation Time constant (only interflow) (Wang et al., 2012, Thompson et al., 2014)	5 days	-	-
Dead storage fraction (only base flow) (Mylopoulos et al., 2007)	-	0.3	0.33

Source: own processing

Table 2: The parameters of interflow and base flow in linear reservoir method.

value and monthly water flow for the same period as the output. The topology used for the prediction was Multi-Layer Perceptron (MLP). We used a network consisting of 2 input neurons, 24 hidden neurons in one layer and 1 output neuron. Each input neuron was connected with all the neurons in the hidden layer.

The method of gradient back propagation was used for the training of MLP network. In this method an objective function is specified which is a measure of how closely the outputs of the network match the target outputs in the training set of data. The improvement of the objective function achieved through the weights modification of each individual processing elements. The Kalman filter also was used in order to train the network due to the effectiveness for noisy behavioral problems and its inherent ability to suppress noise. Kalman filters are based on linear dynamic systems which is applicable to regression type problems in which the number of inputs is not too large (Ioannou et al., 2010). The sigmoid function (Equation 2) was used as the activation function of each neuron.

$$f(x) = \frac{1}{1+e^{-x}} \quad (2)$$

The learning rate was set to 0.1, the network was trained for 1000 epochs, and the max error was set as > 0.01. The AI topology remained stable through training epochs. The known water flow data will be used for the evaluation of output results after the training of ANNs. The correlation coefficient (R) is a statistical analysis that presents the level of matching. The Root Mean Square Error (RMSE) and the Mean Absolute Percentages Error (MAPE) are also calculated in order to evaluate the quality of the ANNs results (Ioannou et al., 2010, Mishra, Singh, 2013).

Results and discussion

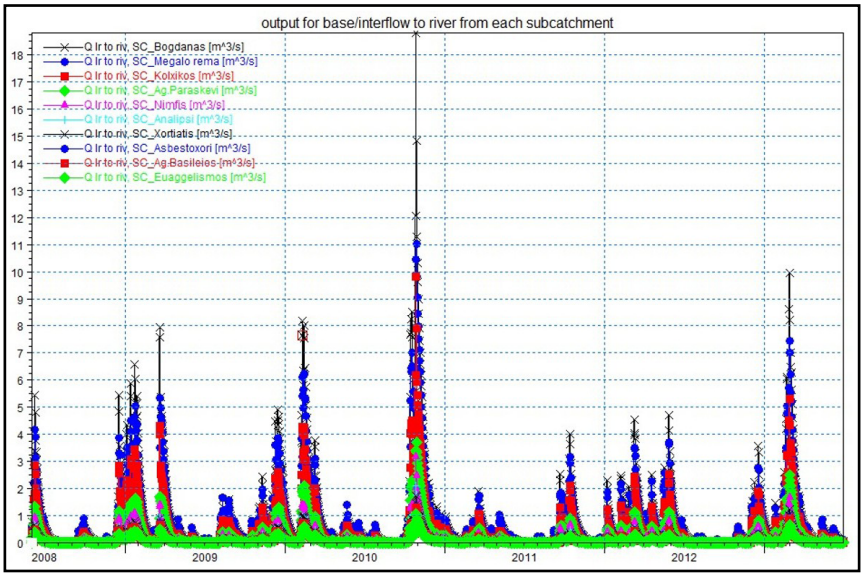
The simulation results present different values depending on the season and the hydrological conditions. In general in summer the actual ET amount is higher in contrast in winter months the ET amount is lower. The higher amounts presented in the northern part of the study area which are covered mostly from agriculture land and the lower amounts in the area around the lake where is covered with short perennial vegetation. The actual amount of ET presents a high range of values throughout the year and the components of precipitation and vegetation play an important role in the total amount of ET. Furthermore the water exchange between the UZ and SZ zone during the summer is relatively low due to the lower amount of precipitation and the higher amounts of ET. The type of soil also affects the exchange between zones. Loamy sand soils have higher amounts of infiltration followed by loam to loamy sand soils. The higher amounts of infiltration are in the area around the lake where the water creates ponds. The higher amount of infiltration and recharge of SZ appears in days with intense rainfall.

The hydrological network is divided into 10 sub-catchments according to the main streams and the water flow was calculated for each sub-catchments. From the results Bogdanas stream presents the highest amount of water recharge followed by Megalo Rema and Kolxikos (Figure 3). The maximum amount of water flow is presented in the winter months and in days with high amount of precipitation. In summer days with no amounts of precipitation, water flow values are close to zero.

Precipitation and stream flow are the main parameters of Lake Koronia's recharging process. The largest amount of water withdrawal presented in areas around the lake and also in the northern part of the Lake where Bogdanas and Kolxikos streams are flowing to the Lake. The water that flows from the northern part of the Lake the last few years has decreased because of the excessive irrigation from the main streams of the Lake and as a result we have the reduction of Lake's water level. Monitoring methods and registration of legal and illegal wells are ways that could offer important information for efficient implementation of water management. The improvement of irrigation systems especially in summer months is essential for the Lake's restoration.

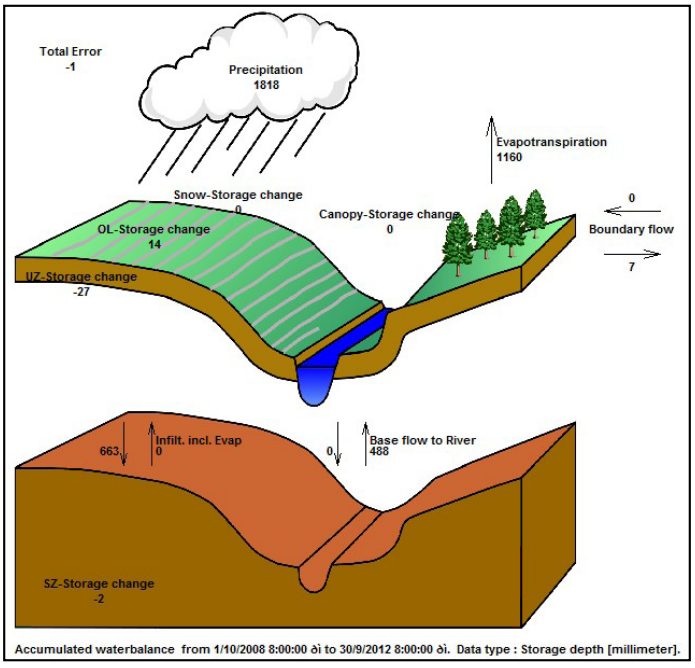
The module of water balance was used for the estimation of water budget for the period of 1/10/2008 – 30/9/2012. Figure 4 presents the results of water balance simulation. An acceptable value of error simulation is equal or lower of 1% of the total precipitation. In our study the calculated error of the water balance simulation has an acceptable value of 0, 05%. The greater loss of the water balance is from the amount of ET with a percentage of 63, 8% of the total precipitation.

Furthermore the annual estimation of the water balance is calculated from the total amount of each component divided by the years



Source: own processing

Figure 3: The daily water flow for each sub-catchment (6/2008-6/2013) produced by the MIKE SHE model.



Source: own processing

Figure 4: The estimation of total water balance (1/10/2008-30/9/2012), the numbers on the chart are in units of millimeters (mm) produced by the MIKE SHE model.

of the simulation. The annual actual ET is calculated at 290 mm and the annual precipitation at 454,5 mm. The amount of annual precipitation (~ 450 mm) presents a reduction (~ 500 mm) and the annual amount of actual ET (290 mm) presents also a reduction (~ 460 mm) for the years 2008-2012 compared with previous study conducted in the area (Mylopoulos et al., 2007). For the decreasing amounts of precipitation and ET we provide two possible assumptions.

The results may present a hydrological change compared to the past years with a reduction of the precipitation amount or the results could be underestimated due to the unavailability of detailed data. The use of the combined Penman–Monteith method may contribute in a more efficient calculation of reference ET if the required data are available. In order to calculate the annual water budget of Lake Koronia we used an equation to convert the total water balance for each component (mm) into m^3/year is:

$$N = \frac{\frac{n}{1000} * A}{t} \quad (3)$$

Where N is the converted values (mm to m^3/year), n is the number in (mm), A is the modeled area (m^2) =>782.000.000 m^2 and t is the simulation period length (4 years). In Table 3 we present the converted values and the total values for each components.

	Values in mm	Values in x10^6 m^3/year
Precipitation	1818	355.42
Evapotranspiration	1160	226.78
Overland storage	14	2.74
Infiltration	663	129.62
UZ storage	-27	-5.28
SZ storage	-2	-0.39
Base flow to river	488	95.40
Boundary flow	7	1.37

Source: own processing

Table 3: The converted values of the water balance from millimeters to m^3/year.

After the conversion we calculated the annual water budget (Table 4). Agriculture needs are the main factor of water consumption followed by industries and municipal needs. According to the annual consumption in order to cover these needs was estimated approximately at 100 x 10^6 m^3/year (Mouzouri et al., 2002). The results of the water budget underline the need to reduce or control the aggravating factors of irrigation. Physical ecosystems have the ability of self-preservation, if we mitigate the degradation factors. The water management plan needs to take into account a self-sustainable system at the catchment level in order to succeed the aforementioned.

The water distribution is highly affected by the amount of precipitation. Artificial Neural Networks were used to predict the values of water flow for Bogdanas and Kolxikos sub-catchment using time series of monthly mean precipitation amount and water flow. A first evaluation of the results accuracy may be observed when the training set and test set of training outputs are similar. Table 5 presents the results of the training and the test process for Bogdanas sub-catchment. We used 42 records for the training process with 61 test records. The R measure is the correlation between the real world target output and model output. In Bogdanas sub-catchment the R was found 0.9 for training and 0.8 for test presenting a good correlation between the observed and training output data.

Figure 5 presents the comparison diagram of the ANN training results and the observed data from the simulated water flow for the period of 6/2008-6/2013.

From the simulation results of Bogdanas River the highest amount of water flow was presented at October 2010 where the amount of precipitation in that month exceeded 200 mm. The ANNs also estimate the highest amount of water flow in that month.

	Inflow (x10^6 m^3/year)	Outflow (x10^6 m^3/year)
Precipitation	355.42	
Evapo-transpiration		226.78
Boundary flow		1.37
Changes in storage (infiltration – base flow to river)		129.62 - 95.4 = 34.22
Water consumption		100
Water budget	Inflow - Outflow = - 6. 95 x 106 m^3/year	

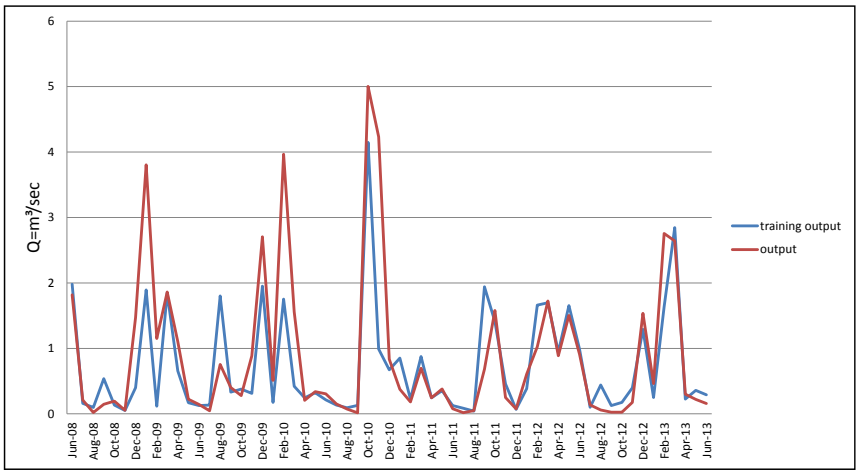
Source: own processing

Table 4: Calculation of water budget of Lake's Koronia Catchment for the period 1/10/2008-30/9/2012 in m^3/year .

OUT_1	R	Net-R	Avg. Abs.	Max. Abs.	RMS	Accuracy (20%)	Conf. Interval (95%)	Records
Train	0.900	0.773	0.277	2.213	0.551	0.905	1.110	42
Test	0.804	0.721	0.375	3.242	0.701	0.852	1.396	61

Source: own processing

Table 5: The training set and the test set of the actual and training water flow values for Bogdanas sub-catchment after the training of ANNs.



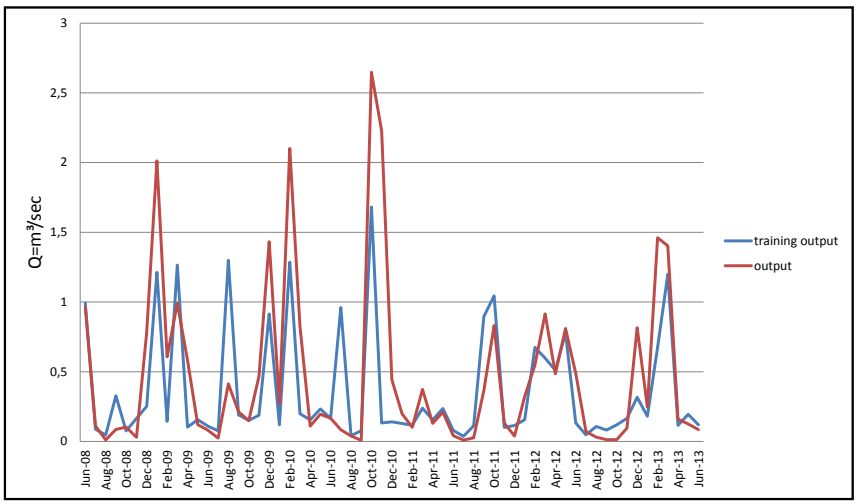
Source: own processing

Figure 5: The ANNs comparison diagram of the actual and training water flow for Bogdanas sub--catchment.

OUT_1	R	Net-R	Avg. Abs.	Max. Abs.	RMS	Accuracy (20%)	Conf. Interval (95%)	Records
Train	0.865	0.791	0.209	0.965	0.333	0.9047	0.670	42
Test	0.7129	0.660	0.249	2.095	0.434	0.836	0.865	61

Source: own processing

Table 6: The training set and the test set of the actual and training water flow values for Kolxikos sub-catchment after the training of ANNs.



Source: own processing

Figure 6: The ANNs comparison diagram of the actual and training water flow for Kolxikos sub-catchment.

Table 6 presents the results of the test facility in Kolxikos sub-catchment and Figure 6 the comparison diagram of the training output and observed data for the period 1/6/2008-30/6/2013. Also the R presents a good correlation between the observed and training output data with values of 0.865 for the training and 0.7129 for the test.

In the comparison diagram (Figure 6) the higher amount of water flow appears also at October 2010. In general the summer presents very low amount of water flow and in winter the largest amounts of water flow.

We also calculate the Root Mean Square Error (RMSE) and the Mean Absolute Percentages Error (MAPE). The RMSE is the root calculated from the difference between the actual from the predicted value and the calculated average squared error. The MAPE is usually presented as a percentage and is expressed as the ratio of actual values minus the predicted divided by the actual values. The result is divided by the number of the values and multiplied by 100 in order to calculate the average error as a percentage. In Bogdanas sub-catchment the RMSE was found ~ 0.701 and the MAPE 93.64 %. In Kolxikos sub-catchment the RMSE is ~ 0.43 and the MAPE 126.78 %. The results of the ANNs show that a fair estimation and prediction of water flow is able when the values of precipitation amount and water flow are known.

Conclusions

Wetlands processes are interlinked with the environmental conditions of precipitation, groundwater, overland flow and evapotranspiration. The adoption of new technologies can provide efficient tools with many applications in the field of water management. In this study we used MIKE SHE model in order to simulate the water flow and water balance tool to estimate the water balance for 4 hydrological years (2008-2012) in the catchment of Lake Koronia. The last twenty years Lake Koronia presents a negative water budget due mostly to excessive irrigation uses. Agriculture needs are the main factor of water consumption followed by industries and municipal needs. The adjustment of the water management to the existing hydrological conditions and the consideration of the stakeholders needs are necessary procedures for the restoration of Lake Koronia. Climatic parameters also affect the water allocation where in the months of summer presented the major deficits of water balance. Improvement of irrigation systems especially in summer is essential for lake's restoration. Although the MIKE SHE model is highly complex and high demanding of input data a fair estimation with the minimum requiring data was developed for the hydrological conditions in the catchment of Lake Koronia.

The results of the water flow from the MIKE SHE model were also used for the training of the ANNs as output values and a set of rainfall data was used as input value for the period 1/6/2008-30/6/2013. An efficient correlation (R) was found after the training of ANNs for Bogdanas (0.9) and Kolxikos (0.86) sub-catchment. The results of ANNs show that a fairly accurate estimation and prediction of water flow is able when the values of precipitation amount and water flow are known.

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Determinants of the Farmers' Conversion to Organic and Biodynamic Agriculture

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Anotace

Cílem článku je posoudit zvolené determinanty, které ovlivňují přechod českých zemědělců z konvenčního na ekologické a biodynamické zemědělství. Je posuzována efektivnost farem (vypočtená metodou stochastické hraniční analýzy), zda farma obdržela AEO nebo LFA platby, jestli je farmář "mladý", zda se jedná o mikropodnik a region. Byl odhadnut logistický regresní model náhodných efektů na panelu českých farem v letech 2005–2012.

Výsledky ukazují, že efektivnost farmy není významným činitelem konverze. Na druhou stranu šance, že zemědělský podnik změní způsob hospodaření, jsou statisticky významně vyšší, jestliže pobírá dotace. Také pokud má farma méně než 10 zaměstnanců a zemědělec je starší 40 let, šance, že přejde na ekologické nebo biodynamické zemědělství jsou vyšší. Naopak jestliže se farma nachází v Olomouckém kraji nebo na Vysočině, šance na konverzi jsou nižší.

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Klíčová slova

Ekologické a biodynamické zemědělství, stochastická hraniční analýza, model náhodných efektů.

Abstract

The aim is to assess selected determinants which influence the conversion of the Czech farmers from conventional to organic or biodynamic agriculture. We assess farm's efficiency (calculated by SFA), whether farm obtains AEM or LFA payments, if the farmer is "young" and the holding is a micro firm, and region. A random effects logistic regression model was estimated on the panel of Czech farms in 2005–2012.

The results showed that efficiency of the farm is not a significant driver of conversion. On the other hand, the odds that the farm will change land management are significantly higher if it obtains subsidies. Also when the farm has < 10 employees and the farmer is > 40 years, the odds that it will switch are higher. If the farm is located Olomoucký region or Vysočina the odds for conversion are lower.

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Key words

Organic and biodynamic agriculture, stochastic frontier analysis, random effects model.

Introduction

For both, organic and biodynamic agriculture environmentally friendly production process is typical. Organic agriculture is utilizing only the inputs with propitious effects on the environment, human health and the health of farm animals. Biodynamic agriculture introduced by Rudolf Steiner in 1924 (Steiner, 2004) is similar to organic in many ways. „The difference from organic agriculture, apart from philosophical and historical aspects, lies in the use of biodynamic preparations which contain specific herbs or minerals, treated or fermented with animal organs, water and/or soil. These preparations are applied in finely-diluted form (homoeopathically), generally as field sprays after dynamisation, i.e., agitated in a specific way for long periods" (Heimler et al., 2009).

Both, organic and biodynamic agriculture "respect the normal functioning of ecosystems, avoiding the use of agrochemicals, and leads to food "free" of synthetic chemicals and, thus, more healthy" (Carvalho, 2006). Because of these favourable effects on the environment and the health and to compensate higher production costs, organic agriculture is subsidized. The amount of subsidies to the organic farming is continuously increasing in the Czech Republic. While in 1998 it was only 48 million CZK in 2004 it increased to nearly 277 million CZK. (Jánský and Živělová, 2007) Dependence of the farmers on the public funds has been analysed in many researches. Therefore, we suppose that subsidies may play its role as a determinant of the change of the land management. Kroupová and Malý (2010) argue that it is necessary to continuously analyse the efficiency of spend public funds in relation to the value added. Therefore, in our article we also include the technical efficiency of the organic and biodynamic farms as one of the determinants. Besides, we also consider the age of the farmer and the size of the agricultural holding.

The article is structured as follows. Firstly the results of previous researches are introduced. Next section presents the data and the methods (Stochastic Frontier Analysis (SFA) and random effect logistic regression (RELR)). The results are discussed then. Last section concludes.

While the conversion from conventional to organic agriculture concerned many authors, the research in biodynamic agriculture is still mild. We are not aware about any research which would examine this issue. Therefore, assessing selected determinants of change to biodynamic farming is the main contribution of our paper. According to Kumbhakar et al. (2009) the main driving forces behind the adoption of the organic technology in Finland are the efficiency of the farms and the subsidies. It was proved by Malá (2011) that the organic farms are less efficient than conventional ones. Similarly Pechrová and Vlašicová (2013) found that there were statistically significant differences between biodynamic (with inefficiency at the level of 58.09%) and organic farms (inefficiency was only 28.60%). We also include efficiency and subsidies into our analysis to see their effect on conversion decision.

Regarding the others determinants Lohr and Salomonsson (2000) showed that the access to more market outlets and information sources are important for farmers and substitute for payment level in the farmer's utility function. They concluded that services rather than subsidies may be used to encourage the conversion to organic agriculture. Läpple and Kelley (2013) examined the farmers' beliefs regarding the adoption of organic methods in Ireland. They found out that the impact of economic incentives and technical barriers on the decision to convert to organic farming vary and that the social acceptance of organic farming restricts the adoption. Wheeler (2008) questioned agricultural professionals and found out that „significant key influences on attitudes towards organic farming were: knowledge, experience, education, informational, occupational effects, and attitudes on the individual aspects of organic agriculture." Also Mzougi (2011) analysed the adoption of integrated crop protection and organic farming from social point of view. He discovered that in France social concerns drive the conversion to both practices, while moral concerns increase the probability of organic farming adoption. Läpple and Rensburg (2011) showed that environmental attitudes and social learning were important determinants for conversion to organic farming. However, acknowledging that "farmers who give high importance to economic concerns (e.g., cutting production costs) are less likely to adopt organic farming" (Mzougi, 2011) does not necessary mean that farms are working inefficiently. We understand the technical efficiency as the relation between inputs and outputs when a firm is more efficient when it uses fewer inputs to produce given output. This is in line with the philosophy of organic and biodynamic farming when fewer chemicals are utilized.

Materials and methods

Firstly, the technical efficiency is calculated by SFA. In the second step, we use RELR to model the influence of technical efficiency and other determinants on the decision of the farmer to convert from conventional to organic management scheme.

At the end of 2013 there were 4060 organic farms at 493 394 hectares of land having mostly grasslands (83.30%) in the Czech Republic (Ministry of Agriculture, 2014). There are only four biodynamic farms certified by Demeter-International e.V. in the CR farming at 3831 hectares. In our sample, there are four of them, but only three are already certified. One biodynamic farm focuses on breeding of beef and dairy cattle and growing of cereals buckwheat, oats, wheat,

wheat – spelt on over 100 hectares. It even has its own bakery. Sometimes the owners hold seminars about healthy nutrition and preparation of biodynamic preparations. Contrary to this family type farm, the second one is joint – stock company farming on more than 1000 hectares. The most of the land is covered by the grassland, arable land accounts only for one quarter. The third farm focuses on wheat, barley, rye, corn and potatoes. The last one is winery managing more than 50 hectares of the vineyards.

The accountancy data of the farms were obtained from Albertina database of Bisnode s. r. o. and the data about the subsidies from State Agricultural Interventional Fund. An unbalanced panel of 50 farms contained 292 observations for years 2005-2012 (5.8 on average). Panel data enable to control the heterogeneity of the farms and thus avoid obtaining biased results. Especially in the case of the change of production technology, a usage of panel data is recommended (Pitt and Lee, 1981). The calculations were done in Stata 11.2.

Stochastic Frontier Analysis

Firstly, using SFA a Cobb-Douglas production function was estimated on the data from 2005 to 2012. The coefficients can be interpreted as the elasticity and their sum expresses whether the constant (equal to 1), increasing (higher than 1) or decreasing (lower than 1) returns to scale prevail. The amount of the production deflated by the agricultural producers' prices (2005 = 100) ($y_{1,\,it}$ – where i (i =1, … n) denotes particular farm in time t) was explained by 4 production factors: consumed material ($x_{1,\,it}$) and capital ($x_{2,\,it}$), both deflated by industrial producers' prices (2005 = 100). Labour as the number of the workers ($x_{3,\,it}$) was calculated as the division of personal costs by average agricultural wages in each region in particular year. The land in hectares ($x_{4,\,it}$) was multiplied by the coefficient reflecting the land quality. This was calculated as the division of the average official land price in the region and the average of that price in the Czech Republic in particular year).

We assumed the heterogeneity among the farms and explained it in the function of the mean of the inefficiency term. The explanatory variables were the sum of SAPS and Top-up subsidies ($z_{1,\,it}$), the payments under Agro-environmental measures (AEM) ($z_{2,\,it}$) and the support for Less Favoured Areas (LFA) ($z_{3,\,it}$). The "True" Fixed-Effects (TFE) model suggested by Greene (2002) was estimated in the following form (1).

$$y_{it} = \alpha_i + \boldsymbol{\beta}^T \mathbf{x}_{it} + v_{it} - u_{it}, \quad (1)$$

where α_i is the farm specific time invariant constant, x_{it} represents the explanatory variables, v_{it} is independently identically distributed $N(0;\sigma^2_{v_{it}})$ error term representing usual statistical noise, and u_{it} is time variant inefficiency term. Both parts of the stochastic term (u_{it} and v_{it}) are individual and time variant. We assumed u_{it} to be truncated normal distributed. The heterogeneity of the farms is explained in the mean function. The maximum likelihood estimation was applied. The inefficiency and the efficiency were calculated as expected value of u_{it} given ε_{it} (Jondrow et al., 1982).

Random Effects Logit Regression Model

In the second step, the technical efficiency was used as explanatory variable in logit model adjusted for panel data. The explained variable is the dummy y'_{it} (i denotes particular farm and t = 1, ..., T is time) taking value of 0 in particular year when the farm was conventional and value of 1 when it was already under organic or biodynamic land management. As explanatory variables were included: $x'_{1,\,it}$ – the efficiency of particular farm i in time t; $x'_{2,\,it}$ – dummy for AEM subsidies taking value 1 when the farm obtains them and 0 otherwise; $x'_{3,\,it}$ – dummy for LFA payment (1 – obtain subsidies, 0 – no subsidies); $x'_{4,\,it}$ – dummy for the age of the farmer taking value of 1 when it is a young farmer (< 40 years according to the definition of the European Commission (EC)) and 0 if otherwise; $x'_{5,\,it}$ – dummy taking value of 1, when it is a micro farm (has < 10 employees according to the definition of the EC) and 0 otherwise.

As "a growing number of studies focus also on the role of spatial effects in the adoption process and find evidence for the spatial clustering of organic farming" (Wollni and Andersonn, 2014), we also included the localization of the farm in one of the 13 NUTS III regions in the Czech Republic (with exception of capital city Prague). Jihočeský region was omitted and all regions were compared to it.

We use logit model adjusted for panel data (for cross-sectional data study see e. g. Šimpach, 2012), which examines the log-odds (a ratio of expected number of successes to each failure) (2).

$$\log\left(\frac{p(y'_{it}|\mathbf{x}'_{it})}{1-p(y'_{it}|\mathbf{x}'_{it})}\right)=\beta_{0i}+\mathbf{x}'^{T}_{it}\boldsymbol{\beta}, \quad (2)$$

where p is the probability and $\mathbf{x}'_{it}$ is a matrix of 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) when we construct the Fixed Effect Model (FEM) or random (y'_{it} is assumed to be conditionally independent given β_{0i}) when we estimate the Random Effect Model (REM). When all outcomes are either positive or either negative (as it is our case – sometimes all observation for a farm are for years when it was already organic) those observations would be dropped from FEM. Besides, if the within-person variation is small relative to the between-farms variation, the standards errors of the FEM might be too large. Unlike the FEM, the REM enables to estimate the effect of variables even when they are not time-variant. Under a random coefficients specification, the parameters are assumed to be randomly distributed across the individuals. The REM is more suitable when there are no omitted variables or if we assume that they are uncorrelated with (independent of) the explanatory variables in the model. We estimated the RELR model by maximum likelihood method.

Results and discussion

The most changes from convention to organic farming in our sample took place between the years 2005 and 2006. This might be due to the entrance of the Czech Republic to the EU and the possibility to obtain subsidies on conversion. Then farms in our sample converted between 2010 and 2011. This follows overall trend in the Czech Republic (increase by 403 farms between 2010 and 2011). New program period 2007–2013 brought increased financial possibilities which also might influence the conversion. In our sample an average amount of the subsidies on AEM was the highest in the years 2010 and 2011 (2.56 mil. CZK and 2.71 CZK per one farm). In comparison with year 2005 (0.09 mil. CZK) the subsidies were almost 30 times higher. Also increasing consumption of products of ecological agriculture (the consumption was three times higher in 2010 than in 2005 – see Hrabalová and Dittrichová (2012)) could have played its role.

The average production of the farms increased in 2005–2007, dropped in the crisis year 2008 and is rising again since that. The use of material was on average 29 772.94 thous. CZK per year and of capital 64 421.98 thous. CZK per year. Average number of workers dropped the most between 2007 and 2008. An average number for the whole period was 93.94. There were 12 micro farms with less than 10 employees (24% of all farms). The size of the agricultural holdings was on average 283.02 ha. One farm received on average 6427.64 thous. CZK of the direct payments (SAPS and Top-Up), 1 435.06 thous. CZK under AEM and 829.17 thous. CZK of the LFA subsidies per year. The amount of SAPS, Top-Up, and AEM grew over time, while the LFA payments were the same in 2009–2010 and dropped in 2011. While SAPS and Top-up are gained regardless the farming management, there were only 152 observations (52.05% of the sample) where the farms received AEM subsidies and 104 (35.62%) where they received LFA subsidies. The average age of the farmer was 48.62 years, 14 farms (28.00% of all) were managed by a "young" farmer.

Efficiency of organic and biodynamic farms

SFA was used to estimate Cobb-Douglas production function in linearized form. The results are displayed at Table 1. Wald $\chi^2 = 4.57e^{14}$ with p-value 0.00 implied that the model as a whole was statistically significant. All frontier parameters were statistically significant at $\alpha = 0.01$ level. All signs were positive according to the expectations. It implies that increase of the material, capital, labour, and land by 1% bring the increase of production by 0.46%, 0.11%, 0.21% and 7.79% respectively. The intensity is the highest in the case of the land.

The parameters of inefficiency mean function are not statistically significant implying that the subsidies do not significantly influence the inefficiency. Similarly Picazo-Tadeo et al. (2011) found out that the subsidies do not have statistically significant impact on eco-efficiency. In the case of the Czech Republic for example Kroupová (2010) did not find any influence of the subsidies on the support of organic farming on the technical inefficiency. Only other subsidies had according to Kroupová (2010) negative impact on technical inefficiency as they increased it.

Direct payments and AEM subsidies cause mild decrease in mean inefficiency. On the other hand LFA subsidies slightly increase it. Contrary to that Boudný, et al. (2011) found out that the most of AEM and LFA payments per hectare were

	Coeff. (Std. err.)		Coeff. (Std. err.)
Frontier		**μu – inefficiency mean function**	
β_1 ($x_{1,it}$ – material)	0.4559 (1.03e^{-6})***	δ_0 (constant)	-170.7862 (371.7199)
β_2 ($x_{2,it}$ – capital)	0.1106 (5.56e^{-7}) ***	δ_1 ($z_{1,it}$ – SAPS+Top-Up)	-0.3413 (1.7474)
β_3 ($x_{3,it}$ – labour)	0.2075 (1.95e^{-6})***	δ_2 ($z_{2,it}$ – AEM)	-0.1770 (3.9670)
β_4 ($x_{4,it}$ – land)	7.7907 (5.22e^{-7})***	δ_3 ($z_{3,it}$ – LFA)	2.9043 (6.3640)
σ_v – stochastic term variance function		**σ_u – inefficiency variance function**	
γ_0 (constant)	-40.9332 (521.0789)	ω_0 (constant)	3.9620 (2.1678)*

Source: own elaboration; Note: statistical significance is labelled: *** at α = 0.01, ** at α = 0.05 and * at α = 0.1

Table 1: TFE estimates, truncated-normal distribution of u_{it}.

obtained by the 25% of the least efficient farms and therefore both type of the subsidies had negative impact on technical efficiency. Sum of frontier's coefficients is higher than one which implies that farms are achieving increasing returns to scale.

When calculating the efficiency, 1 observation was dropped. The average inefficiency was estimated at 28.59%, but it varied a lot, as the standard deviation was 41.55%. The efficiency was relatively high; an average farm produced 79.38% of the potential product with the standard deviation of 19.38%. Half of farms were efficient from more than 82.49%. Compared to the results of Kroupová (2010), where the average efficiency of organic farms was only 55.1% in 2004–2008 we can see that in our case it is higher. This might be due to the location of the farms. There were 70% of the farms located in less favoured areas in Kroupová's sample, but in our case the share was only 35.62% of the observations. The least efficient farm produced only 3.16% of its potential production. There were 49 observations almost 100% efficient. The highest technical efficiency was in years 2010 and 2011 when 10 and 7 farms respectively were 100% efficient.

Biodynamic farms were on average inefficient from 54.42%, while the organic ones only from 26.27%. They also produced only 67.23% of their potential production while organic 80.46%. This suggests that biodynamic farms are on average less efficient than organic. It was proved by Kruskal-Wallis test that organic and biodynamic farms' median inefficiency and efficiency statistically significantly differs. This is in line with the findings of Pechrová and Vlašicová (2013).

The reasons for lower efficiency are given by different technology applied by biodynamic and organic farms. Biodynamic farming applies holistic management practices that address the environmental, social, and financial aspects of the farm. Similarly conventional farms differ from organic ones. Kroupová (2010) and Malá (2011) suggest that the lower efficiency of organic farms can be caused by the fact that they are located in less favoured areas which are less suitable for intensive (or hence efficient) use.

Determinants of conversion to organic and biodynamic farming

The farmer's decision to convert was explained in the RELM. We tried several specifications and chose the one which explains the choice the most statistically significantly. The results are displayed at Table 2. Wald $\chi^{2[17]} = 39.8700$ with p-value 0.0013 revealed that the model was statistically significant. The ρ tells that 30.22% of variation is due to the variation in the panel data which implies that the panel estimator is justified.

The direction of efficiency coefficient suggests that the odds for conversion are higher when the farm is more efficient. When it converts to organic land management, the farm becomes less efficient than conventional – see e.g. findings of Malá (2011). This fact provides a rationale for the compensatory payments to the organic agriculture.

A wide portion of the changes took place between years 2009 and 2010 where the efficiency of the farms was almost the highest. This finding is in line with Kumbhakar (2009) who found out that subsidy is attracting efficient farms. He hopes "that in the long run organic farms will be as efficient as the conventional ones. If so, in the long run subsidy will be necessary only if productivity shortfall of organic farms (pure technological not inefficiency) is not compensated by the price premium they receive" (Kumbhakar, 2009).

The subsidies for organic farming provided through Common Agricultural Policy of the European Union have statistically significant impact on the decision of a farmer to convert. Because all organic and biodynamic farms received SAPS (and Top-Up support), it was not included

Variable	Coeff. (Std. err.)	Variable	Coeff. (Std. err.)
β_0 (constant)	-2.7360 (1.5397)*	β_3' (x_3'$_{it}$ – LFA dummy)	1.8523 (0.8313)**
β_1' (x_1'$_{it}$ – efficiency)	1.8357 (1.1815)	β_4' (x_4'$_{it}$ – age dummy)	-2.0086 (0.9688)**
β_2'(x_2' it – AEM dummy)	2.7488 (0.6666)***	β_5'(x_5'$_{it}$ – farm size dummy)	2.0377 (0.8633)**
Regions' dummy			
α_{0i} (constant)	-2.7360 (1.5397)*		
α_{1i} (Jihomoravský)	-0,3503 (1,2702)	α_{7i} (Pardubický)	0,4816 (1,6737)
α_{2i} (Karlovarský)	2,2144 (2,0435)	α_{8i} (Plzeňský)	-2,2082 (1,8448)
α_{3i} (Královéhradecký)	1,0693 (1,5327)	α_{9i} (Středočeský)	0,1730 (1,8921)
α_{4i} (Liberecký)	1,6620 (1,7708)	α_{10i} (Ústecký)	0,7156 (1,6063)
α_{5i} (Moravskoslezský)	-1,9105 (1,3306)	α_{11i} (Vysočina)	-2,8228 (1,3779)**
α_{6i} (Olomoucký)	-5,0422 (1,9734)**	α_{12i} (Zlínský)	1,5264 (1,3198)

Source: own elaboration; Note: statistical significance is labelled: *** at α = 0.01, ** at α = 0.05 and * at α = 0.1

Table 2: Random-effect logistic regression for farms' conversion to organic / biodynamic farming.

as the determinant of the conversion. On the other hand, only some farms took the advantage from AEM measures and only some of them were located in LFA areas. Both entitlements are contributing positive to the odds that the farmer will switch to organic farming. The higher are the subsidies the higher are the odds that the farm is organic. Farmers see subsidies as significant addition to their income (on average a farmer gets additional 9 mil. CZK each year).

Surprisingly, if the farmer is young, the odds that he will change for organic farming are lower (by 86.95%). It might be due to the fact that he does not have sufficient information about the possibility of the conversion. Besides, 46.7% of the farmers in the CR belong to the age group of 45-59 years as same as there are only 14 young farmers (28.00%) in our sample. Similar conclusion was made by Alexopoulos et al. (2010) for conversion to organic farms in Greece. They found out that "older farmers owning larger farms are more likely to have adopted organic farming". However, regarding the size of the holding, for the CR, the opposite is true. The smaller is the farm in terms of the number of employees, the higher are the odds that it will convert to organic farming. Larger farms may achieve the returns to scale and therefore the conversion would lover their efficiency. For example in our sample there are 12 micro farms (48 observations). There are efficient from 71.11% while the others are efficient from 81.01%. Kruskal-Wallis test revealed that the average efficiency statistically significantly differs.

Another examined determinant was the location of a farm. Statistically significant influence had the fact that the farm was located in Olomoucký region or at Vysočina. In both cases the odds for the conversion were lower. Vysočina is an agricultural region where intensive production on arable land prevails. Therefore, it seems that the farmers feel that the conversion would hamper their effort to produce efficiently. However, the research of Kerselaers et al. (2007) highlighted that "the economic potential for conversion to organic farming is in general higher than assumed or perceived by farmers". Therefore, more information could be needed.

Conclusion

The aim of the paper was to assess selected determinants of the farmer's decision to convert from conventional to organic or biodynamic agriculture. Firstly, the efficiency was calculated for each farm for years 2005–2012. It was found that the average organic or biodynamic farm produces only 79.38% of its potential production. Other factors influencing conversion were whether the farm received subsidies (AEM or LFA) in particular year, the age of the farmer and the size of the farm.

Results show that all factors accept for the age influence the conversion positively. The increase of efficiency increases the odds that the farm will convert to organic farming, but the effect is not statistically significant. It implies that organic farming is attracting more efficient farms, although we cannot clearly conclude. Subsidies are the major driver of conversion. The odds that the farm converts to organic or biodynamic farming are higher when it obtains AEM or LFA subsidies. Similarly, when the farm is smaller, it is more likely to convert.

On the other hand, if the farmer is young, the odds that he or she will change the land management are lower. It might be due to less information available for him. Hence, we suggest providing to the farmers more information about the potential of organic (or biodynamic) farming. If the farm is located in Olomoucký region and Vysočina, the odds that it will convert are statistically significantly lower.

We must keep in mind that our sample is limited in terms of the data's nature (accountancy data) and the number of organic and biodynamic farms included. There are only four of the later ones certified by Demeter International Inc. in the Czech Republic (three of them included in a sample, the forth one is not certified yet). Hence it is not sufficient to perform only quantitative analysis. Besides, farmers' attitude differs. Each one has own preferences and objectives which influence the choice of the farming method. It is a challenge for future research to conduct in-depth interviews with the farmers.

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Analysis of Development of Czech Foreign Trade in Foods and Beverages

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Anotace

Cílem tohoto příspěvku bylo analyzovat vývoj českého zahraničního obchodu s potravinářskými výrobky a nápoji (v systému klasifikace produkce jde o CPA 10 a 11) a zhodnotit pozici jednotlivých skupin CPA a jejich produktů, a to i v rámci EU, za použití dvou indexů komparativních výhod (RCA) a obchodních bilancí. Smyslem je přispět k hlubšímu poznání této problematiky, neboť analytické práce věnované celému agrárnímu zahraničnímu obchodu ČR jsou na oblast potravin a nápojů méně zaměřeny. Přitom by mělo jít o stěžejní oblast tohoto obchodu, a to zejména s ohledem na konkurenceschopnost celého agrárního sektoru. Zdrojem dat o zahraničním obchodě byly veřejné databáze ČSÚ (databáze zahraničního obchodu) a Eurostat (International Trade database). Hodnoceným obdobím jsou roky 2005 až 2013. Ke značným změnám v českém zahraničním obchodě s potravinami a nápoji došlo v souvislosti se vstupem do EU, k těm se však již tato práce nevrací. Zaměřena je na období, kdy již ČR členem EU byla a plně se v ní etablovala. Jde však o to, s jakými výsledky v dané oblasti. Výsledky ukázaly, že hodnota českého dovozu potravinářských výrobků a nápojů se v letech 2005-2013 zvýšila vyšší měrou nežli hodnota jejich vývozu, což vedlo k nárůstu záporného saldo obchodu o 51 % na 29,3 mld. Kč. Stupeň krytí dovozu vývozem se však vzhledem k nižší dynamice růstu dovozu než vývozu zlepšil ze 73,0 % na 77,3 %. Mimo vlastního hodnocení vývoje zahraničního obchodu ČR s potravinami a nápoji se příspěvek zabývá také konkrétním způsobem převodu Kombinované nomenklatury na nomenklaturu CPA. Metodickým přínosem je pak sestavení vlastního souboru kódů celního sazebníku, resp. jejich agregací spadajících do jednotlivých oborů CPA. Tento soubor je využitelný k dalším analýzám.

Klíčová slova

Potraviny, nápoje, vývoz, dovoz, bilance zahraničního obchodu, RCA index, Klasifikace produkce CPA, Kombinovaná nomenklatura EU, agrární obchod.

Abstract

The aim of this paper is to analyse the development of Czech foreign trade in food products and beverages (the CPA groups 10 and 11 within the Classification System) and to evaluate the position of individual CPA groups and their products, even within the EU, using two indices of comparative advantage (RCA) and trade balances. The purpose is to contribute to a deeper understanding of the given issue as the analytical work dealing with whole Czech agrarian foreign trade is less focused on foods and drinks. However, they should be a core area of business, especially with regard to competitiveness of the agricultural sector. The sources of data on foreign trade are public databases of Czech Statistical Office (External Trade Database) and Eurostat (International Trade database ComExt). Regarding the time series, period of the years 2005-2013 is analysed. Significant changes in the sales and purchases of foodstuff and beverages were occurred in the context of accession to the EU but these changes are not in focus yet. The paper is engaged in the period when the Czech Republic has already been a member of the EU, and fully entrenched. The point is which results in foreign trade with.

Results showed that value of Czech imports of food products and beverages in the years 2005-2013 increased in the larger extent than exports, and negative trade balance deepened by 51 % to 29.3 Bn CZK. The degree of coverage of imports by exports, however, improved from 73.0 % to 77.3 % due to lower dynamics of growth of imports than exports.

Besides of the own assessment of the Czech food and beverage foreign trade, our work has consisted in specific transfer of the Combined Nomenclature to the nomenclature CPA. The methodological contribution

is then our own list of customs codes, respectively their aggregations, belonging to the individual CPA disciplines. This should be useful for next analysis.

Key words

Food, beverages, exports, imports, trade balance, RCA index, Classification of Products by Activity (CPA), Combined Nomenclature of the EU, agrarian trade.

Introduction

In generally, domestic food and beverage consumption is covered mostly by foods and beverages produced in the Czech Republic. Food and beverage production is a key sector of the manufacturing industry. However, to maintain its position it is necessary to increase its efficiency and competitiveness. Traill (1998) identified sectoral competitiveness and used the following definition of this term: a competitive industry is one that possesses the sustained ability to profitably gain and maintain market share in domestic and/or foreign markets. Putičová and Mezera (2011) were engaged in the issue of the competitiveness and the performance of the Czech food industry. Both these attributes are evaluated in the framework of the domestic manufacturing sector and domestic market, as well as from the foreign trade point of view in context of European and world markets. They concluded that the sector competitiveness was not in critical situation. However, the sector competitiveness assessed by the RCA indices and foreign trade indicators had not been improving, the stagnation were confirmed. As Čechura (2009, 2012) said, technical efficiency in the Czech food processing industry did not change significantly within the period from 2000 to 2007. A common detected feature of all analysed food processing industry branches (food processing industry total, slaughtering, dairy, milling, feedstuffs, beverages) in the analysed period was that the technological changes did not contribute substantially to the development of efficiency. On the other hand, he concluded that Total Factor Productivity (TFP) in the food processing industry increased significantly within the analysed period. Evidence suggests that innovation activities can have a positive effect on business performance of the food companies, and vertical cooperation increases exports of processed food products substantially (Ghazalian and Furtan, 2007). A technological change is an important factor determining the TFP increase. Nevertheless, the improvement in production possibilities was caused rather by diffusion of knowledge generated in another part of economy, or imported from abroad, than by own sector research and development.

The aim of this paper is to analyse the development of Czech foreign trade in food products and beverages. The paper is organised as follows. First part describes using of classification systems and RCA indices. The second part is devoted to description of the results. The last part presents conclusions.

Materials and methods

Basic foreign food and beverage trade is regular part of "Panorama of food industry", which is published annually by Ministry of Agriculture (with cooperation with Institute of Agricultural Economics and Information). But this publication uses primary data provided by Ministry of Industry and Trade, which are aggregated to whole food and beverage CPA groups[1]. The publication assesses especially production and economic characteristics of the food sector and its branches, and from the broader perspective the sector competitiveness as well. Foreign trade in this publication has only a supplementary character. More detailed view on commodity and territorial structure of Czech foreign food and beverage trade[2] must be obtained on the basis of import and export data of CZSO, i. e. of Harmonised Commodity Description and Coding System, respectively Combined Nomenclature of the EU[3] or SITC[4], from External Trade Database.

Import and export data (in EUR) on foods

[1] Classification of Products by Activity (CPA) is a part of an integrated system of statistical classifications. The CPA is a product classification. Their elements are related to activities as defined by NACE Rev. 2 (Classification of economic activities in the European Communities).

[2] Within the foods and beverages defined by the CPA groups 10 and 11, also animal feed and some products for technical use are included.

[3] Combined Nomenclature of the EU (8-digit codes) is based on Harmonized Commodity Description and Coding System (2, 4 and 6-digit codes).

[4] SITC is the United Nations' Standard International Trade Classification.

and beverages by PRODCOM[5] for the Czech Republic and other EU members are available in Eurostat database (Statistics on industrial production and international trade). These data, however, do not cover foreign trade of countries in the same extent as the external trade statistics. In comparison to values of food and beverage imports and exports in publication "Panorama of food industry" they are obviously lower. It is caused by other source of data, other way of data collection, other reporting units, currency conversion, various data standardisation etc.

Development of foreign trade in processed products and unprocessed commodities is regularly analysed in Agrarian foreign trade yearbook of the Czech Republic, which is published by Institute of Agricultural Economics and Information, but this analysis uses the adjusted classification of Regmi et al. (2005)[6]. It is based on 6-digit HS codes and is related to HS chapters 01-24 (includes also tobacco and tobacco products). That is why the list of processed agrarian products does not correspond to the list of foods and beverages defined by CPA 10 and 11. For example semi-processed agrarian products include live animals and processed agrarian products incorporate eggs according to the adjusted Regmi et al.

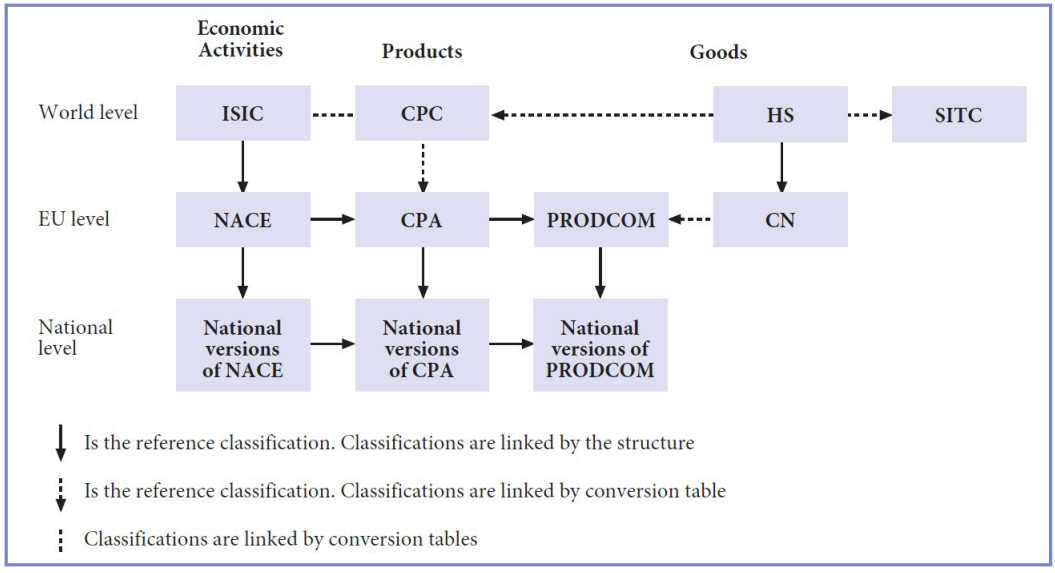
Regarding Classification of Products by Activity (CPA), this classification started in the Czech Republic for statistical purposes on 1st January 2008. Before, Standard Classification of Production (SKP) had been in force[7]. CPA nomenclature is a part of integrated system of statistical classification, see following diagram.

Transition of HS/CN codes to CPA codes is basic precondition of practical monitoring and more detailed analysis of Czech foreign food and beverage trade which can use data from external trade database. However, the converter between HS/CN and CPA codes cannot be created absolutely accurate, and it cannot avoid certain simplifications. Although majority of HS/CN codes correspond to RCA codes, in some cases, exact transition is not possible. Problems by converting are caused, for example, by impossibility of separating agrarian commodities from food products in all cases because some items, even on 8-digit CN codes, contain both unprocessed and processed goods, products within some CN codes could be included in more CPA groups than in one, HS/CN items which are described as "others" could not be identified in every time, as well sometimes it could not be

[5] PRODCOM is the classification of goods used for statistics on industrial production in the EU.

[6] This classification defines four categories: bulk commodities, horticulture products, semi-processed products and processed products. Production of the first two categories depend on land availability, geography and climatic conditions, while the next two categories are less dependent upon those factors, undergo some transformation prior to their final use and in principle, can be produced almost anywhere.

[7] SKP was based on the Industrial Classification of Economic Activities (Czech acronym is OKEČ). This classification and NACE are cohesive till 2-digit codes.



Source: Eurostat, NACE Rev. 2 Statistical classification of economic activities in the European Community

Diagram 1: Statistical classification integral system.

clear what a CPA group incorporates. Problems what is included or removed in individual codes can be partly sort out by relevant explanatory notes of HS, CN, CPA and NACE nomenclature[8], but in some cases, it is not possible even with them. Besides that, nomenclatures are revised and their codes are chanced[9].

Convertors between Combined Nomenclature and CPA classification for 8-digit CN codes and 6-digit CPA codes are at public disposal on Eurostat web, as well as on Czech Statistical Office web. These convertors are available for CN a CPA codes of 2008, so they had to be adjusted.

Additional adjustments were done for the reason of some specifics of Czech agrarian foreign trade. An essential imperfection of the official convertor is that CPA 10.5 Dairy products include the code CN 0401 20 99 "Milk, not concentrated, nor sweetened, of a fat content exceeding 3 % but not exceeding 6 %, in immediate packing exceeding 2 litres", which incorporates predominantly raw milk (unfortunately, raw milk has no own customs code). That is why the code CN 0401 20 99 was excluded out of the group 10.5. In a similar way, there was excluded the code CN 2201 90 00 "Waters, not sweetened nor flavoured" which include normal water, not only packaged (it is deduced, among others, from its extremely low export price), out of CPA 11 Beverages. Next adjustments are small-scale and concerns, for example, selection of unprocessed and processed spices and see fruits.

The official convertor was respected in case of HS 1602 10 "Homogenised preparations of meat, meat offal or blood", which belong to CPA 10.8 Other food products, not to CPA 10.1 Preserved meat and production, as well as in cases of HS 2005 10 „Homogenised vegetables", HS 2006 "Vegetables, fruit, nuts, fruit-peel and other parts of plants, preserved by sugar" and HS 2007 10 "Homogenised fruit preparations", which rank also among CPA 10.8 Other food products, not among CPA 10.3 Processed and preserved fruit and vegetables.

Data sources on foreign food and beverage trade were Czech Statistical Office and Eurostat. Foreign trade is comprised of trade with third countries, as well as of trade with other EU members. The term net exports means trade balance surplus, and similarly net imports trade balance deficit.

Data on trade realised between EU members are collected from subjects who are VAT (value added tax) registered companies and who has exceeded a given threshold for dispatches or for arrivals. In the Czech Republic, the threshold was 4 Mio CZK on the arrival side and 2 Mio CZK on the dispatch side since May 2005 till 2008, and now, since 2009, has been amounted to 8 Mio CZK on the both sides. Subliminal trade is estimated by Czech Statistical Office with the aid of mathematical and statistical methods (but only for 2-digit HS codes). There are so used data without this adjustment in this work. See more in Intrastat Guide CZ.

The Revealed Comparative Advantage (RCA) index, or so called Balassa index, has been used as an indicator of trade competitiveness, which reveals the export efficiency. The advantage of the RCA index is simplicity and quite good interpretation, what is also meant by Smutka and Buriánová (2014). For an analysis of Czech and Slovak agricultural foreign trade, RCA indices were used as well as by Bielik et al. (2013). Various modifications of RCA index are applied. There are following formulas in the paper:

$$RCA\text{-}1 = Xij / Xi : Xj / X,$$

where „*Xij*" is Czech exports of the product, „*Xi*" is total Czech food and beverage exports, „*Xj*" is exports of the product from a reference group of countries, and „*X*" is total food and beverage exports from a reference group of countries. There is the EU a reference group in this work (both EU extra and intra-exports).

If $RCA\text{-}1 > 1$, the Czech Republic specialises in exports of the product and has a comparative advantage, and if $RCA\ 1 < 1$, it is not and has not any comparative advantage.

$$RCA\text{-}2 = ln\ (Xj/Mj : X/M),$$

where „Xj" is Czech exports of the product, „*Mj*" is Czech imports of the product, „*X*" is total Czech food and beverage exports, and „*M*" is total Czech food and beverage imports.

If $RCA\ 2 > 0$, the Czech Republic has a comparative advantage in trade of the products, and if $RCA\ 2 < 0$, it is on the contrary.

The concept has received much criticism due to its shortcomings in numerous articles. RCA values are therefore often investigated over time for a particular country and product group, but changing trade performance of the rest

8 Explanatory notes to CPA and NACE differ between each other slightly.

9 Combined Nomenclature of the EU is revised to a certain extent every year. Bigger changes are managed in years when a revision of Harmonised system by the World Customs Organisation is performed (in 2012 for the last time and in 2007before).

economy will have a high impact on the dynamics of the index. That is the reason why RCA indices are often regarded rather as indicator of specialisation, than indicator of competitiveness.

Results and discussion

Development of Czech food and beverages imports and exports

Share of food products and beverages in total Czech foreign trade in the period of 2005-2013 increased from 2.8 % to 3.2 % on the export side (i. e. to the maximum up to now), and from 4.0 % to 4.7 % on the import side (with the maximum of 5.0 % in 2009)[10].

Value of Czech food and beverage imports in 2013 compared with 2005 rose by 57.4 Bn CZK (i. e. by 80 %) to 129.0 Bn CZK, while value of Czech food and beverage exports increased by 47.5 Bn CZK (i. e. by 91 %) to 99.8 Bn CZK.

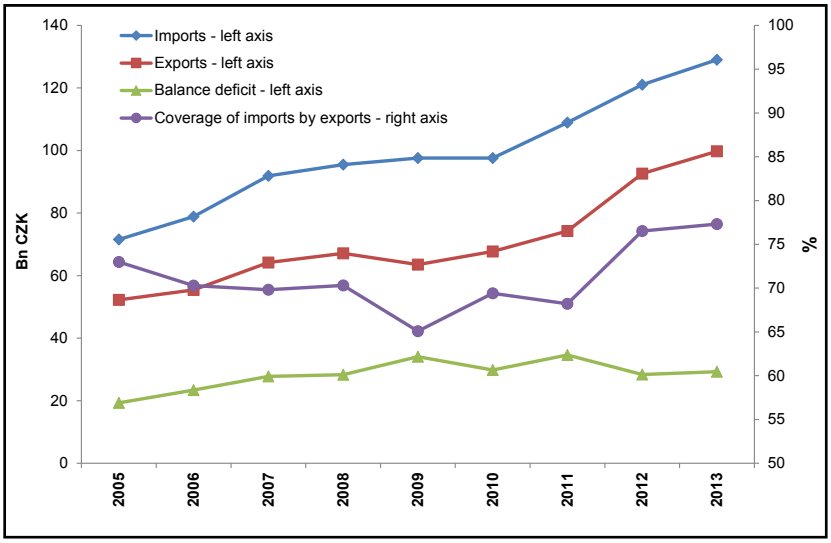
Balance deficit in trade in these products from 2005 to 2013 grew by 9.9 Bn CZK (i. e. by 51 %) to 29.3 Bn CZK, as a result of the higher increase of imports than exports. At the same time, coverage of imports by exports improved by 4.3 percentage points to 77.3 %, in consequence of the higher dynamics of the export growth then import growth[11].

In the monitored period, import value rose especially within groups CPA 10.1 (by 16.0 Bn CZK, i. e. 2.3times to 28.5 Bn CZK), CPA 10.8 Other food products (by 12.0 Bn CZK, i. e. by 63 % to 31.5 Bn CZK) and CPA 10.5 Dairy products (by 6.6 Bn CZK, i. e. 2times to 13.3 Bn CZK). Great dynamics of import growth was occurred not only at groups 10.1 and 10.5 but also at group CPA 10.6 Grain mill products, starches and starch products (where import value increased 2.3times to 5.3 Bn CZK).

The most substantial increases of export values were proved at groups CPA 10.8 Other food products (by 12.0 Bn CZK, i. e. by 53 % to 29.4 Bn CZK), CPA 10.4 Vegetable and animal oils and fats (by 7.5 Bn CZK, i. e. 3,8 times to 10.2 Bn CZK) and CPA 10.1 Preserved meat and meat products (by 7.1 Bn CZK, i. e. 2,4times to 12.0 Bn CZK). Significant increase in percentage expression is apparent at above mentioned group CPA 10.4, and then at groups CPA 10.9 Prepared animal feeds (3.6times to 6.0 Bn CZK) and CPA 10.7 Bakery and farinaceous products (3.1times to 7.4 Bn CZK) as well.

[10] Due the fact that values of food and beverage imports and exports are with "no adjustment", their share are calculated in relation to the corresponding total imports and export with "no adjustment" too. The share in total import and export values with "adjustment" is slightly lower (mostly by 0.1 percentage point).

[11] Within the Czech agrarian foreign trade (defined by HS chapters 01 – 24), balance deficit was 23.9 Bn CZK and coverage of imports by exports reached 86.9 %. It reflects relatively high shares of bulk commodities in Czech agrarian exports (as wheat and rapeseed) and unprocessed animal commodities (as raw milk, live animals and poultry).



Source: External Trade Database of the Czech Statistical Office (data with „no adjustment"), author`s calculations

Graf 1: Development of Czech food and beverages imports and exports in the period of 2005-2013 (%).

Structure of Czech food and beverages imports and exports by CPA groups

Since 2010, the biggest participation in Czech food and beverage imports has been comprised by groups CPA 10.8 Other food products (24.2 % in 2013), CPA 10.1 Preserved meat and meat products (22.1 %), and CPA 10.5 Dairy products (10.3 %).

On the export side, in the long term, the most significant groups are CPA 10.8 Other food products (29.5 % in 2013), CPA 11 Beverages (13.7 %) and CPA 10.5 Dairy products (13.2 %). In 2013 compared with 2005, their shares were distinctly lower. Participation of the next important group CPA 10.1 Preserved meat and meat products, on the contrary, increased from 9.4 % to 12.0 % during the period of 2005 - 2013.

Development of RCA-1 and RCA indices, and trade balance of individual food and beverage groups

Deep trade balance deficit and RCA-1 and RCA-2 indices indicating comparative disadvantage are typical for CPA 10.1 Preserved meat and meat products, CPA 10.2 Processed and preserved fish, crustaceans and molluscs, as well as for CPA 10.3 Processed and preserved fruit and vegetables.

Not taking account an ambiguous value of RCA-2 index in 2008, unfavourable values of all three indicators (although not in such extent as in case of previous three CPA groups) are apparent also within CPA 10.6 Grain mill products, starches and starch products.

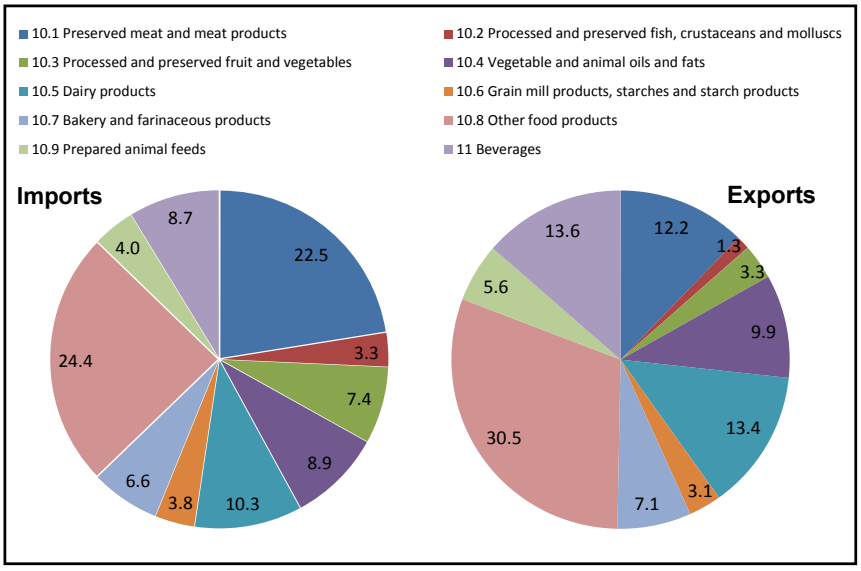
Negative trade balance and simultaneously positive values of both RCA-1 and RCA2 indices is shown by CPA 10.8 Other food products, and since 2009 also by 10.7 Bakery and farinaceous products (RCA-1 became favourable in 2007 and RCA-2 index slightly favourable then in 2009).

Trade balance of CPA 10.5 Dairy products was positive only till 2008, afterwards it was negative. Values of both RCA indices, however, were always favourable und showed comparative advantages, although they have been deteriorated.

Usual trade balance deficit, but changing values of RCA indices, is distinctive for CPA 10.4 Vegetable and animal fats and oils. According to RCA indices, the group was in comparative advantage in last two monitored years.

A change of all three indicators was observed within CPA 10.9 Prepared animal feeds. Their formerly negative balance was slightly positive in 2011 and in 2013; nevertheless, RCA-1 index has indicated comparative advantage already since 2006, and RCA-2 index since 2008.

Trade balance surplus is typical for CPA 11 Beverages. Their RCA-2 index was favourable in the whole monitored period, while RCA-1 index was (except for 2008 and 2009) rather slightly unfavourable.



Source: External Trade Database of the Czech Statistical Office (data with „no adjustment“), author`s calculations

Graf 2: Structure of Czech food and beverages imports and exports in the average of the period of 2011 - 2013 (%).

			2005	2006	2007	2008	2009	2010	2011	2012	2013
10.1	Preserved meat and meat products	Balance (Mio CZK)	-7 647	-8 705	-10 226	-10 844	-12 728	-12 913	-14 830	-16 589	-16 538
		RCA-1	0.53	0.55	0.59	0.61	0.64	0.64	0.68	0.67	0.68
		RCA-2	-0.62	-0.61	-0.58	-0.56	-0.57	-0.61	-0.57	-0.64	-0.61
10.2	Processed and preserved fish, crustaceans and molluscs	Balance (Mio CZK)	-2 469	-2 543	-2 710	-2 753	-2 689	-2 530	-2 601	-2 732	-2 954
		RCA-1	0.17	0.18	0.18	0.20	0.25	0.26	0.25	0.26	0.28
		RCA-2	-1.44	-1.34	-1.30	-1.27	-1.02	-0.98	-0.94	-0.95	-0.92
10.3	Processed and preserved fruit and vegetables	Balance (Mio CZK)	-3 915	-4 860	-5 681	-6 047	-5 533	-5 917	-5 845	-5 705	-6 047
		RCA-1	0.54	0.58	0.54	0.45	0.45	0.41	0.45	0.41	0.42
		RCA-2	-0.67	-0.67	-0.69	-0.87	-0.75	-0.91	-0.78	-0.81	-0.79
10.4	Vegetable and animal oils and fats	Balance (Mio CZK)	-4 465	-4 328	-3 200	-4 779	-6 754	-2 556	-4 447	254	-1 591
		RCA-1	0.83	0.92	1.02	0.89	0.69	1.24	1.00	1.47	1.31
		RCA-2	-0.65	-0.50	-0.21	-0.35	-0.73	0.00	-0.21	0.29	0.11
10.5	Dairy products	Balance (Mio CZK)	1 841	1 443	1 679	933	-516	-833	-328	-916	-50
		RCA-1	1.23	1.34	1.32	1.18	1.18	1.10	1.19	1.02	1.05
		RCA-2	0.56	0.52	0.52	0.45	0.37	0.28	0.35	0.19	0.25
10.6	Grain mill products, starches and starch products	Balance (Mio CZK)	-972	-983	-1 473	-801	-1 673	-1 427	-1 644	-1 615	-2 065
		RCA-1	0.69	0.83	0.80	0.78	0.64	0.73	0.76	0.75	0.81
		RCA-2	-0.24	-0.11	-0.21	0.02	-0.28	-0.21	-0.16	-0.19	-0.24
10.7	Bakery and farinaceous products	Balance (Mio CZK)	-2 082	-2 063	-2 127	-1 999	-2 103	-1 758	-2 294	-1 679	-1 089
		RCA-1	0.89	0.98	1.08	1.17	1.20	1.35	1.42	1.37	1.47
		RCA-2	-0.31	-0.21	-0.12	-0.05	0.01	0.04	0.01	0.03	0.12
10.8	Other food products	Balance (Mio CZK)	177	-2 147	-5 190	-3 527	-3 345	-3 033	-3 350	-1 299	-1 712
		RCA-1	1.96	1.73	1.61	1.72	1.68	1.56	1.56	1.62	1.51
		RCA-2	0.32	0.24	0.12	0.20	0.28	0.23	0.24	0.22	0.20
10.9	Prepared animal feeds	Balance (Mio CZK)	-1 366	-1 255	-1 119	-897	-1 286	-709	100	-103	518
		RCA-1	0.96	1.00	1.11	1.30	1.14	1.33	1.59	1.38	1.59
		RCA-2	-0.29	-0.16	-0.02	0.09	0.03	0.17	0.41	0.25	0.35
11	Beverages	Balance (Mio CZK)	1 554	2 014	2 295	2 369	2 549	1 829	610	1 978	2 274
		RCA-1	0.93	0.97	0.99	1.01	1.09	0.95	0.85	0.77	0.81
		RCA-2	0.51	0.58	0.58	0.58	0.68	0.55	0.44	0.45	0.44

Note: Within the RCA-1 index, reference group is the EU-28.
CPA classification is applied also in the period of 2005 - 2008 although SKP classification was in forced in these years.

Source: External Trade Database of the Czech Statistical Office (data with „no adjustment“), author`s calculations

Table 1: RCA-1 and RCA-2 indices, and trade balances (in Mio CZK).

Main net exported and net imported items

In detailed commodity view, the biggest balance deficit in the average of the period of 2011-13 has been observed in Czech trade in “pig meat”, “soya-been oilcakes“, “wine“, “poultry meat and edible offal”, “cheese and curd“, „bread and bakers` wares, sweetened or not“, “chocolate and other food preparations containing cocoa”, “beef meat”, “fruit, nuts and other edible parts of plants, otherwise prepared or preserved“, “extracts, essences and concentrates of coffee”, „butter“, “glucose and glucose syrup”, „margarine“, “prepared or preserved fish”, “fish fillets and other fish meat”, “spirituous beverages (less than

80 % vol)“, “preparations for infant use, put up for retail sale“, “husk or milled rice“, “other food preparations” (HS 2106), “sauces and preparations therefor (not soya and tomato sauces), mixed condiments and seasonings”, „sunflower oil“, “fruit and vegetable juices“, “other vegetables (without tomatoes), prepared or preserved (not by vinegar or acetic acid), frozen“ and “not frozen”, and „ice creams“. A lot of above mentioned net imported products (aggregates) are also important net exported items.

On contrary, the most substantial balance surplus was showed in trade in “rapeseed oil”, “beer”, “sugar”, “malt”, “milk and cream, concentrated”, “sugar confectionery, not containing cocoa”, “milk and cream, not concentrated”, “rapeseed oilcakes”, “yoghurts”, “homogenised composite food preparations”, “sausages and similar products”, “whey”, “pectins”, “prepared foods obtained by the swelling or roasting of cereals, grains, flakes or other worked grains (except flour, grouts and meal), pre-cooked or otherwise prepared”[12], “sweet biscuits, waffles and wafers”, “homogenised preparations of meat, meat offal or blood”, and “dog or cat food, put up for retail sale“.

Foods and beverages with comparative advantage

The following assessment, using averages of the periods 2005-07, 2008-10 and 2011-13, covers only some products with respect to their importance in Czech trade.

Within CPA 10.1 Preserved meat and meat products“, comparative advantage has been observed only in case of „sausages and similar products” (although their trade balance in average of the period 2005-07 was still negative), and “raw hides and skins”. For meat and meat product comparative disadvantage is otherwise characteristic. Also Smutka and Buriánová (2013) in their paper concerning the competitiveness of Czech agrarian trade observed that the Czech Republic lost out primarily in the case of trade in meat and meat products.

No product aggregate has a comparative advantage within CPA 10.2 Processed and preserved fish, crustaceans and molluscs, as well within CPA 10.3 Processed and preserved fruit and vegetables. Only “vegetables, fruit, nuts and other edible parts of plants, prepared or preserved by vinegar or acetic acid” in the average of 2005-07 and 2008-10 showed tiny comparative advantage according to the index RCA-1 (in spite of negative balance and unfavourable index RCA-2).

A substantial comparative advantage is typical within CPA 10.4 Vegetable and animal oils and fats for “rapeseed oil” (and this comparative advantage has increased according to all three indicators) and “rapeseed oilcakes”. “Margarine” lost his comparative advantage at the beginning of monitored period, and is now a significant net imported product.

Favourable values of RCA indices have been observed at many products within CPA 10.5 Dairy products. It concerns “milk and cream, not concentrated”, “milk and cream, concentrated” (but their comparative advantage has been reduced), and at “whey”. Net exported “fermented or acidified milk products” are characterised by favourable values of RCA-1 index, but value of RCA-2 index was sometimes negative (particularly in average of 2005-07 and 2001-13). “Butter” has been a net imported product since accession to the EU, and is (like “cheese and curd” and “ice creams”) in lasting comparative disadvantage. Also “dairy spreads” have lost their comparative advantage; it happened in second half of monitored years, although in average of 2005-07 value of their RCA-1 index was still one of the best.

Ambiguous situation has been detected within CPA10.6 Grain mill products, starches and starch products at slightly net imported „cereal grains, otherwise worked, and germ of cereals“. These products showed moderate comparative advantage according to the RCA-1 index (according to the RCA-2 only in average of 2011-13). Increasing comparative advantage has been, during monitored years, observed at “prepared foods obtained by the swelling or roasting of cereals, grains, flakes or other worked grains, pre-cooked or otherwise prepared”.

Within CPA 10.7 Bakery and farinaceous products, “sweet biscuits, waffles and wafers” had a stable comparative advantage according to the RCA indices, although their trade balance was positive only in average of 2011-13. Slight comparative advantage, but only in average of 2011-13, and only according to RCA-1 index, was shown at “sweetened bakers` wares“. Relatively high comparative advantage is typical for less traded “gingerbread” (its usually active trade balance was passive in average of 2005-07).

The group CPA 10.8 Other food products include a lot miscellaneous products. According to the all

[12] for example corn flakes and preparation of the Müsli type

indicators, “pectins”, “homogenised preparations of meat, meat offal or blood”, “sugar”, “sugar confectionery, not containing cocoa”, „ketchup and other tomato sauces”, “mustard”, and “homogenised composite food preparations” have comparative advantages. “Sauces and preparations therefor (not soya and tomato sauces) lost their comparative advantage during monitored years.

On contrary, within CPA 10.9 Prepared animal feeds, “dog or cat food, put up for retail sale“ gained a comparative advantage. Usually net imported „other preparations of a kind used in animal feeding“ are ambivalent.

Within CPA 11 Beverages, traditional Czech articles “beer” and “malt” are in clear comparative advantages”. Beer is one of the products which are traded globally, and the Czech Republic participates. Among others Goldberg and Knetter (1999) dealt with competing companies producing beer. “Lemonades“ have a comparative advantage as well, but only according to RCA indices, their trade balance in average of 2011-13 was, in contrast to the previous periods, negative (but only in financial expression, in quantity expression it was always active).

Values of trade balances and of RCA indices are mostly in accordance (both RCA-2 index and trade balance are derived from relation between exports and imports), but it does not agree absolutely. Especially, within CPA 10.8 Other food products, some aggregates show favourable value of RCA-1 index but their trade balance, alternatively RCA-2 index, is unfavourable. It concerns for example “chocolate and other food preparations containing cocoa”, “roasted coffee”, “extracts, essences and concentrates of coffee”, “yeasts and prepared baking powders” or “other food preparations” (HS 2106). The Czech Republic exports these products in a large extent (and their share in Czech food and beverage exports is higher than in corresponding EU exports), but their imports is still larger. In some cases, it is related with fact that these products originate from uncompetitive ingredients.

Conclusion

The article has assessed Czech foreign trade in foods and drinks in more detailed product structure with adjusted methodology which is not provided by other studies. That is why, for example, “Panorama of food industry” has partly different results. Value of Czech food and beverage imports in 2013 compared with 2005 rose by 57.4 Bn CZK, i. e. by 80 %, while value of Czech food and beverage exports increased by 47.5 Bn CZK, i. e. by 91 %. Balance deficit in trade in these products from 2005 to 2013 grew by 51 % to 29.3 Bn CZK, as a result of the higher value of increase of imports than exports. At the same time, coverage of imports by exports improved by 4.3 percentage points to 77.3 %, as a consequence of higher dynamics of the export growth than import growth.

Since 2010, the biggest participation in Czech food and beverages imports has comprised by groups CPA 10.8 Other food products (miscellaneous products), CPA 10.1 Preserved meat and meat products, and CPA 10.5 Dairy products. On the export side, in the long term, the most significant groups are CPA 10.8 Other food products, CPA 11 Beverages, and CPA 10.5 Dairy products.

There are identified food and beverage products with comparative advantage within the CPA groups 10 and 11 in the article. The biggest balance deficit in the average of the period of 2011-13 has been observed in Czech trade in “pig meat”, “soya-been oilcakes“, “wine“, “poultry meat and edible offal”, “cheese and curd“, „bread and bakers` wares, sweetened or not“, “chocolate and other food with cocoa”. The most substantial balance surplus was showed in trade in “rapeseed oil”, “beer”, “sugar”, “malt”, “milk and cream, concentrated”, “sugar confectionery, not containing cocoa”, “milk and cream, not concentrated”, “rapeseed oilcakes”, “yoghurts”, “homogenised composite food preparations”, “sausages and similar products”, “whey” and “pectins”.

Among others, RCA indices for CPA groups and their commodities, for periods 2005-07, 2008-10 and 2011-13, have been calculated. It is important to mean that RCA indices do not incorporate all factors influencing foreign trade, they are not fully decisive. However, despite their limitations, in context of other information, RCA indices serve as a useful analytical tool. As for whole CPA groups, deep trade balance deficit and RCA-1 and RCA-2 indices indicating comparative disadvantage are typical for CPA 10.1 Preserved meat and meat products, CPA 10.3 Processed and preserved fruit and vegetables, CPA 10.2 Processed and preserved fish, crustaceans and molluscs, and CPA 10.6 Grain mill products, starches

and starches products. Negative trade balance and simultaneously favourable values of both RCA 1 and RCA2 indices is shown at CPA 10.8 Other food products, and since 2009, also at CPA 10.7 Bakery and farinaceous products and CPA 10.5 Dairy products. The indicators within CPA 10.4 Vegetable and animal oils and fats have been changing. Trade balance surplus, unfavourable RCA-1 index and favourable RCA-2 are typical for CPA 11 Beverages.

The results may be useful for agricultural policy makers. Some products will be always imported to the Czech Republic, such tropical fruits and the like, but other products, included so-called sensitive products, can be, with a certain support, produced domestically, and their import can be limited.

Contribution of the work is, among other things, also methodical. Official converter between the Combined Nomenclature and the CPA has been subjected to critical examination, and on its basis our own list of CN codes pertaining to individual CPA branches has been compiled, which can be used for further analysis, for example from the territorial aspect.

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The Hot Spot Analysis: Utilization as Customized Management Tool towards Sustainable Value Chains of Companies in the Food Sector

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Abstract

The food and agricultural sector will face numerous challenges in the next decades, arising from changing global production and consumption patterns, which currently go along with high resource use, causing ecological and socio-economic impacts. The aim of this paper is to illustrate and evaluate the practical applicability of the Hot Spot Analysis methodology in the context of supply chain management in companies. The HSA is a method to identify social and ecological problems along the entire life cycle of a product. Special emphasis is put on a customized implementation in the value chain beef of McDonald's Germany. The HSA of McDonald's beef value chain shows that the main ecological problems arise in the phase of raw material extraction, whereas the main social problems can be identified in the phase of slaughtering. Finally, the paper shows potentials and shortcomings of such a customized application and how the results can be implemented in the sustainability management of a company.

Key words

Hot Spot Analysis, food, beef, sustainability assessment, supply chain management, McDonald's Germany.

Introduction

The use of natural resources by societal metabolism has been constantly growing during the recent decades and since the year 2000 global resource extraction has increased stronger than ever before (Bringezu et al., 2009). Caused by such (over) use of natural resources, ecological, social, and economic impacts were identified (Rockström et al., 2009). Among other stakeholders, companies are key actors for sustainable development (Seuring, Müller, 2008). Sustainable innovation and internal departments for sustainability management are on the move and 87% of German DAX-companies now publish sustainability reports (PWC, 2011).

Results of current sustainability research show that resource-intensive production and consumption systems of companies have to be modified strongly. However, it is still a major challenge to combine sustainability actions and evaluate their impacts in a transparent way.

The present paper focuses on nutrition as one of the three most resource intense areas next to mobility and housing and the related food sector, including agriculture (Lettenmeier et al., 2012). This sector is economically important in Germany, e.g. illustrated by sales figures of around 154 billion Euro in the food retail sector or regarding the 5,900 companies with over half a million employees in the food industry (BVE, 2014). Although the food sector has a huge environmental impact so far only few studies have assessed the environmental and social impacts of single products or entire value chains (Lettenmeier et al., 2014; Liedtke et al., 2010). Furthermore, methods and tools introduced so far are sometimes deemed too academic and often company's needs are not satisfied. Thus, reliable and applicable tools are highly needed that support the identification of key impacts as a basis for sustainability management of national and international supply chains. Therefore, this paper presents the methodology of the Hot Spot Analysis (HSA) and its application in specific value chains as such a more applicable tool. The HSA has been established as a method to generate knowledge about long term and mid term risks in value chains by using a brought range of key indicators. It was explicitly developed to assess sustainability impacts in entire value chains, from raw material extraction or farming,

use phase to waste disposal (Bienge et al., 2010).

The objective of the paper is to illustrate and evaluate the practical applicability of the HSA in the company McDonald's Germany as well as to identify critical ecological and social aspects along the life cycle of beef. Furthermore the paper shows how the results can be discussed within the company and with stakeholders and implemented in the sustainability management of a company. In the course of the on-going research project "Sustainable McDonald's Germany", HSA has been applied on two value chains (beef and chicken), which are highly related in economical, social and ecological issues and which are specific in their regional and global organisation. Based on these two case studies, the HSA has been further applied as an enabler for a company to assess its own sustainability impacts and to integrate this method in a holistic management perspective. This application and modification of the methodology is presented in the following.

The paper first shortly outlines existing approaches to evaluate ecological and social issues along value chains. Concluding from this, the concept of the customized HSA is introduced using current examples of application of this method. One main focus is the beef value chain of McDonald's Germany. The paper ends up with a short conclusion on advantages, challenges and shortcomings of the method.

Companies addressing ecological and social impacts

The European Commission decided in April 2014 that companies with more than 500 employees have to publish non-financial reports, e.g. sustainability reports, which disclose all relevant social and ecological aspects. These reports are expected to be obligatory for the financial year 2017 (European Commission, 2014). Nevertheless, several (inter-)national companies already today publish non-financial reports and it is expected that the number of companies, which publish separate general purpose, non-financial (sustainability) reports, will rise following this decision. Within their sustainability reports, companies mainly address several ecological and social aspects, often using freely accessible indicator systems, e.g. the Global Reporting Initiative framework (GRI, 2011). To report ecological and social impacts along company internal processes, the identification of all relevant material flows in supply chains are obligatory (Kirsch, 2013). In the long term instruments are needed to integrate valid data into these non-financial reporting frameworks. For instance, ecological impacts of relevant procedures are often displayed by using specific assessment tools. In this case, the application of footprint assessments, e.g. Carbon Footprint, Water Footprint (Cucek et al., 2012) or Material Footprint (Lettenmeier et al., 2009) is common to underline improvements in production systems. Besides the footprint methodologies, further quantitative assessment methods and indicators are available to measure environmental impact of a product, e.g. the MIPS approach and Life Cycle Assessment (ISO 14040/44) (for methodological differences see Liedtke et al., 2014). In contrast to environmental footprint concepts, social indicators have a qualitative perspective (e.g. poverty and slavery footprint) (Cucek et al., 2012). The categories provided by UNEP/SETAC (2009) and GRI (2011) are comprehensive but sometimes difficult to apply on single products due to their very detailed framework. Many companies start reporting by using few selected indicators.

However, the demonstrated concepts are often focused on one specific topic. Instead, HSA as a tool, which includes several indicators, could be very helpful to gain a more comprehensive view on value chains. Within the analysis, ecological and/or social categories along a whole value chain of a product are evaluated. It comprises more aspects than environmental footprints but not as many details as the lists of indicators by UNEP/SETAC or the GRI.

Materials and methods

In 2002, the Research Group 4 of the Wuppertal Institute developed the Hot Spot Analysis methodology (for further information on method development see Liedtke et al., 2010 and Bienge et al., 2010). The starting point was the idea to develop a quick and reliable life cycle assessment method based on available information, which highlights the most urgent problems within a product value chain. The HSA is a qualitative life cycle analysis that estimates the social and/or ecological impacts of a products life cycle. Historically, the method has been applied to several food value chains (Liedtke et al., 2010) and it was proved that the method is suitable for a systemic application on entire life cycles.

Bienge et al. (2010) described the Sustainability

HSA method. Based on that, the authors in the following give an overview of the HSA method to provide a better understanding of further methodological developments in recent years, including applications in the food sector.

The main objective of the HSA is to identify key impacts along the entire value chain. Environmental and social impacts of each life cycle phase and their interrelations are identified as well as the overall impact level of different social and environmental categories. The environmental and social "peaks" identified are defined as hot spots. The HSA method is divided into five steps (Bienge et al., 2010).

First of all the aim and scope of the study has to be determined. This includes the definition of the life cycle phases and the categories to be assessed. For most products, the life cycle phases can be roughly divided into raw material extraction, processing, usage and waste disposal. Depending on the scope, examined life cycle phases are adaptable (e. g. subdividing of raw material extraction phase or separate analysis of important phases like transport or packaging) but should cover the whole life cycle of a product. Secondary analysis of existing scientific literature is conducted to identify typical value creation processes of a product, such as the usual countries of origin of raw materials and characteristic production methods.

Along the defined life cycle social and/or ecological categories can be analysed. Table 1 shows the main environmental and social categories. The selection of the categories depends on the research question and aim of the project. Aspects and descriptions are derived from the international standards GRI and UNEP SETAC Life Cycle Initiative (UNEP/SETAC, 2009; GRI, 2011; Bienge et al., 2010). They are updated on a regular basis and best available scientific knowledge. The categories can be adapted to keep up with recent developments. The Sustainability HSA considers both environmental and social aspects (Bienge et al., 2010). The HSA method in general allows focusing on either social or environmental aspects and the selection or widening of aspects (Liedtke et al., 2010). However, any adaption should be documented.

After defining the categories and life cycle phases, step 2 comprises an extensive literature review to assess the significance of each aspect within the life cycle phases. The secondary literature review includes scientific studies as well as studies without a typical scientific background (e.g. data from trade unions etc.) and internal data from companies. The data can be complemented with knowledge of internal or external experts. The data is integrated for each category in every life cycle phase. To this aim, it is recommended to create a table for every life cycle phase and within the table one line for every category. So for every category the collected data are put together clearly. Upon completion, the categories are evaluated according to their social or ecological relevance by constructing an index with values 1-3, whereas 1 means low relevance and 3 means high relevance.

Afterwards the life cycle phases have to be weighted one to another (step 3). Similar to step 2, the phases are assessed by their relevance of 1-3. The life cycle phase or phases with highest impact receive the highest value, whereas a stage with a low relevance is assigned a low value. The hot spots are determined by multiplying the value of the category and the value of the phase (step 4). This results in the lowest value being 1 and the highest one equals 9. Hot spots are defined

Environmental aspect	**Social aspects**
Abiotic raw materials	General working conditions
Biotic raw materials	Social security
Energy resources	Training & Education
Water resources	Workers health & safety
Land use	Human rights
Waste	Living wages
Emissions to air (incl. greenhouse gas emissions)	Consumer health & safety
Emissions to water	Product quality

Source: Bienge et al., 2010

Table 1: Main environmental and social HSA categories.

for values of 6 or 9. As the final step 5, results are presented to and evaluated by relevant stakeholders and experts. This is necessary to close gaps and to increase acceptance and reliability of results.

HSA application in companies and research projects

Since 2002, several ecological and/or social HSA have been conducted and applied in companies (Liedtke et al., 2010, Bienge et al., 2010), consumer information (REWE Group, 2014), quality assessment (Alfred Ritter GmBh & Co. KG, 2011), social learning environments (Nordmann et al., in press), and design processes (Liedtke et al., 2013) have been elaborated.

The case studies of REWE and Ritter Sport as companies, which are already using the methodology for a longer time, are briefly introduced here.

The German retailer REWE developed the Label PRO PLANET, which helps consumers to recognize products that are more sustainable than comparable products. The aim of the label is to promote the concept of sustainability as well as to minimize the problems along a specific value chain. Suggestions for products, that should be analysed, are made by a sustainability management group of REWE, the advisory board of the PRO PLANET label or by external stakeholders. For REWE, the HSA is important to identify ecological and social problems along a value chain. REWE divided the value chain in four sections: Agriculture/resource extraction, production, logistics/trade, and consumption/end of life. In addition to the basic method the analysed categories are supplemented by two categories. In the ecological analyses, the category 'emissions to air' is subdivided in the categories 'greenhouse gas emissions' and 'emissions to air'. The social analysis is supplemented by the category 'animal welfare'. To visualize results, a 'HSA-map' is developed for every labelled product. A product achieves the label if one or more hot spots have been overcome by the implemented measures. In contrast to the basic method, REWE modified the categories and also uses fixed life cycle phases. But all in all, the changes are not very extensive and close to the basic method (REWE Group, 2014).

The chocolate producer Ritter Sport uses the HSA in another way of modification. Besides ecological and social effects of a product, the Ritter Sport HSA considers the economic perspective of products. Important questions are related to the wage level or avoiding monopoles. Employees from different departments discuss the results and develop measures. The biggest change in contrast to the basic method is the addition of an economic perspective. The Ritter Sport HSA, thus, includes the three main topics of sustainability. This example shows that the analysis framework is open for modification if necessary. Among other effects, the analysis can thus become more comprehensive or focused on specific topics, but might also take more time (Alfred Ritter GmBh & Co. KG, 2011; Forum Nachhaltiges Wirtschaften, 2014).

Results

In the following, the application of the HSA in the case of McDonald's Germany Inc. is illustrated as a third example, presenting new results from the project "Sustainable McDonald's", which has been established from 2011-2014. Within the project, several sustainability topics were analysed. One part of the project was the assessment of specific and economically relevant value chains in Germany. Within this step, the conceptual framework for applying ecological and social HSA to the case of McDonald's value chains was developed.

The original HSA method is carried out in five steps (cf. above); the company-specific application is now based on up to eight steps. Differing from the original method, the new management tool was expanded and adjusted to some relevant objectives. Table 2 compares key similarities and differences of the HSA method and the customized HSA application.

The Hot Spot Analysis was carried out to gain detailed knowledge about risks and potentials of relevant value chains, which goes beyond regular standards and may be established by the sustainability department of McDonald's Germany Inc.

Two economically and ecologically relevant value chains were analysed as a whole: beef and chicken. Both are relevant to a large number of products. In particular, beef is systematically very crucial for McDonald's Germany Inc., due to its high share in products. Further, the idea to control national and international sourcing strategies was in the centre. Quantitatively, potatoes are the economically and quantitatively next most

important value chain, but the focus was set on animal products, thus, the value chain of chicken was chosen. For the sustainability department it was particularly important to gain insights into ecological and socially relevant hot spots. Additionally, the department wished to develop a specific field manual to internally map value chains.

Considering all framework modifications of the Hot Spot Analysis (see table 2), one of the most important changes is the modification of information sources. While the original HSA is based on a theoretical literature review, the customized Hot Spot Analysis will be applied based both on a theoretical literature review and additional primary data collection. Such data collection is rather labour-intensive, which however leads to generating more explicit and significant data. Furthermore, a comprehensive view is created by the integration of all relevant contact persons of suppliers (aim).

Based on these general and company specific aims and the development within the project, eight key steps of the customized HSA were carried out within the period of one year. The modification was led by results of primary data collection. Table 3 shows the main differences

	HSA Method	HSA application in company supply chain management
Overall HSA aspects		
Aim	• Sustainability assessment to identify most relevant impact along the value chain • List of recommendations for action	• Sustainability assessment to identify most relevant impact along the value chain • List of recommendations for action • Relevant persons, e.g. sustainability manager, quality manager or supply chain manager and the suppliers are integrated in the process • Management aim: definition of specific Hot Spots as a support for internal risk management • Establishment of company specific HSA database and monitoring tool called "toolbox HSA" linked with overall sustainability strategy of the company
Application	• Generic product value chain • Specific product value chain • Assessment results for e.g. supply chain management, design processes, consumer information/label, education	• Specific product value chain: Most relevant supply chains considering future management strategies, relevant for sustainability issues and sourcing; based on present scientific results • Assessment results for supply chain management: Translation of assessment results into supply chain management to improve sustainability performance (incl. monitoring)
HSA conduction	• Company • Science • Design	• Company – Unit Corporate Responsibility and Supply Chain Management • Science within the project framework
Source of information	• Secondary literature: Scientific literature, Further fact-based information (e.g. reports, media • External expert knowledge (e.g., company, sector, NGO, trade unions, federations, consumer associations, experts)	• Secondary literature: Scientific literature, further fact-based information (e.g. reports, media) • External expert knowledge (e.g. company, sector, NGOs, trade unions, federations, consumer associations, experts) • Primary data collection and internal expert knowledge: Data gathered in own supply chain (value chain data, management / process knowledge)
Stakeholder involvement	• Generally non-recurring (data gathering, assessment) • Involvement generally in step 5 (earlier involvement in step 1 to 4 possible) • Internal and / or external stakeholder involvement	• Probably recurring (data gathering, assessment, management plan, implementation, monitoring) • Internal stakeholder involvement: Involvement of the company in all steps of the assessment and following steps • External stakeholder involvement: Supply chain and optional further associated stakeholder

Source: HSA methodology based on Liedtke et al., 2010; Bienge et al., 2010; extended by unpublished datasets

Table 2: Comparison of HSA method and HSA application in company.

	HSA Method	HSA application in company supply chain management
HSA phases and corresponding steps and specific aspects of HSA integration into Sustainable Value chain management		
Management (ex ante HSA)	(Not included in general HSA steps, depending on specific application)	The HSA is included in the sustainability management strategy; the results shall be used for the internal detection of hot spots. Two value chains were analysed – both very economically and ecologically relevant
Defining scope & aim	Step 1: Definition of the life cycle stages and categories	Step 1: Definition of the life cycle stages and categories
Analysis	Step 2: Aspects significance assessment	Step 2: Literature review Step 3: Company and factory visits (parallel to step 4) Step 4: Surveying suppliers along the value chain; consideration of existing, internal standards Step 5: Analysis and evaluation of the specific and generic data including assessment
Assessment	Step 2: Aspects significance assessment Step 3: Life cycle phase significance Step 4: Identification of Sustainability Hot Spots	Step 5: Analysis and evaluation of the specific and generic data including assessment und identification of Sustainability hot spots
Review	Step 5: Stakeholder evaluation and verification	Step 6: Presentation and discussion of the results with internal and associated stakeholders (e.g. selected companies of the value chain or direct suppliers)
Recommendation/ measures	Optional (not included in general HSA steps but mostly part of HSA application)	Step 7: Develop measures and afterwards implementation (for example integration in internal standards)
Update	Optional (not included in general HSA steps but recommended)	Step 8: Recommend update of the HSA (e.g. every 3 years); Update of data and update of stakeholder dialogue
Management (ex post HSA)	Optional (not included in general HSA steps)	Integration of results into the sustainability management strategy, e.g. multi-stakeholder dialogue or comprehensive project to support and improve identified hot spots

Source: own composition based on Liedtke et al., 2010; Bienge et al., 2010, extended by unpublished datasets

Table 3: Comparison of HSA method and HSA application in company.

between the original methodology and the customized HSA for McDonald's Germany Inc. step by step.

Compared to the basic method, the first part of the analysis of McDonald's beef is identical. First of all, the overall management aim and relevant value chains have to be defined. The identification of relevant phases and categories is next. For the case of value chains of McDonald's Germany this means that a definition of important categories for the sustainability management of McDonald's Germany and of aims of the analysis is required. Analysing the beef value chain, all categories were included to gain a brief overview of all relevant aspects. At the same time the literature research is carried out as the second step of analysis. Preferably, scientific studies are used, but also other studies or reports such as information from trade unions can be important data for the analysis. For the case of McDonald's beef, information from associations of the meat sector was important and for the question of animal protection, animal welfare NGOs delivered useful information. Also internal data from companies is important. In this case it should be acknowledged that grey literature such as reports from trade unions or other organisations is not always scientifically reliable. As far as possible scientific literature and experts' information should thus be used. In addition to the basic method, steps 3 and 4 supplement the method.

Step 3 includes visits of companies or factories along the value chain. This is important to achieve a better impression and a better understanding of the value chain. The project team visited all relevant stages of the value chain such as a slaughter house and worked for one day in a McDonald's restaurant. The problem is that the visits only show the situation in the visited factory or company. The situation could be completely different

in other companies or factories. Especially in other countries the preconditions could be different e.g. because of other laws.

In parallel and as a fourth step, company and supplier are surveyed along the value chain; considered are existing, internal standards. Within the fourth step questionnaires were developed to collect primary data. The supplier companies were asked for general information and to provide information on their ecological and social impacts along their production steps. For example, the specific consumption of resources, water and energy of companies were included, as well as question on wage levels as a social aspect. If procurable, such statements of companies should be verified using scientific literature.

Step 5 provides the analysis and evaluation of the specific and generic data including assessment und identification of Sustainability Hot Spots. This includes that the collected data are analysed and evaluated. This procedure has to be performed for the literature sources as well as for the value chain phase specific questionnaire. The document then is red by every participant of the internal project team and evaluated individually. Afterwards the individual evaluation schemes are compared in detail, discussed and modified if necessary. This team review process results in a collective assessment of the value chain.

Step 6 includes the internal presentation of the results. Following this the findings can be discussed with stakeholders. The previous internal discussion is important so that the project team has a consistent argumentation strategy during the discussion with the stakeholders. The exchange of information with the stakeholder can be important because they can give additional information and can draw attention to possibly existing mistakes. The results of the beef analysis were discussed e.g. with the "Bayerische Bauernverband" – the Bavarian farmer's association and different slaughter houses regarding the extraction of raw materials.

As a temporarily final step 7, measures are developed after the discussions with internal and associated stakeholders. The question is at which point of the value chain the biggest problems occur and how they might be solved. For example new internal standards or guidelines can be developed. The results of the beef analysis were discussed with the different stakeholders.

The optional but recommended step 8 includes an update of data within the period of three years or in shorter. The HSA can be updated after a certain period, which is essential because after a certain period of time several conditions may have changed, e.g. processes, laws and guidelines.

The following table 4 shows the results of the HSA beef in the project "Sustainable McDonald's Germany". Represented are the multiplied results of the values for each phase and category. As mentioned before, if a category receives the value of 6 or 9 it is identified as a hot spot.

The results show that hot spots are concentrated in specific phases of the value chain beef. In the ecological analysis the hot spots are accumulated in the phase of raw material extraction. All ecological categories in this phase are identified as hot spots. The reasons for this lie e.g. in the huge requirements of raw materials, water, energy and land use, that are needed to produce animal feed. Due to the high amount of waste arising in the restaurants, the category Waste disposal can be seen as a hot spot in the stages Usage and Waste treatment. Other hot spots are energy demand in the stage of Usage and biotic raw materials in the stage of Waste treatment.

The social analysis shows that several categories in the stage of Slaughtering can identified as hot spots. The reasons can be seen in the high amount of unskilled workers, the absence of social security, low payment and bad effects on workers' health – as great problem overall Germany. The category Product Quality in the stage of Agriculture can be identified as a Hot Spot as well as the categories Training & Education and Consumer health in the stage of Usage. Finally, the workers' safety and health can be seen as critical factors in the stage of Waste treatment.

Considering the adjustments, particularly two significant changes become apparent. Whereas the customized analysis strictly involves internal and associated stakeholder, the original method supports the integration of several stakeholders and points out the importance of a multi-stakeholder dialogue to evaluate the results. From the company perspective, internal and associated stakeholders are the first choice. The integration of a multi-stakeholder dialogue in a customized HSA may lead to a diverse and less goal-oriented dialogue, which is in the first step not necessary, but may be a good opportunity for a future management application

Category	Raw material extraction	Slaugh-tering	Pro-cessing	Use	Waste disposal
Ecological aspects					
Abiotic raw materials	**6**	1	1	(4)	(4)
Biotic raw materials	**9**	1	1	(2)	**6**
Energy resources	**6**	2	1	**6**	4
Water resources	**9**	2	1	4	2
Land use	**9**	1	1	4	(2)
Biodiversity	**9**	1	1	2	2
Waste	**6**	2	1	**6**	**6**
Emissions to air	**9**	1	2	4	2
Emissions to water	**6**	2	1	2	2
Social aspects					
General working conditions	4	**6**	2	4	4
Social security	2	**6**	4	4	4
Training & education	2	**6**	2	**6**	4
Workers health & safety	4	**6**	4	4	**6**
Human rights	4	**6**	2	4	4
Living wages	4	**9**	4	4	4
Consumers health and safety	4	3	4	**6**	-
Product quality	**6**	3	4	2	4

* values in brackets are preliminary results
Source: own analysis and calculation, unpublished datasets

Table 4: Results of the HSA beef.

(ex post HSA). Further, the recommended update of primary data collection and a circular update of the internal stakeholder dialogue are opportunities to gain a good perspective on changing risks and potentials in value chains.

In the presented example of McDonald's beef, the results were discussed with various stakeholders. Because of the accumulation of ecological hot spots in the phase of Raw Material Extraction, the results were discussed with the Bavarian farmer's association. The social hot spots are accumulated in the phase of Slaughtering mainly because of working conditions and were discussed with the dismemberment and slaughtering sector. Based on the results of the HSA, the sustainability management team implements several action plans to overcome these hot spots. For instance, a project to improve the husbandry conditions for cows (this project is called 'Best Beef') was established due to the consolidated findings in the project. Another point was a check of work contracts of suppliers as part of the Social Workplace Accountability (SWA) audit (McDonald's Germany, 2013; McDonald's Germany, 2014).

Conclusion

The customized Hot Spot Analysis provides a comprehensive framework to evaluate several impacts of specific value chains. It is a flexible methodology, which, as we have shown in this paper, is adaptable to specific cases. Interestingly, the method is applicable to different stages of sustainability management systems and helps the internal sustainability management team to extend their view on the companies' relevant systems. Due to the wide range of included indicators, a brought view on supply chains in all phases is achieved.

The results of the example of McDonald's beef show how to use the customized HSA. By collecting primary data it becomes more

obvious that specific problems of the life cycle are accumulated in the phase raw material (ecological analysis) and Slaughtering (social analysis). Steps towards and integration of results in the sustainability management of McDonald's Germany show in the form of the presented action plans, such as the check of work contracts of suppliers.

Applying the methodology, several potentials became apparent. One main potential of the method is that the results of the analysis emphasise the core impacts and problems of the different life cycle phases. After identifying these aspects, action plans can be created to tackle hot spots. So all in all the analysis can help sustainability management departments of a company to identify ecological and social problems and develop measures. The integration of suppliers in the whole process is a decent method to get in touch with several suppliers in a more familiar and non-hierarchical way. This point reflects another potential of the HSA. Furthermore, the recommended update after a period of three years may again strengthen the contact between company and supplier.

As one more important aspect, the scientific support within the first application of a HSA analysis is essential. During a first implementation and analysis process, companies and suppliers and the scientific institution may gain in-depth knowledge of relevant processes. Afterwards, all stakeholders will acquire comprehensive process know-how and companies may conduct the process on their own. Based on these considerations, another opportunity is manifested: the analysis can be carried out without inappropriately high resource input within the company. This even more applies to the update of HSA. Thus, the sustainability department is able to analyse value chains on their own at relatively low expenditure.

Nonetheless, also shortcomings of the method and its application became visible. Collection of primary data and connected processes are labour-intensive and the data delivered by companies may not be verified in detail. Additionally, a major challenge is manifested in the collection, differentiation and comparison of different data sets of several suppliers from different countries. The more complex the data material is, the more time-consuming the analysis turns out. Thus, the decision about most relevant value chains is essential.

For the future, it may be desirable to encourage several national and international companies, even small or medium enterprises, to create a more sophisticated database for transparent value chains using the methodology of the HSA, among others. Especially in the sector of food production, a database of transparent datasets would be very useful. Within this context, the methodology might prove helpful because it is applicable to all phases of these value chains. Even the „more distant" first phases in the agricultural production, where regularly hot spots are discovered, can be easily evaluated.

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Rainfall Forecast Analysis using Rough Set Attribute Reduction and Data Mining Methods

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Abstract

Developments in information technology has enabled accumulation of large databases and most of the environmental, agricultural and medical databases consist of large quantity of real time observatory datasets of high dimension space. The curse to these high dimensional datasets is the spatial and computational requirements, which leads to ever growing necessity of attribute reduction techniques. Attribute reduction is a process of reducing the data space by removing the irrelevant, redundant attributes from large databases. The proposed model estimates the enhancement achieved in spatial reduction and classifier accuracy using Rough Set Attribute Reduction Technique (RSART) and data mining methods. The first module of this proposed model has identified an efficient attribute reduction approach based on rough sets for spatial reduction. The next module of the proposed model has trained and tested the performance of Naive Bayes (NB), Bayesian Logistic Regression (BLR), Multi Layer Perceptron (MLP), Classification and Regression Tree (CART) and J48 classifiers and evaluated the accuracy in terms of each classification models. The experimental results revealed that, the combination of RSART based on Genetic Algorithm approach and Bayesian Logistics Regression Classifier can be used for weather forecast analysis.

Key words

Attribute reduction, rough set, genetic algorithm, Bayesian Logistics Regression, rainfall forecasts, classification, accuracy.

Introduction

Rough set theory was proposed by Zdzisław Pawlak in 1982 as a mathematical tool for data analysis; it is a different mathematical approach to handle vagueness and imperfect knowledge. Pawlak (1982) stated that Indiscernible relation is the mathematical basis of rough set theory, i.e. every object in the universal set has some information, objects characterized by same values are indiscernible in view of the available information and objects with different values are discernible. Any non-empty set of all indiscernible objects is called an elementary set and forms a basic grain of knowledge about the universe. Pawlak (1982) described that the union of some elementary sets is defined as a crisp set otherwise the set is rough. Each rough set has boundary region with objects which cannot be classified to a particular set. In any rough set a pair of precise sets, called the lower and the upper approximation is the grain of rough set. The lower approximation consists of all objects which certain to be a member of a set and upper approximation has the possible members of the set. The upper and the lower approximation difference constitute the boundary region elements in a rough set (Grabowski, Jastrzebska, 2009).

Rough set based on data analysis starts from a data table called a decision table, columns of which are labelled by attributes, rows or tuples by objects of the table are attribute values. Attributes of the decision table consists of disjoint groups called condition and decision attributes. Rough sets have been used in various medical, meteorological applications for knowledge discovery (Shen, Jensen, 2007). In this approach all manipulations are performed on the corresponding data itself without any prior perception of any additional information about data description.

Some more essential concepts in rough sets theory are the cores and reducts. For instance let {S} be a subset of universal set, {X} is an information system let {A} be the attribute superset that containsthe complete set of conditional attributes and decision attribute now the reduct is defined as {R} (Pawlak, Skowron, 2007) {R} be the subset of attribute superset {A} that has the most significant attributes, then the R-lower approximation { S} is the set of all elements of {S} which can be with certainly

classified as elements of a specified concept. Let R-upper approximation set of S is a subset of {X} and R is non null set with objects that are possible members of specified concept. Approximation space of {S} is determined by information contained in {B} using B-lower approximation space and B-upper approximation space w.r.t to {S}. Approximation set are represented as $\underline{B}S$ for lower and $\overline{B}S$ for upper.

Lower approximation set of S, is the set of elements of X which can be with certainty classified as elements of S w.r.t a specified concept, R-lower approximation set of S is defined as $\underline{B}S = \{x \mid [x]_B \subseteq S\}$, upper approximation set of S, is set of elements of X which can possibly be classified as belonging to the set S w.r.t a particular concept R-Upper approximation set of S is defined as $\overline{B}S = \{x \mid [x]_B \cap S \neq \phi\}$.

Boundary region represents the uncertain portion of the dataset, with less information about the datasets to definitely establish the class of data (Pawlak, 2002). Boundary region is defined as [{upper approximation} – {lower approximation}]. A reduct set contain significant set of attributes of superset {A}, attributes in a reduct set {R} are more predictive of a given decision variable as that of {A}. Reduct set are generated based on indiscernibility matrix, discernibility matrix, boundary region elements, positive region elements and the equivalence partitions of rough set theory.

Lower and upper approximation space is determined using the cardinality of approximation space, the accuracy is defines as below

$$\alpha_B(S) = \frac{|\underline{B}(S)|}{|\overline{B}(S)|}$$

For {S}, if the accuracy α(s) = 1 then S is a crisp set with respect to B. If α(s) < 1 , then S is a rough set with respect to B with imperfect knowledge. Core in rough set theory consists of significant attribute that it is most predictive feature of a decision table, core is determined as indispensable attribute of {A} belonging to {R}. Identification of coreattributes is a significant task in knowledge processing. Processing raw data directly is not advisable as it may affect the quality of the data analytics. In this situation, the process of attribute reduction that identifies the significant attribute of {A} play a key role by removing the redundant, irrelevant attributes. (Wei et al., 2012) described the application of rough set concept for hybrid data which involve different data with imperfect knowledge can be handled efficiently using rough set. (Greco et al., 2001) described about the use of rough sets concept for multi criteria data analysis. The reduct {R} generated by attribute reduction algorithm is then subject to classification. Classification is a two step process consisting of training phase and testing phase. It constructs a classifier model by learning from a training set. (Yu et al., 2005) described a new classification approach by integrating feature selection algorithms to enhance predictor accuracy.

In testing phase, the model is tested with unseen samples and the classifier's accuracy is determined. If the test samples are the disjoint records that are randomly selected from the data set independent of the training samples then accuracy of a classifier for a given test set is the percentage of test set samples that are correctly classified. The associated class label of each test record is compared with the learned classifiers class prediction for that record. If the accuracy of the classifier is considered acceptable, the classifier can be used to classify future data records for which the class label is not known.

In our research investigation we have used Rough Set for attribute reduction to generate the reduct sets based on Johnson algorithm and Genetic Algorithm approach. From our results we realized that, the irrelevant attributes can pull down the prediction accuracy and can even mislead the learning process.

Literature review

(Yao, 2009) stated that rough sets discernibility matrix based on attribute reduction approach has been adopted widely to find reduct sets for different applications and they have demonstrated the importance of attribute reduction using some sample dataset. (Li et al., 2010) described that elementary matrix simplification operations and introduced operations to transform matrix into a simpler representations. Have emphasized that the elements of positive region are of great importance and it is necessary to verify that the objects in positive region are never missed in attribute assessment.

(Qablan et al., 2012) shown a new attribute reduction approach based on Ant Colony Optimization algorithm. The application of this method confirms that the computation is reduced and the results are good using this algorithm compared with the traditional algorithm. Thus, it is proven that this method is a fast and efficient algorithm

of attribute reduction. Modified binary discernibility matrix and attribution reduction algorithm based on binary discernibility matrix is an ordering approach with a new simple link concept in the algorithm has supported to reduce the size of the table to reduce the computation and storage complexity.

A reduct optimization method based on the condition attributes has been discussed; this can classify the grouping generated representative data to simplify the discernibility matrix, and the order of the discernibility matrix, and the complexity of the attribute reduction (Miao et al., 2009). Johnson reduction algorithm and the Object Reduct using Attribute Weighting technique algorithm (ORAW) for reduct computation are some simple widely applied reduct and rule generation techniques. (Suguna et al., 2011) have described presented a new feature selection method based on rough set approach integrated with the Bee Colony Optimization (BCO). This proposed approach generates minimal reducts for medical datasets.

(Sudha, Valarmathi, 2013) and (Suguna et al., 2011) have mentioned that attribute reduction approach based on quick reduct, entropy measure based on reduct, hybrid rough set based on genetic algorithm), Ant Colony Optimization (ACO) and Particle Swarm Optimization (PSO) were widely adopted for attribute reduction. Experimental results conclude that rough set bases techniques achieved optimal reduction and have generated better number of reducts than other methods. Rough Set attribute assessment based on Genetic Algorithm approach is recommended for the numerical datasets in order to achieve global optimization.

Analogical matrix based on attributed reduction algorithm, a totally new approach towards attribute reduction has been discussed from experimental evaluation reveal that it can reduce time complexity and spatial complexity without breaking the coherence of information contained in decision table (Mahapatra et al., 2010).

(Bal, 2013) stated that a two-step attributes reduction technique based on Bayesian model for decision theoretic rough set using different classification properties. The first step creates reconstruction of the complete decision table; the second step determines the optimal reducts for data analysis. A new Scan vector approach based on attribute reduction; the proposed method defines a new conception of discernible vector by which the discernible matrix information table can be transformed into discernible vector set (Xu E et al., 2006).

(Wei et al., 2012) introduced Attribute Reduction of Decision Table based on attributes similarity relation. Hao and Zhang (2010) have described about reduct optimization method based on the condition attributes that classify the grouping generated representative data to simplify the discernibility matrix, and the order of the discernibility matrix, and the complexity of the attribute reduction. Thus the time complexity and space complexity made optimization, save the time and space complexity.

(Huang et al., 2013) introduced a new algorithm of attribute reduction using the analogical matrix, and the correctness and feasibility of it was proved. The algorithm can reduce time complexity and spatial complexity of attribute reduction, and do not break the coherence of information contained in decision table. The analysis of the realistic example shows that the algorithm is effective and feasible.

(Olaiya et.al , 2012) mentioned that the following approaches based on Artificial Neural Network, decision tree, Genetic Algorithms, Rule Induction, Nearest Neighbor method, memory-based reasoning, logistic regression and discriminant analysis are widely adopted for predictive data mining tasks. Taking advantage of these models they show that the Artificial Neural Network approach and decision tree were used for rainfall forecast analysis to study the climate change.

Valmik and Nikam et al. (2013) have described a rainfall prediction model based on Bayesian classifier. In Bayesian approach perform well for those datasets with predictor class label however in the absence of predictor class label for a given dataset the bayesian classification model assumes the record with zero probability there by affecting the overall accuracy.

Materials and methods

This observatory meteorological data has eight parameters: Max (maximum temperature), Min (minimum temperature), RH1 (relative rumidity-1), RH2 (relative humidity-2), Wind, SR (solar radiation), SS (sun shine), and EVP (evapotranspiration). The above mentioned parameter‘s values are recorded in an observatory in daily basis as per the standard norms. For our experimental analysis we have used around 10,000

days recorded observatory records. Materials used in recording the atmospheric values were thermometer for temperature measurement, robinson cup anemometer for recording the wind speed, pirenometer for recording solar radiation, sun shine recorder strip to record sunshine andevaporimeter for recording evapotranspiration. In our research work we have used a real time observatory post rainfall predictions weather data.

The targeted sample input is in the form of the Table1 as defined in rough set theory. The parameters other than RF (Rain Fall) are referred as condition attribute and RF is the decision attribute w.r.t Rough Set theory approach, the reduct set {R} contains the significant attributes of set {A}, where {A} is the complete attribute set of a given input table. Set {R} is a reduct, which is our input for the classification module. The sample format of our dataset is represented in Table 1. In this research, our initial focus is to identify the most significant attributes from the complete attribute set {A} which results in identification of essential attribute subset {R}. The identified minimal attribute sets in turn will reduce the data space, computational complexity and it can improve the prediction accuracy.

Rough Set Attribute Reduction Techniques

The proposed model incorporates rough set based on attribute reduction techniques. In general identification of significant attribute is one the significant task knowledge representation. The input for attribute reduction module is the set of tuples of the data table and corresponding attribute set inclusive of conditional and decision attribute (class label).

Rough Set based Johnson Algorithm (JA)

Johnson algorithm is widely adopted for finding the significant attribute set from the complete attribute list; the algorithm has been evaluated and implemented using Java and Rosetta software. The Johnsons reduct starts with initialization of an empty Reduct Set R-{} followed by step 1-6

1. For each Row r_i in Discernibility Matrix compute attribute with Maximum Frequency, add the attribute to the Reduct set R{}
2. While there are still entries left in r_i.
3. Add the attribute (a) with maximum frequency to Reduct Set.
4. If more attributes have the same maximum frequency then chose any one at random
5. Delete all entries that contain attribute (a) from r_i.
6. End.

Rough Set based Genetic Algorithm (GA)

Rough Sets based Genetic Algorithm, the solutions can be coded as strings of 0's and 1's. An initial population of solutions is generated randomly and the best solutions, according to some fitness function, are iteratively chosen to breed new generations of solutions using genetic operators such as mutation and crossover. Algorithm encodes potential solution candidates referred as chromosomes and the set of potential solution candidates labelled as generation. Actual realization starts with a population of chromosomes and set of algorithm based on operators determines

MAX Celsius	MIN Celsius	RH1 %	RH2 %	WIND km/hrs	SR KCalories	SS hrs	EVP mm	RF Class Label
28.0	16.0	95.0	42.0	8.6	243.2	10.2	4.4	0
28.5	16.5	85.0	41.0	9.0	241.6	10.4	2.8	0
28.5	17.5	95.0	52.0	8.0	183.2	7.0	5.0	0
28.0	17.5	92.0	57.0	6.1	209.6	8.6	2.6	0
28.0	14.0	94.0	55.0	7.4	260.0	10.2	3.4	0
28.0	18.0	95.0	51.0	9.0	232.0	9.4	4.2	0
35.0	23.6	85.0	43.0	7.0	214.4	7.6	5.1	1
33.0	23.0	90.0	69.0	6.4	332.3	6.2	3.9	1
29.0	22.0	91.0	48.0	3.5	477.0	8.7	3.4	1
31.5	22.5	90.0	56.0	10.6	432.1	7.8	4.4	1
31.0	22.0	90.0	58.0	5.1	352.5	7.6	2.6	1

Source: TNAU Coimbatore India

Table 1: Observatory record of rainfall prediction (1984 – 2012). Dataset.

the better solutions. Genetic Algorithm is a population based model that makes use of selection and recombination operators to find better solutions in the search space. In this Rosetta software this genetic algorithm approach is implemented as supervised learning, it involves a number of search problems that may easily be approached with heuristic search.

Proposed model

The assessment of suitable model for rainfall forecast analysis for optimal prediction accuracy consists of several processing stages. For clarity we have modularized the stages as two specific modules, the first module consists of five stages so as to generate the possible feature subsets using rough set approach hence module I is referred as attribute reduction module and next is the classifier identification module in which a suitable classifier is identified. Reduct sets are the input for this classifier identification module, it has two main sub stages model training and model testing phase followed by accuracy analysis of each classifiers.

Attribute Reduction Module

Step 1 - Data pre-processing.

Step 2 - Removal of outliers from raw data.

Step 3 - Apply RART on target data using Johnson algorithm approach.

Step 4 - Apply RART on target data using Genetic algorithm approach.

Step 5 - Generation of reduct sets {R}.

The reduct sets of Johnson algorithm and Genetic Algorithm were later evaluated by classifiers to analyze the enhancement in accuracy in the next module.

Classifier Identification Module

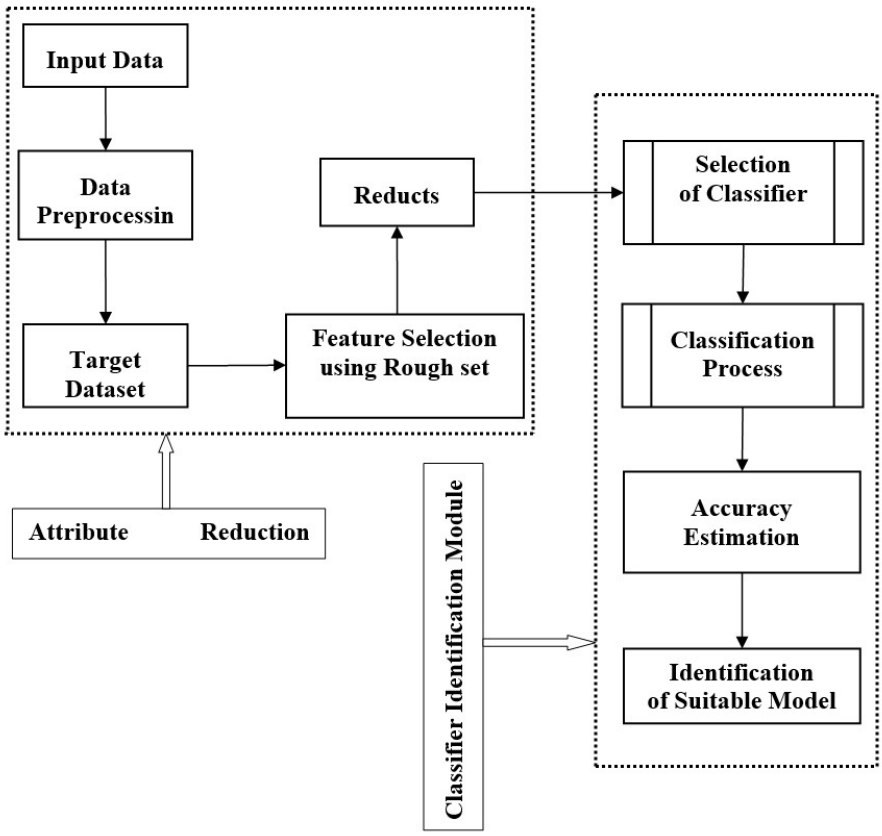
Step 1 - Input - reduct sets {R}.

Step 2 - Identify the Classifier.

Step 3 - Construct confusion matrix for each reduct.

Step 4 - Estimate the accuracy obtained.

Step 5 - Terminate the process.



Source: own processing

Figure 1: Rough Set and data mining based Rainfall Forecast Model

In classifier identification module we have analysed the performance of Naïve Bayes, Bayesian Logistics Regression, Multi-Layer Perceptron, Classification and Regression Tree (CART) and J48 classifiers to identify the suitable classification model that outperform for this meteorological dataset. The classifiers are trained and tested with the complete reduct sets {R1} to {R10} independently. Later all the reduct set accuracy is estimated using true positive and true negative classification. Evaluation process of the classifier is done using Java based weka3.11 software

Working Model of Classifiers

Naive Bayes Classifier, Bayesian Logistics Regression, Multi Layer Perceptron J48 and CART classification algorithms performance were estimated. These classification algorithms were used to analyze the real meteorological data registered between 1984 and 2013 post rainfall around the Coimbatore region of India. We have used Weka (Waikato Environment for Knowledge Analysis) software; a widely adopted suite of machine learning written in Java, developed at the University of Waikato for our classifier performance assessment. WEKA is free software available under the GNU General Public License. It contains a collection of visualization tools and algorithms for data analysis and predictive modelling, together with graphical user interfaces for easy access to this functionality (Accessed: 23 Feb 2014). WEKA is used for analysing the selected classifiers and evaluation of module II were based on the testing set. A simple 10 fold cross validation was performed, as described in (Cao et al., 2013). So we have used 65% for training and the remaining 35% tuples for testing. The process was repeated ten times and the accuracy for true, false, and total accuracy estimated based on confusion matrix. The final accuracy is the average of the accuracy in all tests.

Naive Bayes Classifier

Bayesian Classifier is classifier based on conditional probability and the effect of an attribute value on a given decision is independent of the values of the other attributes. This hypothesis is called class conditional independence. Naïve Bayes Classifier predicts class membership probabilities such as the probability that a given tuples belongs to a particular class. Estimating this probability distribution from a training dataset is a difficult problem, because it may require a very large dataset to significantly explore all the possible combinations in the training phase, the probability of each class is computed by counting how many times it occurs in the training dataset. Naïve Bayes Algorithm computes the probability for the instance X, given C with the assumption that the attributes are independent (Ramana, et al., 2011). Later the probabilities are calculated from the frequencies of the instances in the training set. During training, the probability of each class is computed by counting how many times it occurs in the training dataset. This is called the "prior probability" P(C=c). In addition to the prior probability, the algorithm also computes the probability for the instance x given c with the assumption that the attributes are independent, the algorithm attempts to estimate the conditional probabilities of classes given an observation as rainfall occurred or else rainfall has not occurred (Krishnaiah et al., 2013).

Bayesian Logistics Regression

Logistic regression is a discriminative linear classification model with some decision boundary. It has been proven that logistic regression shows higher accuracy when training data is large. Naive Bayes Classifier has shown good result when the training data size is small. In our process of classification we have used binary class label as RF = 1 or RF = 0, this RF is characterized by set of eight conditional attributes referred as Feature vector X, Bayesian approach with logistic regression is used in different field of application (McNevin et al., 2013), it has shown significant performance in medical data diagnosis in disease identification and it performs well for larger datasets (Miao et al., 2009).

Multi-Layer Perceptron Classifier

In a classification process, the outcome of MLP classifier is class membership for the given input reduct set. The advantage of a neural network algorithm is it adjusts themselves to the application by means of the training or learning process. MLP network-based classifiers have shown good results in application (Zhang et al., 2000). Multi-Layer Perceptron is feed forward neural network which is widely using in classification of data. In MLP the raining processing with the set of input values X and its target T makes use of an objective function such as error, cost or some function. O (Y, T), to find the deviation of the predicted output class labels, Z = MLP (Y; W) from the observed data value T and makes use of the assessed outcome to converge to an optimal set of weights W is based on the algorithm.

J48-Induction Tree

J48 is a classification algorithm based on induction tree algorithm; it uses information entropy and information gain measure for the splitting criterion. The attribute with the highest normalized information gain is chosen to make the decision and then recurs on subset. It constructs a decision tree starting from a training set T, training set is a set of rows in the rainfall dataset. The class label has only discrete values 0 means no rainfall and 1 means rainfall occurred. We denote with numeric values 0, 1 for the Class values of the class. The J48 algorithm constructs the decision tree with a divide and conquers strategy. According to J48 in each node in a tree is associated with a set of cases that are assigned with weights to take into account unknown attribute values. At the beginning, only the root is present, with associated the whole training set S and with all case weights equal to 1:0. At each node the divide and conquer strategy is applied in order to find the locally best option and backtracking is not allowed.

Classification and Regression Tree

Decision tree classification models are usually used in data mining to observe the data to induce the tree and its rules will be used to make predictions. In a decision tree each branch node represents an option between a number of alternatives, and each leaf node represents a decision. CART is widely used in determination and classification of medical diagnostics datasets (Nishida, Nobuko, 2005) and (Deconinck et al., 2005). Classification and Regression Tree (CART) generates trees with only two branches at each node. Such a tree is called a binary tree. When more than two branches are allowed this is called a multiway tree (Data mining Models and Algorithms, 2014). This tree structure will enable to make easy and efficient class prediction.

Results and discussions

Rough sets based attribute reduction is carried out using Johnson's Algorithm and Genetic Algorithm approach. In Johnson approach only one reduct is generated which is not of scope. Rough Set based Genetic Algorithm has shown significant result for our meteorological data set. Table 2 projects the reduct sets with the significant attributes and the corresponding spatial reduction achieved using genetic algorithm approach.

Result analysis of Module-I

Reducts set	Significant attributes	Number of attribute in each reduct	Reduction achieved
{R1}	R1_12346	5 attributes out of * 8	37.5 %
{R2}	R2_12356	5 attributes out of * 8	37.5 %
{R3}	R3_12457	5 attributes out of * 8	37.5 %
{R4}	R4_13457	5 attributes out of * 8	37.5 %
{R5}	R5_13467	5 attributes out of * 8	37.5 %
{R6}	R6_23456	5 attributes out of * 8	37.5 %
{R7}	R7_23457	5 attributes out of * 8	37.5 %
{R8}	R8_23467	5 attributes out of * 8	37.5 %
{R9}	R9_2567	4 attributes out of * 8	50 %
{R10}	R10_4567	4 attributes out of * 8	50 %

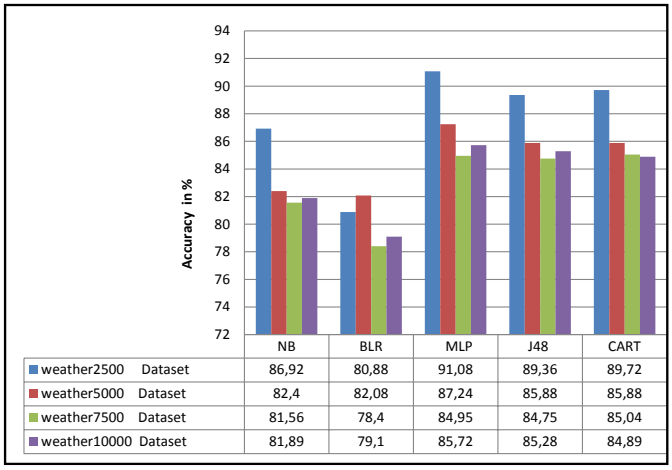
Source: own survey

Table 2: Reduct set attribute reduction

The attribute reduction achieved is shown in Table 2. The genetic algorithm has generated ten significant reduct sets {R1} to {R10} with 4 to 5 significant attributes out of 8. Spatial reduction achieved for every feature subset (reduct) is given in Table 2.Using this attribute reduction we have achieved significant data reduction of 37.5% and maximum of about 50 %of spatial.

Result analysis of Module II

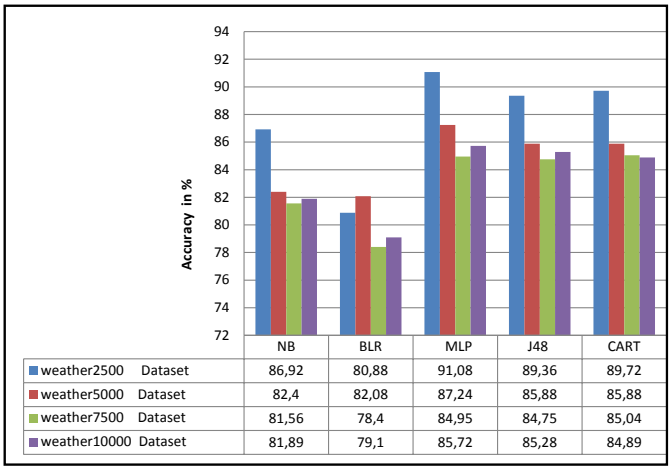
The Chart 1 and the Chart 2 projects the estimation of classifier accuracy before and after using rough set attribute reduction based on Johnson algorithm approach. The accuracy estimation [(Tp+Tn)/(Tp+Tn+Fp+Fn)]*100] of Genetic algorithm approach based on the confusion matrix is given in the Chart 3, all the reducts {R1} to {R10} is evaluated using all the five selected classifiers. Bayesian Logistics Regression (BLR) model has shown significant enhancement than other classifiers in terms of accuracy. BLR has achieved an improved accuracy on the following reduct sets {R1} = 80.19%, {R2} = 80.11%, {R3} = 80.43%, {R4} = 80.59% and {R7} = 79.95%. The experimental results of this proposed model has shown that Rough Set Attribute Reduction technique based Genetic algorithm (RSAT-GA) and Bayesian Logistics Regression (BLR) model has shown significant enhancement than other classifier.



	NB	BLR	MLP	J48	CART
weather2500 Dataset	86,92	80,88	91,08	89,36	89,72
weather5000 Dataset	82,4	82,08	87,24	85,88	85,88
weather7500 Dataset	81,56	78,4	84,95	84,75	85,04
weather10000 Dataset	81,89	79,1	85,72	85,28	84,89

Source: own processing

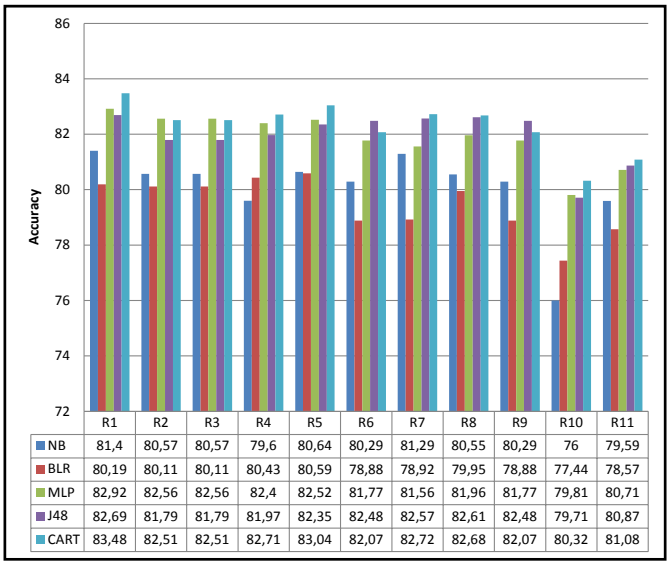
Chart 1: Accuracy before Attribute Reduction.



	NB	BLR	MLP	J48	CART
weather2500 Dataset	86,92	80,88	91,08	89,36	89,72
weather5000 Dataset	82,4	82,08	87,24	85,88	85,88
weather7500 Dataset	81,56	78,4	84,95	84,75	85,04
weather10000 Dataset	81,89	79,1	85,72	85,28	84,89

Source: own processing

Chart 2: Accuracy after Attribute Reduction using Johnsons Algorithm.



	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11
NB	81,4	80,57	80,57	79,6	80,64	80,29	81,29	80,55	80,29	76	79,59
BLR	80,19	80,11	80,11	80,43	80,59	78,88	78,92	79,95	78,88	77,44	78,57
MLP	82,92	82,56	82,56	82,4	82,52	81,77	81,56	81,96	81,77	79,81	80,71
J48	82,69	81,79	81,79	81,97	82,35	82,48	82,57	82,61	82,48	79,71	80,87
CART	83,48	82,51	82,51	82,71	83,04	82,07	82,72	82,68	82,07	80,32	81,08

Source: own processing

Chart 3: Accuracy after Attribute Reduction using Genetic Algorithm

Conclusion

The main findings of our proposed model are listed as follows. (1) Rough Set Attribute Reduction Technique based Genetic Algorithm approach (RSAT-GA) has achieved optimal reducts for realtime meteorological (rainfall prediction) dataset with eight atmospheric parameters. (2) Bayesian Logistics Regression (BLR) have shown improved prediction accuracy than other classifier after attribute reduction. (3) This model is cost effective, simple and reliable. (4) It is suitable for larger datasets.

Future research directions

In future, we would like to evaluate our model with latest classification techniques and have proposed to incorporate latest dimensional reduction approaches like Map Reduce Paradigm along with data mining methods to achieve optimal enhancement in weather forecasts.

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Cross-Platform User Interface of a Web Application in Agrarian Sector

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Anotace

Předložený článek se zabývá procesem vytvoření optimalizovaného výstupu webové aplikace pro mobilní zařízení v podobě responsivního layoutu se zaměřením na agrární WWW portál. Velkým přínosem bylo použití a otestování technik user experience (UX) v krocích UX, výzkumu, designu a testování. Pro výzkum a otestování byly použity dvě skupiny uživatelů po pěti lidech reprezentující cílovou skupinu. Výsledný responsivní layout byl vyvinut s důrazem na ergonomické uspořádání ovládacích prvků a obsahu, konzervativní design, zabezpečení přístupnosti obsahu pro handicapované uživatele a možnost rychlé a jednoduché aktualizace. Výsledné poznatky jsou aplikovatelné na webové informační zdroje agrárního sektoru (zemědělství, potravinářství, lesnictví, vodohospodářství) a rozvoje venkova a v širším kontextu platí obecně.

Klíčová slova

Informační zdroj, responsive layout, webová aplikace, user experience, UX, mobilní zařízení.

Abstract

The paper treats the process of the creation of a web application optimal output for mobile devices in the form of a responsive layout with focus on the agrarian web portal. The utilization and testing of user experience (UX) techniques in four steps - UX, research, design and testing - were of great benefit. Two groups of five people representing the task group were employed for the research and testing. The resulting responsive layout was developed with the emphasis on the ergonomic layout of control elements and content, a conservative design, the securing of content accessibility for disabled users and the possibility of fast and simple updating. The resulting knowledge is applicable to web information sources in the agrarian sector (agriculture, food industry, forestry, water supply and distribution) and the development of rural areas. In wider context, this knowledge is valid in general.

Key words

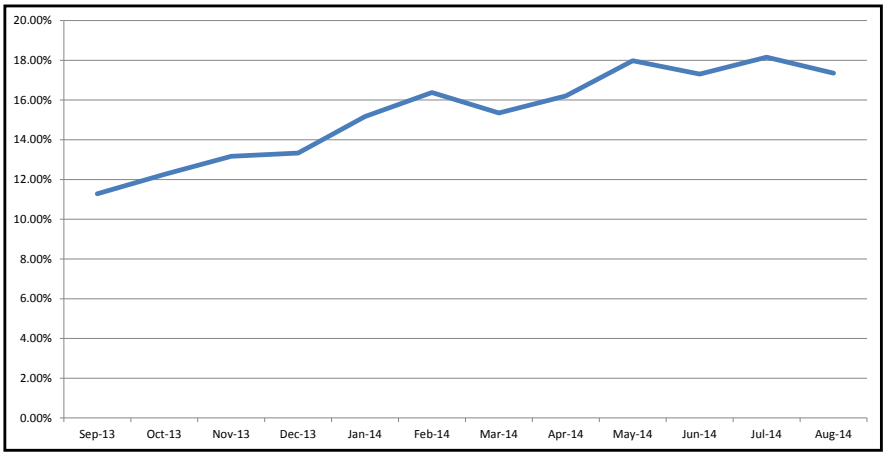
Information source, responsive layout, web application, user experience, UX, mobile devices.

Introduction

Currently, more and more users of web and internet information sources have been using mobile devices. According to the NetMarketShare agency people use access to web presentations and applications from mobile devices in approximately 17-18 %[1] of cases (NetMarketShare, 2014) and there has been a tendency of permanent growth of this percentage. The similar situation exists in the agrarian sector. The latest research data about the use of information and communication technologies by agricultural enterprises in the Czech Republic (carried out by the Department of Information Technologies, 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 WWW, statistics shows an incessant increase in this respect, too.

Users should therefore have a chance to work with web applications from their mobile devices, too. However, in a number of events the designers and administrators of such applications will not allow them to do it in sufficient comfort. In practice this leads to situations in which information is scattered on various screens which is rather annoying for the users (van der Kolik at al.,

[1] August, 2014



Source: NetMarketShare

Figure 1: Browsing by mobile devices.

2013). Modern web applications should offer them an ergonomic interface for mobile devices.

One option how to solve this problem is a responsive design or a responsive layout. The responsive design enables the optimal display of user interface of the application on mobile devices, reduces requirements on scrolling (Lestar et al., 2014) and thus represents a long-term solution of current demands of developers, designers and end users. (Rempel, Bridges, 2013).

In the creation of web applications' design there is a great benefit in the utilization of user experience (UX). The insight into users' preferences (platforms Android, iOS and Windows Phone or 8, at least) is crucial for both product designers (Chien et al, 2014) and the developers of web applications. There exist various techniques of UX testing method: for instance, five-second test includes the display of visual or information web design for a period of five seconds. The respondents are subsequently asked about various aspects (Doncaster, 2014). To other techniques belong: a) eye tracking which is often used in applicability tests (Olmsted-Hawala et al, 2014); b) the evaluation of users' satisfaction during their interaction with digital content (Zahidi et al, 2014); c) the research of usefulness in relation to context and experience factors (MacDonald and Atwood, 2014). In any case, the results depend on the task group of users. This fact has been established by a great many researches. Significant differences will exist, for instance, between university students and seniors (Brajnik, Giachin, 2014).

Material and methods

The agrarian WWW portal Agris shows an increasing number of mobile devices utilization, too. This portal has become of the most frequently visited unified on-line information sources for the area of the agrarian sector (agriculture, food industry, forestry, water supply and distribution) and rural areas. Based on Google Analytics it was found out that in 2012 only 3% users accessed the portal from mobile devices but by 2014 the number has risen to 13% (10% from smart phones and 3% from tablets). Even though this is less than what has been shown by the research of agricultural enterprises' equipment with mobile devices, a rapid growth has been registered. One of the reasons of this disproportion is the nonexistence of the agrarian portal mobile version which would be optimized for different mobile devices of the most frequently utilized platforms Android and iOS with browsers Android Browser, Safari and Opera Mini.

In 2014 we moved to the task of making the content of the agrarian WWW portal Agris accessible for mobile devices. The work has been carried out in three steps:

1. the creation of a responsive design for web browsers,
2. the creation of a native application for the Android platform,
3. the creation of hybrid applications for platforms iOs, Android and Windows Phone 8 (Šimek at al., 2014).

The requirements on the creation of the resulting responsive layout were as follow:

- ergonomic layout of the responsive design control elements and content,
- a conservative design because the users of the agrarian WWW portal Agris are rather conservative,
- the possibility of a fast and simple updating,
- the securing of content accessibility for disabled users.

The whole implementation process consists of four integral steps:

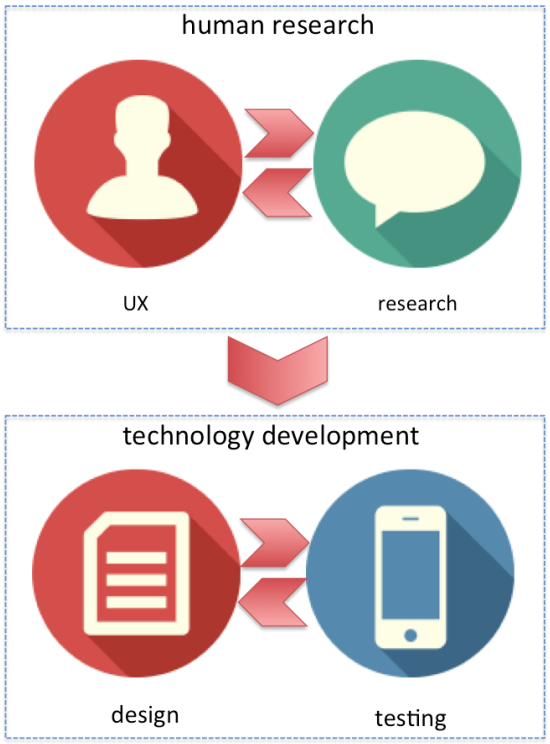
1. UX (User eXperience),
2. research,
3. design,
4. testing.

Into User Experience we include people's behaviour, their attitudes and emotions during their utilization of the agrarian WWW portal Agris in desktop versions of web browsers. It contains practical, meaningful and valuable aspects of the users' interaction with the web output of the agrarian portal.

The research part of the process comes immediately after UX and is based on the task group of users' requirements. Input data are the results from Google Analytics (users' behaviour), results from UX and from interviews with five users representing the task group of users. Users' requirements are thus sufficiently covered and at the same time an excessive redundancy of input data is prevented.

The design part of the responsive design implementation of the agrarian WWW portal consists of plans of sketches and processes, the creation of wireframes and the consequent transfer into a graphical design. During the creation of sketches and processes the maximal emphasis is placed on the effective accessibility of the agrarian portal content and functions. The graphical design is consequently transferred into the real responsive layout.

The final testing consists of two parts: a technological testing and a user testing. The technological testing is concentrated on the correct display of content and functions on a wide range of mobile devices. The user testing is concentrated on the ergonomics of applicability and a comfortable control by the users. In the event of serious errors these are described both uniquely and in detail and then returned to the design level.



Source: authors' own research
Source of icons: IconArchive.com, author: PelFusion (pelfusion.com)

Figure 2: The responsive layout implementation process of the agrarian WWW portal Agris.

Results and discussion

Based on knowledge about both the utilization of the agrarian WWW portal Agris by mobile devices users and the UX results, the first step of the optimization of the displayed content and available functions on the most frequently utilized mobile devices was implemented. The responsive design was developed with the help of MediaQueries technology in Cascading Style Sheets 3 (CSS3) which allows the adaptable depicting of the agrarian portal output depending on the parameters of users' end devices. Considered are the data on:

- the web browser of the mobile device,
- the size and resolution of the display,
- the layout of the mobile device (portrait, landscape).

The whole agrarian web portal is configured in order not to be considered as masked (by for instance a full-text Google browser) because that would lead to the elimination from search results.

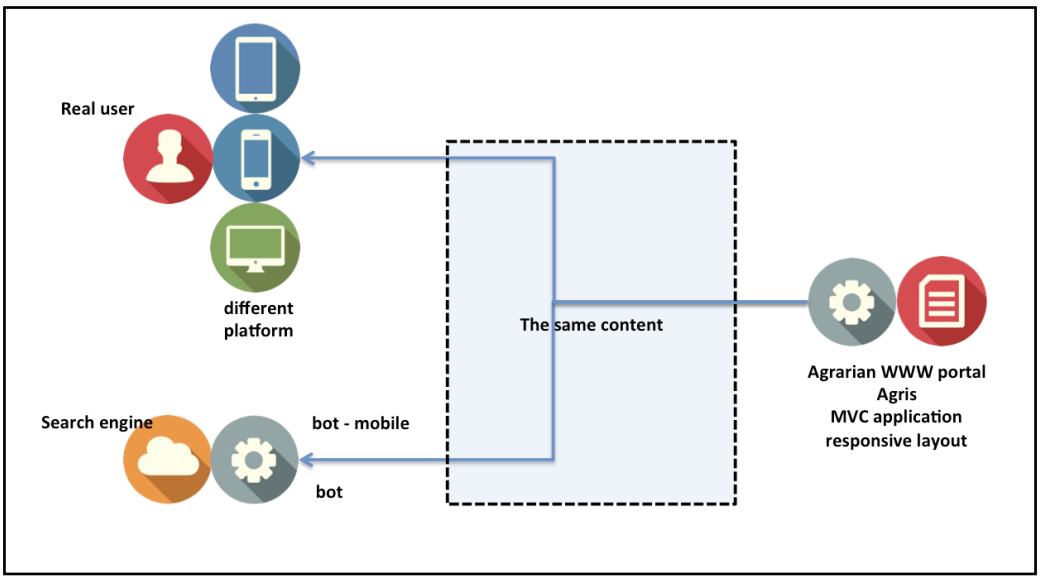
The same content is therefore submitted to browsers of all the end devices including the robots of full-text browsers, for instance Google (Googlebot-Mobile) (Figure 3).

During the final implementation BootStrap, jQuery Mobile, CSS pre-processor Sass, Kickstrap and YUI tools were used. The result is an ergonomic layout of control elements and content with the emphasis on the possibility of an easy and fast adjustments and updating, and the accessibility of the content to disabled users. Thanks to the utilized tools it is possible to implement minor improvements in the display on a chosen mobile device in a couple of minutes. The creation of an independent output for a new mobile device can take – depending on the demand factor and reusability of the code – hours or days.

The accessibility was carried out according to international methodology Web Content Accessibility Guidelines version 2.0 (WCAG 2.0) at level one A (W3C, 2008) and in accordance with intimation No 64/2008 Col. of the Czech Ministry of Interior at the level of compulsory rules. The result thus meets all four requirements:

1. Perceptibility – information and components of user interfaces are presented in order for the users to be able to perceive them.
2. Controllability – all the parts of the user interface and all navigational elements are controllable.
3. Understandability – information and the control of the user interface are understandable.
4. Robustness – the content is robust enough to be reliably interpreted by a wide range of access devices including assistive technologies.

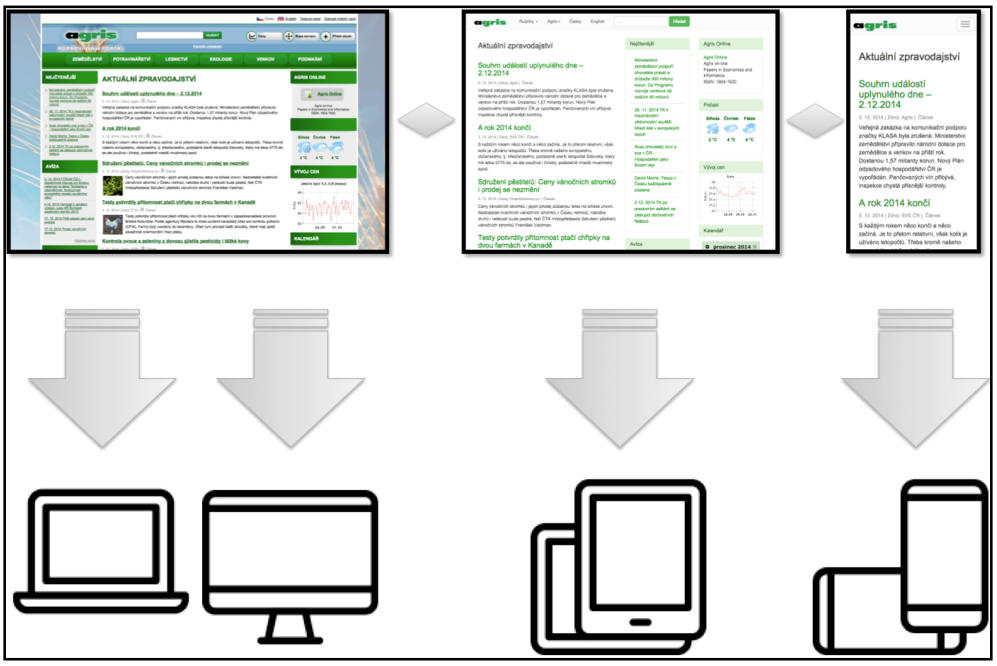
The final testing with the users was carried out in the form of manual work with the resulting responsive design on two types of equipment: Samsung Galaxy S III and Samsung Galaxy Note 10 in both horizontal and vertical layouts. It evaluated users' satisfaction during their interaction with the digital content (Zahidi et al., 2014) and did a partial research of usefulness in relation to context and experience factors (MacDonald and Atwood, 2014). Thanks to UX it was possible to design the ergonomics of control and content so successfully that five testers (who had been chosen from the task group of users) had only minor critical comments on the agrarian WWW portal Agris control on mobile devices. Their comments were incorporated into the design and tested again with a slight delay only. These users were different from those who had taken part in the research part of UX. For the screening of the appropriate display on various devices, a development tool for the simulation of mobile devices in desktop browser Google Chrome was used.



Source: authors' own research

Source of icons: IconArchive.com, author: PelFusion (pelfusion.com)

Figure 3: The distribution of the content to various http clients.



Source: authors‘ own research
Source of icons: IconArchive.com, author: IconsMind (iconsmind.com)

Figure 4: The distribution of the agrarian WWW portal Agris layout to end devices.

Conlusion

By the creation of the responsive layout the first step was made for both the optimization of the content display and the improvement of the ergonomics of the agrarian WWW portal Agris control on mobile devices. The users, who access the portal by smart phones or tablets and whose number is incessantly growing, are able to utilize the full spectrum of service and information comfortably.

Another advantage is that users can switch from „mobile“ to „classic“ design. This will be appreciated by the users of 10“ tablets with high resolution (retina displays). This switch is ergonomically placed into the upper right-hand corner (next to the language and text version options) and has been in this place since the last change of the global design of the portal in 2011. The users who regularly visit the portal are already accustomed to looking for technical control elements here.

The responsive layout has one disadvantage and it is the need of permanent connectivity and online work with the portal. A certain solution could be the utilization of Web Storage technology (W3C, 2014). However, this is not a pure responsive layout or the creation of an optimum design for the mobile devices of the current agrarian portal. This drawback will be eliminated by the creation of a native application for Android platform and hybrid applications for Android, iOS, Windows Phone and Windows 8 platforms which will be implemented during next two steps of making the agrarian WWW portal Agris available for mobile devices with a consequent comparison of efficiency.

Aknowledgement

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Competition among Companies in the Fast Food Market in the Czech Republic

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Anotace

Cílem článku je vyjádření podstaty a rozsahu změn spotřebitelských preferencí v souvislosti s nástupem nadnárodních oligopolních řetězců zahrnující restaurace s rychlým občerstvením. Metodika zpracování článku spočívá ve vyjádření růstu podílu restaurací rychlého občerstvení ve spotřebitelské poptávce v ČR formou komparace výkonových ukazatelů firem. K nejvýznamnějším restauracím s rychlým občerstvením patří v Česku řetězce McDonald's, KFC, Subway a nově i Parky's, které tvoří základní oligopolní strukturu na daném segmentu trhu. Podíl firmy McDonald's na trhu rychlého občerstvení z hlediska výkonů společnosti tvoří v současnosti 46 % trhu. Stať tedy analyzuje část posledního článku zemědělsko-potravinářské vertikály s jasnými konsekvencemi na poptávku po zemědělských surovinách a po potravinách jako celku. Tato studie byla zpracována na základě podpory interní grantové agentury Provozně ekonomické fakulty ČZU v Praze (Projekt č. 20141025 - Růst podílu restaurací rychlého občerstvení (Fast Food) ve spotřebitelské poptávce).

Klíčová slova

Oligopol, rychlé občerstvení, jídlo, cena, konkurence, spotřebitel.

Abstract

The aim of the paper is to express the nature and the extent of changes in the consumer preferences in the context of the oligopolistic multinational chains of fast food restaurants. The methodology of the paper is based on the analysis of growing market shares of fast food restaurants in the Czech Republic using the performance indicators of companies. Among the largest fast food restaurants in the Czech Republic are McDonald's, KFC, Subway and the new fast food chain Parky's. McDonald's market share in terms of output is currently 46% of the fast food market. The paper therefore analyzes the last part of the agri-food vertical with clear consequence on the demand for agricultural commodities and for food as a whole. This study is supported by the Internal Grant Agency of Faculty of Economics and Management, Czech University of Life Sciences Prague (Projects No. 20141025 – The growing share of fast food restaurants in consumer demand).

Key words

Oligopoly, fast food restaurant, food, price, competition, consumer.

Introduction

Czech people are more and more interested in eating in one of the 26 current fast food restaurants due to the more accelerated lifestyle in the last few decades. McDonald's, KFC, Subway and the new Parky's are the biggest fast food restaurants in the Czech Republic. These restaurants form the oligopolistic structure in the particular market segment. While the American McDonald's has a direct representation in the Czech Republic, KFC operates in the domestic market through the Polish Group AmRest. The Polish Group AmRest also owns the majority of Burger King fast food restaurants, Pizza Hut, cafes Starbucks, Fresh Point, Rodeo Drive and other fast food restaurants in Europe.

According to the estimations of „Makro", which is the food chain where both individuals and businesses can purchase raw materials for their restaurants, there are over seven thousand restaurants in the Czech Republic which can be described as „fast food". This amount of restaurants represents an increase by 35 % compared with 2005 (Incoma, 2013). Evidence is growing that

access to unhealthy food establishments increases consumption of fast-food (Boone-Heinonen et al., 2011) and fast-food consumption is a risk factor for obesity (Anderson et al., 2011, Garcia et al., 2012 and Duffey et al., 2007).

The theoretical aspect of oligopolistic market structures is presented in publications of prominent economists, such as Samuelson (Economics, 2007), Varian (Microeconomics, 1995), and Frank (Microeconomics and Behavior, 1995). New issues on market competition were presented by Schiller in his book Microeconomics in 2004 (Microeconomics, 2004) and by Morrison in his integrated structural approach from 1990 (Market power, economic profitability and productivity growth measurement, 1990).

The behavior of dominant firms in oligopolistic markets is currently scrutinized by the French economist, the Nobel Prize winner in economics for 2014, Jean Tirole. Even in the early 80´s of the 20th century there were only a few economists, which had studied the oligopolistic market structure where a small number of companies may affect prices, quantities and qualities of products. The Royal Swedish Academy of Sciences has classified Jean Tirol as one of the greatest economists of our time for his works that have discovered new understandings in problems of regulation of the oligopolistic market with a small number of dominating firms (Horáček, 2014). Jean Tirole does not consider the dominance of firms as a strongly negative phenomenon in markets. Among other things, he proved that the market with dominant firms should not be necessary inefficient and inflexible as it is generally believed in economics (Tirole, Fudenberg, 1986).

„In some sectors there may be one dominant company purely for historical reasons. However, if a certain company enters the market first, it may reach high cost advantages, which may help the dominant firm to deter other companies from entering the industry. For example, assume that there is a very high cost for entry into the market. Then the dominant company may convince a potential entrant that if they attempt to enter into the market, the dominant firm will drastically lower its prices. So a certain company can finally get the dominant position in a certain market. “ (Varian, 1995) „If all oligopolies in a particular market follow the dominant firm's price increases, the result is as if all firms argue on prices for certain products in the given market“ (Schiller, 2004).

Material and methods

The paper obtains the relevant data on fast food chains' profit, which is followed by the comparative analysis of firms and by the comparison of the general equilibrium model (consumer-company) for the analyzed companies. One of the aims of the paper is the expression of the nature and of the extent of changes in the consumer preferences in the context of the oligopolistic multinational chains, particularly on the example of the entrance a new company in the relevant market. The research also determines whether any of the analyzed companies on the market has a dominant position on the market or whether all firms are perfect competitive. The paper therefore analyzes the last part of the agri-food vertical with clear consequence on the demand for agricultural commodities and for food as a whole.

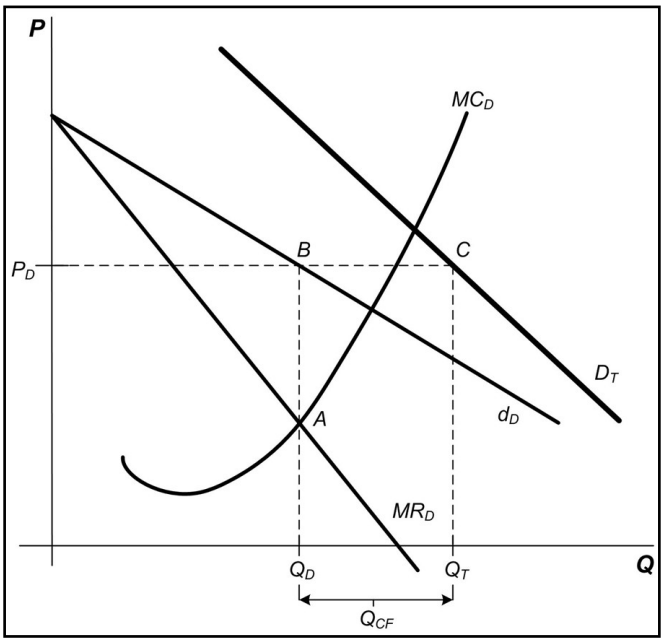
The model of the competitive behavior of fast food restaurants

Oligopoly with a dominant company is an oligopoly market model where a strong (dominant) company occurs, for which it is advantageous to give up part of the market to weaker competitors at so called competitive fringe (edge). However, these small and middle-sized companies at competitive fringe are not able to influence the market in any fundamental way by their decisions about the amount of production or price. On the bigger part of the market, which it keeps, the dominant company then behaves as a monopoly.

We assume that companies at the competitive fringe behave the same way as perfectly competing companies; they can sell any volume of production for the price established by the dominant company and the demand curve after their output is therefore horizontal, given the established price.

Determination of optimal output (Q_D) and price (P_D) of a dominant company is represented by the following Figure 1.

The offer of companies of the competitive fringe is composed of the horizontal distance between market demand curve (D_T) and the curve of demand for production of the dominant company (d_D). The equilibrium point of the dominant company (A) is found in the intersection of its curves of marginal costs (MC_D) and marginal incomes (MR_D); based on the “golden rule of profit maximization”, the dominant company derives its optimal output (Q_D) and optimal price (P_D).



Source: Samuelson, Nordhaus, 2007

Figure 1: Oligopoly with a dominant company.

At this price, companies at competitive fringe offer output (Q_{CF}) originating as the difference between overall output of a sector (Q_T) and offered amount of production of the dominant company (Q_D).

The large firm is assumed to determine the price in the market and the firms in the competitive fringe act as price takers. Therefore, the large producer sets its price by maximizing profit subject to its residual demand curve (Tasnádi, 2010). Since these small (alternatively middle-sized) companies – due to their size - do not have yields from volume of production, their cost conditions are worse compared to the dominant company, and therefore they cannot offer production for lower price than the dominant company is selling for. If they sold production for a price higher than the dominant company, considering the substitutability of their products, the companies of competitive fringe would risk decrease in sales with large part of their customers (in favor of the dominant company's products).

In the model of oligopoly with a dominant company, price of production is determined at a lower level and volume of output is bigger than in monopoly. It is the consequence of oligopolistic competition, although limited; therefore even in this case the price of output stays higher than average costs (P = AR > AC), so oligopoly is realizing higher than normal gain, that is clean economic profit. If the price for which dominant company is selling allows companies at competitive fringe to create clean economic profit, extend their production at the expense of the dominant company, one of these companies can later replace the dominant one on its place of price leader. The leader is usually the biggest company in a sector of fast food restaurants (for example McDonald´s), with the lowest costs, long tradition, well-known brand, etc.

The model of oligopoly that assumes changing companies in the role of price leader is in economic theory called a model with barometric company; it expresses certain instability in a sector as a result of efforts to redistribute markets, movements of prices, and etc. The described model is based on the article of authors Severová L., Kopecká L., Svoboda R., Brčák, J (2011).

Tools of analysis

For the analysis of fast food chains are used fixed base indexes, chain base indexes, regression analysis and forecast of the analyzed companies' indicators. The article compares the main indicators of companies, its growth trends within the Czech Republic and outside the country. Among other indexes, which are used in the article, is return on sales. The index is presented in the further analysis.

Return on sales

Return on sales (ROS) is also known as operating margin, operating profit margin and operating income margin. Behind various names of the index, its calculation presents net profit as a percentage of sales revenue. Managers of companies usually find "return on sales" metric very useful, because profits and sales in absolute values are less comparable among industries. Hence, ROS is one of the indicators of profitability and is often used to compare the profitability of companies and industries of different sizes. ROS can be calculated as the ratio of operating profit divided by sales, presented in percent (Best, 2005). The formula is written as follows:

$$ROS = \frac{operating\ profit}{sales} * 100,$$

where *operating profit* is net profit after tax and sales present revenues of the company.

Table 1 presents calculations of the ROS index for McDonald's in years 2005-2012 in billions CZK. We observe an increase in the value of index in the analyzed years. Return on sales presents the growth of the profitability of the company.

Data for AmRest Group (which includes chain stores such as KFC and Burger King) were found only for the year 2009 and 2010. Return on sales index of AmRest Group was higher than the same indicator of McDonald's in 2009. In 2010 return on sales index of AmRest Group decreased and was significantly lower than the same indicator of McDonald's. Table 2 represents calculations of the return on sales index for the AmRest Group within the Czech Republic.

Results and discussion

Competition of fast food restaurants in the Czech market

There is a new trend of international and European oligopolies in the food markets, which occurs due to the gradual globalization of economies. These international oligopolies affect consumer preferences and economic competition internationally. One of the examples of such oligopolies can be fast food restaurants and fast food chains. McDonald's, KFC, Subway and the new fast food chain Parky's belong to the biggest fast food restaurants in the Czech Republic. They form the oligopolistic structure in the particular market segment. Although, it is not a business with high margins, the majority of companies prosper for a long time and all of them have positive economic profits. For example, McDonald's as the most representative restaurant in the Czech Republic has not showed any single drop in the operating profit for the last few years. The competitive chain KFC has also positive economic profit. However, a profit

Year	Sales (billions CZK)	Operating Profit (billions CZK)	Return on Sales (%)
2005	2.282	0.062	2.717
2006	2.576	0.013	0.505
2007	3.203	0.044	1.374
2008	3.777	0.117	3.098
2009	3.871	0.137	3.539
2010	3.800	0.152	4.000
2011	3.998	0.177	4.427
2012	4.167	0.181	4.344

Source: McDonald's annual reports; own calculations

Table 1: McDonald's return on sales in the Czech Republic, 2005-2012 (billions CZK).

Year	Sales (billions CZK)	Operating Profit (billions CZK)	Return on Sales (%)
2009	1.60	0.070	4.375
2010	1.58	0.005	0.316

Source: AmRest Group's annual reports; own calculations

Table 2: AmRest Group's return on sales in the Czech Republic, 2009, 2010 (billions CZK).

of the company fluctuates significantly while revenue of the company grows stable for the period of the company's existence in the Czech market.

- The total amount of revenue of the two largest fast food chains **McDonald's** and KFC was four billion Czech crowns in 2013. After calculating the revenue of McDonald's franchise branches the total amount of revenue of both fast food chains had raised to six billion Czech crowns. For the comparison of indicators, the net profit of the American fast food chain McDonald's has declined in the first quarter of 2014 by 5.5 percent to 1.2 billion dollars; the operating profit has declined by one percent to 1.94 billion dollars while revenues have increased by one percent to 6.7 billion dollars (McDonald's, 2014).

Graph 1 shows the development of sales of McDonald's since its arrival on the Czech market in 1992 till 2013. We can observe an obvious trend of steady growth in sales of McDonald's, which although had slowed due to the economic recession, but sales had not diminished at that period of time. The growth of sales might be caused by a change in the consumer preferences, because of the fact, that customers preferred cheaper meals at fast food restaurants compared to more expensive restaurants in the fear of the impact of the recession on their incomes.

The following equation describes the linear trend of sales:

$y = ax + b$,

where y represents sales, x represents a current year, b is the point of the intersection with the vertical axis (y or sales) and a is the incremented value of sales during the given period of time or the regression coefficient, which represents the rate of change of y; or the slope of the regression line. For the given data we can derive the linear trend for McDonald's sales as:

$y = 0{,}2056x - 0.2031$,

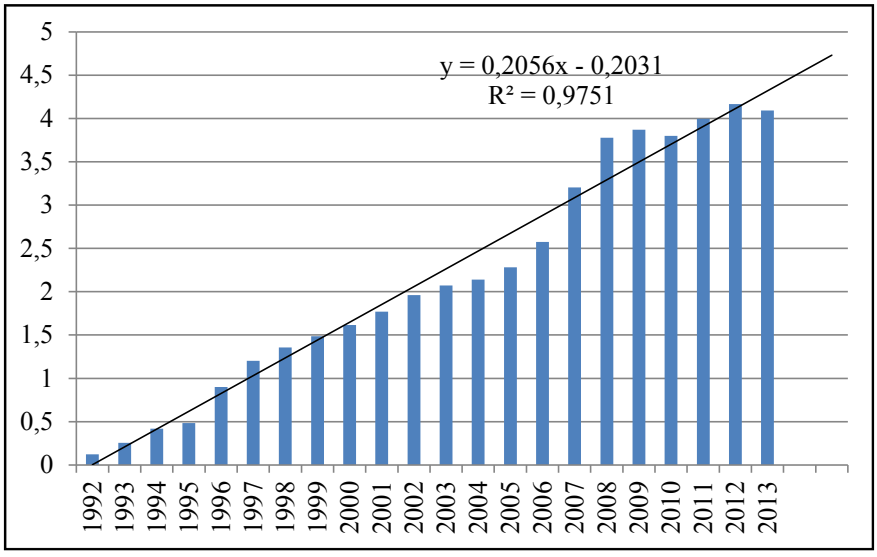
where the regression coefficient equals to 0.2056, i.e. year-to-year prediction growth is 0.2056. The value of the reliability of the approximation (a number from 0 to 1, showing the correlation between the values of the trend line to the actual data) is equal to 0.9792 (R^2). This number indicates a strong correlation between the calculated numbers with the data.

The prediction based on the linear trend shows: by the end of 2014 sales of McDonald's will be 2.67 billions of CZK and in 2015 sales will achieve 2.88 billions of CZK.

Table 3 represents sales of McDonald's in the Czech Republic (in billions CZK) from 1992 to 2013. It characterizes the development of McDonald's sales using a fixed base index number (1992 = 100) and a chain base index number. The fixed base index number we calculate as:

$$Fixed\ base\ index = \frac{s_n}{s_{base}} * 100,$$

where s_n are sales of the current year and s_{base} are sales of the base year (1992).



Source: McDonald's, 2014; own calculations

Graph 1: McDonald's sales in the Czech Republic, 1992-2013 (billions CZK).

The chain base index value is calculated as:

$$Chain\ base\ index = \frac{s_n}{s_{n-1}} * 100,$$

where s_n are sales of the current year and s_{n-1} are sales of the previous year.

For example, Table 3 shows that the value of the fixed base index in 2013 had 33.8 times raised from the base year 1992 (the growth was 3282 %); the value of the chain base index for 2013 represents the decline in sales from 2012 to 2013 (the decline of sales between 2012 and 2013 was 5.7%). We can see from the Table 3, that the fixed base index does not applicable for the following data in the long period of time (over 2 decades). Hence, the chain base index can be used for the analysis of the development of McDonald's sales.

By comparing the revenues of both companies (McDonald's, KFC) we can evaluate their share on the oligopolistic market. It should be noticed that the fast food market in the Czech Republic also includes other smaller chains (Subway, Parky's, etc.), which offer close substitutes to the dominant companies' products. The fast food market has a large number of small, specialized sellers, which are focused on the national cuisine (Thai, Chinese, Arabic, and etc.). They do not affect the market's revenues significantly. These small sellers belong to the analyzed oligopolistic market's so called „competitive fringe".

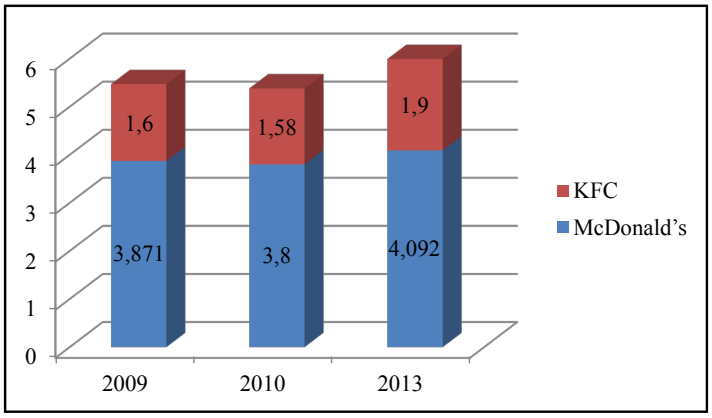
The following graph (Graph 2) expresses the competition between McDonald's and KFC in the previous few years in terms of their sales.

According to the Graph 2, McDonald's has been acquiring the decisive position in the fast food market (burgers, wraps, and etc.) during the given years. That is why, the company is considered to be the dominant firm in the market. The relative share of sales of the company had been changing from 3.8 billion CZK and 1.58 billion CZK in 2010; to 4.1 billion CZK and 1.9 billion CZK in 2013. McDonald's reported it had reached 46 % from the total fast food market in 2014. The company has been reaching the dominant position in the market for a long period of time; KFC as a medium-sized company and other small

Year	Sales (billions CZK)	Fixed base index (1992=100)	Chain base index
1992	0.121	100	-
1993	0.255	211	211
1994	0.419	346	164
1995	0.482	398	115
1996	0.899	743	187
1997	1.202	993	134
1998	1.356	1121	113
1999	1.485	1227	110
2000	1.617	1336	109
2001	1.77	1463	109
2002	1.961	1621	111
2003	2.073	1713	106
2004	2.14	1769	103
2005	2.282	1886	107
2006	2.576	2129	113
2007	3.203	2647	124
2008	3.777	3121	118
2009	3.871	3199	102
2010	3.8	3140	98
2011	3.998	3304	105
2012	4.167	3444	104
2013	4.092	3382	98

Source: McDonald's annual reports; own calculations

Table 3: McDonald's sales in the Czech Republic, 1992-2013 (billions CZK).



Source: Annual reports of companies

Graph 2: The Comparison of sales of McDonald's and KFC in the Czech Republic in 2009, 2010 and 2013 (billions CZK).

Year	Sales of McDonald's (billions CZK)	Sales of KFC (billions CZK)	Fixed base index (2009=100) of McDonald's	Fixed base index (2009=100) of KFC	The ratio of sales (McDonald's/KFC)
2009	3.871	1.6	100.00	100.00	2.42
2010	3.8	1.58	98.17	98.75	2.41
2013	4.092	1.9	105.71	118.75	2.15

Source: Annual reports of companies; own calculations

Table 4: The ratio of sales and the fixed base indexes for McDonald's and KFC in the Czech Republic in 2009, 2010 and 2013 (billions CZK).

fast food sellers (about 7,000 companies) form a competitive fringe in the oligopolistic fast food market. The dominance of one firm will not prevent KFC or other firms (e.g. Subway) to occupy that position in future in the given market segment. In the case of the sector's instability in the country that could be caused by changes in consumer preferences, the barometric model of oligopoly with a dominant firm may arise, where the dominant position is rotated by firms in the given market structure.

McDonald's has 93 restaurants in 2014 in the Czech Republic and other restaurants are prepared to be open in the next few years. Management of the chain plans to open new branches near railway and bus stations with smaller sizes of restaurants, with limited number of offers and with extended number of take away offers (McDonald's, 2014). McDonald's, in particular, has traditionally focused on a strategy centered around high accessibility (Jekanowski, Binkley and Eales, 2001). This strategy is rooted in the philosophy that the overall number of transactions per capita in a specific market increases as the number of McDonald's restaurants increases (Samuels, 1996).

Table 4 shows the ratio of sales between two companies. We can observe that McDonald's ratio is bigger during the given period of time and it decreases. The fixed base indexes for KFC increase faster than the fixed base indexes for McDonald's. It proofs the possibility that KFC could occupy the dominant position in the market in the case of the sector's instability. To calculate chain base indexes for both companies we should know sales of KFC for the given period of time. We have found sales of KFC only for the years 2009, 2010 and 2013. Hence, it is not possible to calculate chain base indexes for both companies in the given period of time due to the lack of information.

- **Parky's** company placed its fast food restaurants nearby railway stations like McDonald's, where it sells its meals (hot dogs) containing sausages from "Kostelecké uzeniny", which is the company, that belongs to Andrej Babis - the billionaire and the Finance Minister in the Czech Republic. "Kostelecké uzeniny" in collaboration with its strategic partner Parky's plans to open dozens of stalls. These stalls will offer hot dogs in the country. The main part of the business will be the production of sausages manufacturer with its traditional production from 1917.

The company has proved several stalls pilot projects, which were opened in 2013, nearby the main railway stations in Prague, Kolin and Olomouc. The Smíchovský's stall was closed because it was less profitable than others. However, new stalls would be added to the existing ones in the near future. For example, one of the new stall is opened in the ski area "Snowhill Herlíkovice" in Krknoše (Kütner, 2014).

„Kostelecké uzeniny" had struggled with losses in the recent years. The new project might be one of the ways, how to return the company back to successful profits. Expansion of the company is planned in the whole country, but first changes would be held in the most attractive location of the country.

The Parky's project, which was launched by „Kostelecké uzeniny", is now entering the next phase from mobile food stalls to normal restaurants. The company has successfully tried several different concepts and now uses a franchise model not only for stalls, but also for so-called "shop-in-shop chains" or sales in already existing restaurants. By the end of 2014, there could arise a dozen of new "shop-in-shop chains", but it also depends on the contractual partners of the company (Parky's, 2014).

- **KFC** also tries to increase its market share in the Czech market. The fast food chain belongs to the American company Yum Brands together with other restaurant chains such as Pizza Hut and Taco Ball. KFC has more than 60 restaurants in the Czech market. The company is focused on the sales' growth not only by establishing new restaurants, but also by increasing the attractiveness of existing ones. Management of the company plans to invest in the reconstruction of the oldest (first opened) and the most congested restaurants during the year. It is interesting to mention that the Agrofert Group, which belongs to one of the richest Czechs Andrej Babis, prosper due to the popularity of KFC's chicken meals, because a large portion of chicken comes from the poultry farm Vodňanská drůbež, which in turn belongs to the Agrofert Group (KFC, 2014).

While American McDonald's has a direct representation in the Czech Republic, competitive KFC is presented in the domestic market by the Polish Group AmRest. The Polish Group AmRest also owns the majority of Burger King fast food restaurants, Pizza Hut, cafes Starbucks, Fresh Point, Rodeo Drive and other fast food restaurants in the Czech Republic.

Table 5 and Graph 3shows operating profits of the largest fast food chains in the Czech Republic from the year 2005 to 2012. Fixed base indexes and chain base indexes are used for the further analysis. The operating profit of McDonald's had increased in comparison with the base year 2005. Chain base indexes have increased over time; and the highest rise in the chain base index was measured in 2007. The operating profit of AmRest Group fluctuates in the given period of time. The fixed base index presents an increase in profits in comparison with the base year 2005. The chain base index of AmRest Group increases in 2006, 2009 and 2011; and decreases in 2007, 2008, 2010 and 2012.

We can derive the linear trend for McDonald's operating profit as:

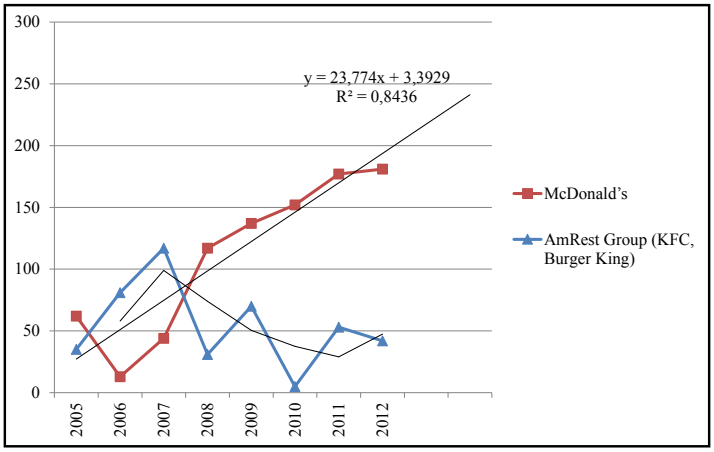
$y = 0.0238x + 0.0034$,

where the regression coefficient equals to 0.0238, i.e. year-to-year prediction growth is 0.0238. The value of the reliability of the approximation is equal to 0.8436 (R^2). This number indicates

Year	McDonald's	Fixed base index (2005=100) of McDonald's	Chain base index of McDonald's	AmRest Group (KFC, Burger King)	Fixed base index (2005=100) of AmRest Group	Chain base index of AmRest Group
2005	0.062	100.00	-	0.035	100.00	-
2006	0.013	20.97	20.97	0.081	231.43	231.43
2007	0.044	70.97	338.46	0.117	334.29	144.44
2008	0.117	188.71	265.91	0.031	88.57	26.50
2009	0.137	220.97	117.09	0.070	200.00	225.81
2010	0.152	245.16	110.95	0.005	14.29	7.14
2011	0.177	285.48	116.45	0.053	151.43	1060.00
2012	0.181	291.94	102.26	0.042	120.00	79.25

Source: Annual reports of companies; own calculations

Table 5: Operating profits of the largest fast food chains in the Czech Republic, 2005-2012 (billions CZK).



Source: Annual reports of companies; own calculations

Graph 3: Operating profits of the largest fast food chains in the Czech Republic, 2005-2012 (billions CZK).

a strong correlation between the calculated numbers with the data.

The prediction based on the linear trend shows: in 2013 the operating profit of McDonald's should be 0.217 billions CZK and in 2014 the operating profit should achieve the value of 0.241 billions CZK. The data are predicted for the year 2013 and 2014 due to the lack of information for the given years.

The linear trend function for AmRest Group's operating profit is:

$y = -0{,}0046x + 0.075$,

where the regression coefficient equals to -0.0046, i.e. year-to-year prediction decline is 0.0046. The value of the reliability of the approximation is equal to 0.1068 (R^2). This number indicates low correlation between the calculated numbers with the data. Another function should be found in order to characterize the development of the operating profit correctly. We can use a median-median linear curve fit or other possible regression functions (polynomial, multiple linear, logarithmic, exponential, and etc.).

The prediction based on the linear trend shows: in 2013 the operating profit of AmRest Group should be 0.0335 billions CZK and in 2014 the operating profit should achieve the value of 0.0288 billions CZK. The data are predicted for the year 2013 and 2014 due to the lack of information for the given years.

While the operating profit of McDonald's grows, the operating profit of AmRest Group decreases over time in the Czech market. McDonald's has a strong position in the market, which grew even in the period of recession in 2008. The Polish AmRest Group loses its market position in the Czech market. It can be caused by the consumer preferences, by the different amount of restaurants, by lower prices or by a stronger advertising policy of competitive firms. For example, a Czech citizen consumes about 80 kg of meat per year, 40 kg of that belongs to a pork meat, 25 kg to a poultry meat and 15 kg to a beef meat according to the Czech Statistical Office. It means that from 80 kg of meat 69 % belongs to pork and beef meat and only 31 % to poultry (Czech Statistical Office, 2014). That is why we can state that Czech people prefer meat to poultry. As for the number of restaurants, McDonalds's has more than 90 restaurants while AmRest Group owns only 70 restaurants in the Czech market (McDonald's, KFC, Burger King, 2014). Therefore, McDonald's has more options for selling its meals. And finally if we compare prices of chains, we can admit that the price of the cheapest sandwich (Hamburger) in McDonald's is 20 Czech crowns while the price of the cheapest sandwich in KFC (Longer) is 30 Czech crowns and the price of the cheapest sandwich in Burger King (Hamburger) is 39 Czech crowns for the 25th of September, 2014. Therefore, McDonald's is still cheaper for a consumer than other fast food restaurants. (McDonald's, KFC, Burger King, 2014)

- **Subway** is another fast food chain, which operates in the Czech market. Subway is a fast-food franchise chain. It was founded in 1965 by Fred De-Luca. The company still belongs to its founder and it operates in 101 countries. Subway is a stronger international player than McDonald's

in terms of the number of restaurants in the world. While Subway has 39 700 restaurants, McDonald's owns only 35 000. However, McDonald's has higher revenues than Subway in terms of the worldwide viewpoint (Subway, 2014).

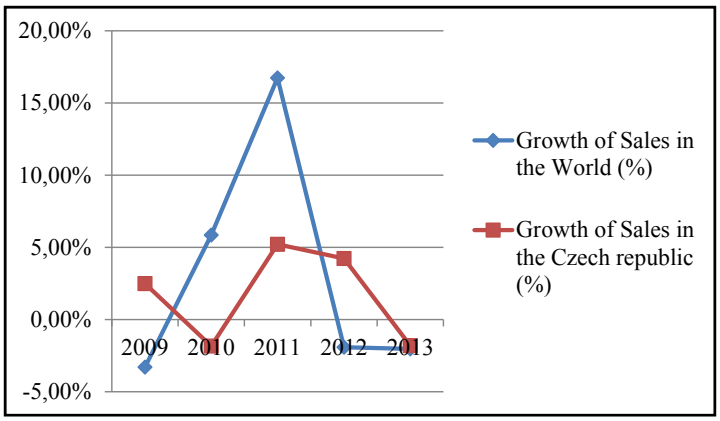
American Subway plans another significant expansion in Europe. Europe and North America are currently the strongest and fastest growing markets for the company, and most likely these continents will remain to be significant for the company's profit. Subway prepares to open approximately one thousand restaurants in the old continent during 2014. The Prague's Subway office will play an important role in the expanding of businesses as far as it controls franchises in Central and Eastern Europe. For example, Subway in Prague will control franchises in Ukraine and in the Baltic states. More than 4 000 restaurants were opened in Europe in the last few years and the 4 001st restaurant was opened in Romania in 2013. However, the first country for the company's expansion in Europe remains the United Kingdom. As for the Czech Republic, the company will continue the expansion in the country. Subway plans to open more than twenty restaurants during the following year and plans to find new potentials for a growth in the Czech market.

The company produces new products twice a year. Regions are partially free to choose products from the general offer, although basic meals are similar in every restaurant in the world. New products are tested in each region before they will be included in general offers. For example, Subway tested whole grain bread and avocado's sandwiches in Morava in 2013. The latest product is an American flatbread, which has strong filling tastes that make a pleasant surprise for a common customer. The Subway's franchise owners are not completely independent in their decisions; there are certain restrictions and limited standards in a number of cases. They should also have sufficient starting capital and they should be personally involved in the running of a restaurant.

McDonald's Comparison of sales in the world

McDonald's operate restaurants in over 100 countries and it owns more than 35 000 restaurants in the world. The company's total revenues consist of sales by company-operated restaurants and fees from restaurants operated by franchisees. The world's revenues of the company are divided geographically into the U.S. region, Europe, APMEA (Asia Pacific, Middle East, Africa) and other countries. Company-operated sales achieved 18 875 millions of dollars in 2013. They are generally bigger than franchised revenues, which are only 9 231 millions of dollars for the same year. For the company-operated sales, the most profitable region is Europe (8 138 millions of dollars). As for the franchised revenues, the most profitable region in the world is the U.S. with 4 339 millions of dollars.

The average growth of sales in the world for the company is 3.06 %, while the average growth of sales in the Czech Republic is 1.66 % for the years 2009-2013. If we compare the growth rate we will observe fluctuations during the analyzed period. The most successive year for company's sales was year 2011. Sales of the company had decreased after 2011. The following Graph 4 presents comparison of total sales growth of the company between the Czech Republic and the world.



Source: Annual reports of companies; own calculations

Graph 4: McDonald's growth of sales in the Czech Republic and in the world, 2009-2013 (%).

Big Mac: the McDonald's Most Famous Burger and the Economic Indicator

The Big Mac is a sandwich with two slices of grilled beef, American cheese, iceberg lettuce, pickles, onions and the Big Mac's sauce. The Big Mac is well known all over the world. But the history of its creation is not so popular. The Big Mac had two other names before its final title. The first was the „Aristocrat", however it was difficult to pronounce for customers and this name did not succeed in the market; the second name was the "Blue Ribbon Burger" or in other words, the „premium burger". This name either did not succeed, and only the young secretary of McDonald's came up with the current name "Big Mac". The author of the Big Mac's recipe is Jim Delligatti, one of the first franchisees of McDonald's founder Raye Krace. The recipe was created in 1967 in the restaurant Ross Township in Pennsylvania. The sandwich quickly became popular in restaurants all over the United States. McDonald's opened the Big Mac Museum in the restaurant in North Huntingdon, Pennsylvania on the occasion of its 40th birthday in 2007. The museum was opened personally by the author of the Big Mac's recipe, who was 89 years old at that time.

As McDonald's states: "If you order the Big Mac, you will always get a sandwich consisting of two slices of grilled beef, American cheese, "special sauce" (a variant of Thousand Island dressing), iceberg lettuce, pickles, and onions, served in a three-part sesame seed bun. Only boneless front cuts of beef are used in order to produce hamburger's beef slices. Meat is frozen, and only in McDonalds it is barbecued without additional thawing. Meat is grilled under 70 ° C, therefore it is healthy, and at the same time it does not lose its juiciness. After the careful grilling which brings the robust flavor of the meat, it is lightly salted and peppered." (McDonald's, 2014).

The Big Mac is known worldwide and is often used as a symbol of American capitalism. Economists have also used it as a reference point for comparing the cost of living, currencies and the purchasing power of populations in different countries. So called the Big Mac Index is used because it is widely available and is comparable across markets. This Big Mac index is published every year in economic journals. Economists monitor prices of Big Macs in each country and then derive, whether the local currency is undervalued or overvalued against dollar. For example, a customer will find the cheapest Big Mac in Kiev, Ukraine, mainly because of the extremely weak domestic currency. While in Oslo a customer will find the most expensive burger in the world. The price of the Big Mac in Oslo is 7.76 $ per unit, while the price of the Big Mac in Kiev is 1.63 $ per unit.

Final Analysis

1. The advent of fast-food restaurants in the 90´s of the 20th century after the arrival of McDonald's, KFC and other famous fast food brands has become one of the symbols of the modern meals. Nowadays, there are many of chains that offer burgers and sandwiches, as well as individual hot dogs' sellers in the Czech Republic. However, hot dogs' chain is a new trend in the country that was lacking before.
2. McDonald's market share in terms of output is currently 46% of the market. If market shares of a company exceed 40 % of the relevant market, the company achieves the dominant position in this market according to the Office for the Protection of Competition in the Czech Republic (2001). Therefore McDonald's has the dominant position in the Czech relevant market.
3. Although Subway is the market leader in the United States of America, it is still not a major player in the Czech market. It loses its market power in terms of the amount of restaurants, as well as in a customer's loyalty compared with the existing chains McDonald's or KFC.
4. The Parky's is a company owned by Andrej Babiš, one of the richest Czech people in the world. It focuses on a specific segment of the market - sales of meals nearby railway stations. Sales of hot sausages at railway stations have a long tradition in the Czech Republic. Furthermore, railway stations are not so popular among big fast food chains, what reduces a competition for Parky's. A small size of restaurants economizes costs and on the other hand provides meals for a large number of customers. A typical customer of Parky's passes through the station and wants to eat quickly and cheaply. That is why, Parky's can replace old and cheap station's restaurants that were traditional stop for many passengers of railway and bus stations in the past.

5. In terms of profits for the two main players in the fast food market (McDonald's and KFC) it can be stated that the Czech chain of McDonald's has a long-term profit growth, as it was showed by the increasing linear trend in the graph (see Graph 1). McDonald's profit grew even in the period of the economic recession, but just at a slower rate. The reason of the growth might be the fact that products offered by McDonald's (especially hamburgers) are relatively cheaper substitutes for more expensive meals in common restaurants. Moreover, a customer service in fast-food restaurants is quick and thus saves time and increase the capacity of a restaurant. It also proved that especially children prefer eating at fast food restaurants: "Factor analysis explored preference of unhealthy foods by children. Results of hypotheses testing revealed a strong dependence relating to techniques of pester power, accommodating their requests and transact the purchase." (Balcarová, Pokorná, Pilař, 2014)
6. The growing consumer interest is also evidenced by the survey of "Edenred", which gives meal vouchers called "Ticket Restaurant". For example, 11.9 % of its customers had ordered meals in fast food restaurants in 2009, while 13 % of its customers had ordered meals in fast food chains in 2012.
7. Return on sales is an indicator of profitability and is often used to compare the profitability of companies and industries of different sizes (Best, 2005). Return on sales calculated for McDonald's has showed the growth of the company's profitability for the years 2005-2012. Return on sales index of AmRest Group was higher than the same indicator of McDonald's in 2009. In 2010 return on sales index of AmRest Group decreased and was significantly lower than the same indicator of McDonald's. Return on sales index has proved that McDonald's prevails in profitability compared to other companies in the industry.
8. McDonald's total revenues consist of sales by company-operated restaurants and fees from restaurants operated by franchisees. The world's revenues of the company are divided geographically into 4 regions: the U.S., Europe, APMEA (Asia Pacific, Middle East, Africa) and other countries. Company-operated sales are generally bigger than franchised revenues for years 2008-2013. For the company-operated sales, the most profitable region in 2013 was Europe with 8 138 millions of dollars. As for the franchised revenues, the most profitable region in the world was the U.S. with 4 339 millions of dollars in 2013. The average growth of McDonald's sales in the world is generally higher than the average growth of sales in the Czech Republic for years 2009-2013, which highlights that McDonald's is more successive in the world than in the Czech republic in terms of sales for the given years.
9. KFC as a major competitor of McDonald's is trying to attract new customers. It tries to product the similar products (Twister and ChickenMcWrap) and decrease prices. However, McDonald's benefits from its initial dominant position in the Czech market from 1992 offering well-known and deeply loved products. The significant position of McDonald's is supported by the constant product innovation and by images of its stores.

Conclusion

Multinational fast food chains appeared in the Czech Republic just after the creation of a market economy in the country. One of the first international fast food chains was McDonald's and its successful entry on the market contributed to the dominant position of the firm in the analyzed sector (currently McDonald's has 46 % of the total market segment). Fast food restaurants are used by people in order to save time. They are opened for 24 hours per day; as a consequence people use them for meetings with friends or for businesses' meetings. We can mention a new social function of fast food restaurants which helps to strengthen their market position. They have relatively low prices which are preferred in a period of economic recessions and in periods of low salaries. Therefore fast food restaurants still hold a position of dominant firms in the sector.

It is important to mention, that competition increases and new firms get into the market, so fast food chains fight for every customer. It is reflected not only in advertising and price policies, but also in investments, discounts offers and in other possible ways. Fast food chains have prospered in the Czech Republic for a long period of time and a further growth is possible in this segment

of the market. Despite the fact, that bankruptcy of small and middle sized restaurants have increased, especially in small towns of the country; fast food chains still keep the dominant position in the market.

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Evaluation of Effectiveness of Feedback's Amount

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Anotace

Informační vazby jsou nedílnou součástí fungování každého reálného systému (ať již jde o biologické systémy, ekonomický systém státu či řídicí systém firmy). Pro správné fungování systému je nutné mít přesně definované informační vazby, a to jak: přímé, nepřímé a zpětné vazby. Práce je zaměřena na problematiku zpětných informačních vazeb. Celkově vzato se nelze ubránit dojmu, že problematika zpětných vazeb je považována za výsostně teoretickou doménu a praktickým důsledkům správné funkce či disfunkce zpětných vazeb v reálném životě se soustavně nevěnuje náležitá pozornost. Je opomíjena potřeba cílevědomého využívání a zdokonalování zpětných vazeb v rámci budování či udržování systémů všech úrovní a oblastí, řídicí systémy nevyjímaje. V odborné literatuře nepanuje zcela jednotný názor na existenci a množství zpětných vazeb, které jsou – nehledě k jejich struktuře a kvalitě – limitujícím faktorem praktické výkonnosti řídicích systémů. Tento článek se zaměřuje na rozlišení (resp. selekci) zpětných vazeb, relevantních pro efektivní plnění funkcí komunikačního procesu v řídicích a organizačních strukturách vybraných zemědělských podniků ČR a na kvantitativní vyjádření vztahu jejich počtu a spolehlivosti přenosu řídicích a zpětnovazebních informací. Výzkum byl realizován ve 178 zemědělských podnicích. Teoretickým a praktickým výstupem výzkumu je navržen matematický model testování informačních vazeb. Tento model byl aplikován na příkladu řízení informačních vazeb v rámci obchodních procesů a je rovněž popsán v článku.

Klíčová slova

Informační vazby, komunikace, efektivní komunikace, manažer, informační zpětná vazba, relevantní zpětná vazba, nežádoucí zpětná vazba, pozitivní a negativní zpětná vazba.

Abstract

Information links are an integral part of the functioning of any real system (whether it is a biological system, the economic system of the state or the control system of the company). For proper operation of the system is necessary to have a well-defined information flows both: direct, indirect and feedback. The work is focused on feedback information links. Overall, the issue of the feedbacks is considered eminently as a theoretical domain and the practical consequences of the correct function or dysfunction feedbacks in real life are systematically not paying proper attention. It is ignored the need of purposeful use of feedback and improvement within the building or maintenance of systems at all levels and areas, including control systems. In the literature does not exist consensus on the existence and amount of feedback, which are - regardless of their structure and quality - the limiting factor in the practical performance of control system. This paper is focused on the resolution (or selection) feedbacks relevant to the effective performance of the functions of communication in the process of management and organizational structures of selected companies in the Czech Republic and quantitative expression of their relationship and the transmission reliability control and feedback information. The research was implemented in 178 farms. The output of theoretical and practical research is designed of mathematical model testing information links. This model was applied to the example of management information links within business processes and is also described in the paper.

Key words

Information links, communication, effective communication, company, manager, information feedback, feedback, relevant feedback, unwanted feedback, positive and negative feedback.

Introduction

The competitiveness of enterprises is (whether directly or indirectly) influenced by many factors. One of these factors is determinate importance of the effectiveness of communication. In the literature, there is no consensus on many aspects of the issue of effective communication. The authors hold different views on this issue; they are not always practical differences motivated research based rather predetermined starting or current experience. It can be accepted fairly logical assumption those authors who have concluded that feedback plays an important role in communication. The initial consideration was one of the motives for our research; its general character at textbook examples inspired us, however, to attempt a deeper and more systematic analysis of the relationship between quality and quantity of feedback between efficiency and corporate communications. Therefore, this paper will deal with the evaluation of effectiveness and the amount of feedback in communication. The authors can be found in the literature, who deals with the issue of feedback systematically.

For example Veber et al. (2000) claimes, that the core of effective communication are the human feedbacks not electronic feedbacks. Although communication is in all areas of management, the greatest importance has for the management leadership. Effective communication is the lifeblood of a successful organization and it reinforces the organization's vision, connects employees to the business, fosters process improvement, facilitates change, and drives business results by changing employee behavior (Bulent, Adnan, 2009).

The authors say that if it is an international organization, it should prepare their employees to work and communicate with people of other nationalities, cultures and religions. The most common mistake in communication is typing and stereotyping, which would be workers should avoid (Charvát, 2008).

Vlachos (2009) claims, that „*…sharing of information may have a dual effect: Firstly, it conveys employees the right meaning that the company trusts them. Secondly, in order to make informed decision, employees should have access to critical information. Communicating performance data on a routine basis throughout the year help employees to improve and develop.*"

Střížová (2006) claims that: *„Communication does not mean a link that allows reciprocal understanding and real cooperation, in the organization. It's not just about formal compliance obligations to ensure that the information given on time at the right place, but much more. Workers generate and clarify opinions on everything that is happening, what is the order of the values of the organization. The reputation of organization speaks to the stuff, objectives, internal atmosphere, quality of management, successes, failures, traditions, rituals, rules, compensation, penalty, interest of managers to employees, the culture of the working environment, the level of job aids, know - how, the level of negotiations with customers and public."*

Šilerová and Kučírková (2009) says, that: "*A number of information, both external and of course internal, creates the requirements for their quality ensuring. It requires to set inner firm's channels effectively, to aggregate the data properly and to stipulate differentiating values.The processes in the firm are supported by various information systems and organizational procedures connected with them because of optimalization and data exchanges, information and knowledge among single organizational units of the firm.*

The quality of this process is dependent on the way of firm's section managing that ensures the development and managing of information systems and information and communication technologies."

Roese and Sikström (2014) claim that: …"*communication is argued to be an important means of forming and executing strategy, particularly if that strategy involves change.*" Lososová and Zdeněk (2013) claim that: "*One of the important elements of the evaluation is to assess the economic performance of management efficiency…*".

In our literature is described more inspiring procedures, using the feedback mechanism at work - both in terms of pure information, and in terms of interaction between people, e. g. for the purposes of education and self-education. One of them is called „targeted feedback". In the Czech context, is also known as reflection, review or debriefing (Reitmayerová, Broumová, 2012).

On the other hand and last but not least, communication is not only technical transfer of information. There are many of points of view, how to use them to improve level and quality

of knowledge base, i. e. "*knowledge management represents an ongoing relationship between and among people, processes and technology systems involved in designing, capturing and implementing the intellectual infrastructure of an organization*" (Charvát, Gnip, 2010).

It turns out that in terms of communication links is also very important the internal organizational structure of the units. This highlights the innovative activities investigated units, such as the introduction of a new product design or location services on the market.

It was found that the speed of implementation, whether new or a change of products, has a significant influence of the internal communication links with other units of the company. Very isolated units without internal links takes longer product introduction, while less isolated units with greater communication link handle often already in half the time.

In addition to communication links is also very important that the correct type of communication used. Basically, it is possible to distinguish two types of information:

- Explicit, specific, „hard" information,
- Unspecified with different interpretations, „soft" information.

The first group of explicit information, it can be included such as market data, production results, simple software codes, financial results, the results of research. This information can be distributed quickly and easily.

The non-specific information includes technical expertise, use of production technologies, operational know-how. This information need high degree of interpretation, it cannot be transferred automatically.

These characteristics lead to the conclusion that each type requires a different way of information transmission mechanism. Unspecified information need high level meeting „face to face", such as conferences, meetings, training courses so that the participants reached a common and consistent interpretation of unspecific information. Conversely explicit information can be transmitted electronically without personal contact.

Improper use prevents communication link services are able to effectively communicate and exchange information. If the company seeks to use the free connection, egg intranet database to communicate unspecified information, communication will fail. On the contrary, it would be a waste of time to transmit explicit information on meetings and meetings. According to research, those companies that transmit explicit information loose connections, introducing new products by 25% of the time sooner than those used for the transmission of this type of information sessions and meetings. However, if the free concentration unspecified transmitted information, then the time is extended by the introduction of 20%.

This proves that the company effectively created an organizational structure has better conditions for effective communication and faster response to market needs. The importance of good communication links, however, managers are beginning to realize if the company gets into serious trouble. Each random thoughtless process of creating communication networks has significant negative economic consequences. Managers are encouraged to plan communication network very thoughtfully and carefully with a view to the future. The first step is to specify the information and knowledge they will need, and then create an appropriate communication network to provide the necessary knowledge with minimal cost. Authors say, that „*In the world there is considerable emphasis on the work of knowledge, through which it is possible to achieve the desired results.*" (Dunford, Snell, Wright, 2001).

It should be noted that the information necessary for the management system is composed of the several layers and subsequent functional purpose subsystems. In addition to the specific management information has growing importance of information (interactive) background as a source of factual, cognitive, and other reference information for the execution of the main mission of the information system. This is inseparably linked with Internet technologies. A significant contribution represents a set of graphical database systems through services such as eg. map outputs in the web application development needs of farms and regions.

Vaněk, Brožová, Masner, Šimek and Vogeltanzová (2013) describes level, structure and forms of their use in terms of organic farms in the Czech Republic. They confirms, that projects and solutions requiring support, such as e.g. Map Portal for Regional Development Version 2.0 (MPRR) solution significantly can contribute to an effective informational support of regions, i. e. can it support many different kinds of regional

activities, including the organic farming sector.

Rydval, Bartoška and Brožová (2014) solve the problem of mutual information links differently. Rather than concentrate on the feedback separately, but they understand all information flows in terms of their possible impact on information asymmetry. These authors deals with the describing, modelling, and analysis of the factors affecting our rational thinking, our ability to make rational decisions; in particular, with the framing effect in decision - making process and its graphical representation and quantification, using semantic networks and analysis with the Analytical Network Process (ANP method). The suitable method to map and quantify the distortion of information which occurs in the decision-making may be based on the semantic networks, which can capture the basic elements of the information frames and their mutual relationships to express the possible loss of information and its asymmetry.

The communication networks are the technical means for transmitting, processing and storing information. It often happens that the technical component of the communication network changes in the preferences of managers from among the part of the objectives of work. Stusek emphasizes that „*Executives must promote such technological innovation architecture of information systems that are open and their components will be capable of relatively independent development.*" (Štůsek et al., 2008). An essential part of communication networks, however, are people - and it all. Therefore, building and securing appropriate communication network means not only to their formal organizational position but also the use of informal competencies selecting teams, work allocation and release of information adapting to the current situation. This leads to the spread of tacit knowledge and information, the selected workers creates effective feedback and act as a reference source of information. In such an environment, it is easier to block unwanted information feedback and strengthen those feed backs that contribute to the accuracy of the information and to minimize noise.

Materials and methods

The aim of the research was to valorize the effectiveness and the amount of feedback in the communication process in companies in the Czech Republic and to suggest the calculation of the required design (ultimate or optimum) amount of feedback to ensure effective communication, which will lead to a higher quality of communication and thereby support business performance.

The theoretical bases were formulated from the analysis of the literature review, which served to define relevant feedbacks selected types (desirable, stabilizing, homogeneous, substitution).

Quantitative research was carried out to a limited number of feedbacks. Quantitative research was conducted through a questionnaire survey in the file of 3671 respondents. From this file was generated with the random selection 1685 respondents. These respondents were asked for the cooperation in this research. From these respondents were filtered respondents on the law of transitivity. The final file was 176 respondents for those workers who have been designated as the default theoretical analysis of structural elements (resources, creators, transmitters of information, information consumers, modifiers or prominent wearers) relevant information within the enterprise communication system. In quantitative research was determining the deduction method that allows the general assertion deduce concrete conclusions. To verify and supplement the results was also used qualitative research. Furthermore, was used the method of induction for the formulation of the problem of mathematical relationships.

Newly discovered facts and dependence were compared with theoretical assumptions and subsequently described in the conclusion.

Results and discussion

Answers in questionnaire showed, that there is very important to know in which virtually the respondents were unable to agree. This information was knowledge of informal channels, their function and content in terms of reliability and representation of desirable or undesirable feedback. Their use is thus practically available informal and active (responsive) to members of social groups. Thus the company is preparing a powerful tool for efficient communication.

Some practical insights have helped substantiate the deduction of the general starting points very effectively. For example, were examined situations where the process of innovation (the product or service on the market, the application of the company as a supplier for a key customer, etc.) there are problems. It is a failure of quality, deadlines, finding the guilty, operating obstruction between teams of cooperating companies or other

typical symptoms

He found a major difference in the success of projects and strong communication „under the end of a good, all good." This eventually stated by one of the case studies of the management that in a crisis situation (negative trend of accumulation of problems, displacement and threats to key terms of the contract) to ensure immediate information feedback and came with not done but rapid information-style curriculum meeting the following example:

- We are at this stage, but according to plan, we should be here …
- Consequences if you are not going to change anything for the company following ...
- We have no choice, we must reverse the trend ...
- We caught up with this positive, which gives us confidence that we are able to complete the contract in time ...
- The biggest causes of problems are as follows ...
- We have problems with your partner and the customer, but the sweep in front of its own house
- We will strengthen capacities, but expect your higher deployment ...
- We will be more assertive towards its partners and negotiate better cooperation because we put its own house in order and we have already proved that these points are experts and responsible partners.
- We changed the organization of work, because what does not work, it has to change...
- We have changed the composition of personnel ...
- All of this was done from the perspective of top management, what we see and what we have response from you ... but we have deeper
- At the same time we are working hard to uncover the underlying causes, will lead to further change the style of work and organization - there is need feedback from you
- Discussing all this with you and then everything with our partner - and as we expected now the debate will contribute to change, which we started to do, so our changes will be affected by the limits of our partner - because later this week with you so we meet again meetings outside of any structure, so that you know what turned out to be unrealistic, or where the situation has improved, eventually. where it is necessary to reschedule orders.

These were examples of functional feedback from practice. The essence of an effective communication system, personal conversation. Communication between the recipient and the sender in this case works best. The reason for greater efficiency and immediate feedback.

This is confirmed by Veber, stating that, regardless of whether it is an internal or external communication, it is essential to ensure adequate feedback. At the beginning of this process carries you need to convince the other party that is interested in her opinion, it is extremely important to her (Veber et al, 2000).

Functioning of feedback has visibly reflects on other activities that at time communication effectiveness increased.

Sender (communicator) transmits information through the communication channel. The shipper must properly articulate their message (news, information) and select the appropriate vehicle for his message to the recipient. The receiver then given information it receives and interprets. An integral part of the communication process is feedback. Some resources (tools, channels) enforce feedback, but it only allow (egg email asking for permission to deploy a new software release can be completed by a supervisor read receipt and a copy of the worker, on the contrary executive order to deploy the software is effective to provide a hidden copy of all whose activity is dependent on the software failure)

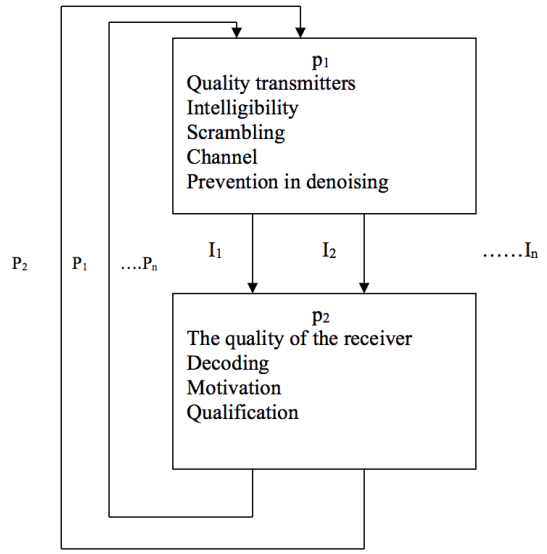
Střížová (2006) states that: „*The managers are the bulk of the responsibility for the level of communication within the organization. You will need to provide their employees properly explain all the relevant rules and modalities. They must also ensure that they were properly understood, support the functioning of feedback. If employees do not respond to communications management activities according to their expectations, is eighty percent of the cause of poor communication lines. Responsible is always the one who is at a higher hierarchical level. It should not happen that the communication between subordinates and superiors will be influenced by human desire to control and manipulate. Although subordinate does what the boss wants, but it remain distrust*

in him, reluctance to continue talking."

Keeping in mind the human factor in communication, then according Plaňava (2005) may be apprehensive feedback and positive, and neutral understanding, understanding and negative, uncomprehending that needs precise.

Some authors argue that the most important is the existence of immediate feedback that can be achieved only in oral communication; on the other hand, other authors tend to ensure adequate feedback or deal with quality feedback.

Research has examined assessment required amount of feedback in companies. It was examined whether due to the increased amount of feedback have a positive effect in the management of personnel, or (purely mathematically), there is that potential.



Source: Charvátová, 2001

Figure 1: Illustration of feedback from employee to manager.

Here informational links I_1 and I_2 ..... I_n presents direct control information. P_1 and P_2 .... P_n represent feedback information (assuming their homogeneity, substitutability, and it is desirable for links). Then apply to the resultant transmission reliability of the information, and

therefore communication effectiveness (1,2 ..... n links):

$$\sum P = 1 - \prod_{i=1}^{n} (1 - p_i)$$

where $\sum P$ is the reliability of the task, more reliable transfer of information (the probability with which the controlling entity learns that a powerful element of the report was adopted, or anything done, or something learned.

The fulfillment of the tasks is the result of the aggregate number of other factors.

That relationship is valid only for a homogeneous network feedback - even though it is a theoretical calculation, the practice is implemented personal communication group of workers in a social group, working on the same task, which operates between tacit knowledge sharing and multiple channels of information equivalent toward superiors (barrier channels for information such as yes, no, what, when, where and what are the inputs, outputs, and which resources are missing to perform the task). In practice it is necessary to take into account the direction of feedback (negative, positive) and type of information, eventually, their value. There can be dispersed, but streamlined information.

If $n = 2$, then the change may be inferred that the reliability of information transmission, therefore, increases the potential of effective communication:

$$\Delta P = (P_{zb} - P_b)$$

where:

P_{zb} - a number of defined feedback

P_b - a number without feedbacks

Increasing the number of control or feedback in practice happens at zero cost. The problem is more complex in that the costs include the costs of technical-organizational and technological development and installation of communication channels N_{ich} and for their operation N_{pch} (channels can be shared by multiple information flows - feedbacks). Furthermore there include the cost of acquisition and preprocessing own information $N_{i.}$ Their sum constitutes the total cost *CN* that in deciding on the effectiveness with which reflected the positive feedback effect in control *PE* staff:

$$\sum PE = \Delta P * CN_{NE} - (t.n_t + V_n * q)$$

where:

ZP - feedback

PE - positive feedback effect in the management of personnel

CN - total costs

NO - ineffective communication

q - number of feedback from employee to manager

Vn - Cost of one implementation feedback

nt - Cost per unit of time

There is a certain limit or optimum value of the number of inbound links, over which it is inappropriate to increase their number. The benefit of further feedback has no economic justification; the risk is negligible unreliability to be included in the calculation of the total balance. In economic terms, it is theoretically useful to perform feedback if:

$$PE = (P_{ZP} - P_B) * CN_{NE} - (t.n_t + V_n * q) > 0$$

Indifferent (there are other reasons worthy of special consideration) economic benefit is not increased if applicable, that:

$$PE = (P_{ZP} - P_B) * CN_{NE} - (t.n_t + V_n * q) = 1$$

From an economic standpoint it is theoretically useful to increase the number of inbound links if applicable, that:

$$PE = (P_{ZP} - P_B) * CN_{NE} - (t.n_t + V_n * q) < 0$$

+ Positive	- Negative
Reliability	Time costs
The development of human resources in the organization	Cash costs

Source: Charvátová, 2001

Table 1 Evaluation of the amount of feedback.

The above relations were applied in companies while driving to meet business obligations in the supply of products, which was established as a destination complying with all parameters supplied at predetermined prices.

Managers used to control (issuing of control commands) direct links to subordinates. By default (original usual control procedure) was used only one type of feedback reports on the task in combination with the transfer of information to ensure delivery within the normal document flow.

Reliability of supply compliance parameters ranged from 0.8 to 0.9. The analysis revealed that the cause is the limiting low reliability of single feedback, ensuring the human element (reliability 0.8 to 0.9). Feedback circulating documents showed considerable delay, so that practically did not. Therefore, he was forced to perform control worker personal control condition, which caused the increase in costs (time spent checking his work also) and allow correction of unfavorable condition.

Therefore, it was designed:

a) To increase the likelihood of achieving the required parameters supplied by increasing the number of inbound links, comprising less reliable human element. To advance the desired confidence level 0.99 out minimum number of inbound links as follows:

$$\sum P = 1 - \prod_{i=1}^{n} (1 - p_i)$$

$$\sum P = 1 - \prod_{i=1}^{3} (1 - 0{,}85) = 1 - 0.003375 = 0.996625$$

The causal relation to this increase was the result of the potential for effective communication:

$$\Delta P = (P_{ZP} - P_B)$$

$$\Delta P = (3 - 1) = 2$$

The effectiveness with which reflected the positive feedback effect in the management of personnel, we expressed an indicator of *PE*:

$$\sum PE = \Delta P * CN_{NE} - (t.n_t + V_n * q)$$

$$\sum PE = 2 * 9{,}8 - (12 * 0{,}8 + 6{,}0 * 3) = -8.00$$

where total costs take into account time-saving control controller. The calculation also served as a control, which confirmed that it would not make economic sense to increase the number of inbound links through human elements (PE < 0).

b) To speed up the circulation of the documents so as to start and operate the feedback. The discrepancy between the original document circulation system, which served primarily recording, accounting and business statistics and the new system of document circulation, which was to ensure the management of online, was temporarily resolved at the cost of duplication. It was a comprehensive circulation of documents in electronic form, then adding formalities. It was technically assured double feedback notification messages (information on the results of operations) on your mobile manager.

This newly established feedback and at higher cost proved to be very reliable in itself (0.995) and there was no need to duplicate it further.

$$\sum P = 1 - \prod_{i=1}^{1} (1 - 0{,}995) = 1 - 0.005 = 0.995$$

The causal relation to this increase was the result of the potential for effective communication:

$$\Delta P = (P_{ZP} - P_B)$$

$$\Delta P = (1 - 0) = 2$$

The effectiveness with which reflected the positive feedback effect in the management of personnel, we expressed an indicator of PE:

$$\sum PE = \Delta P * CN_{NE} - (t.n_t + V_n * q)$$

$$\sum PE = 1 * 6.97 - (12 * 0.45 + 0.9 * 1) = 0.67$$

- total costs take into account time-saving control of the management staff, the cost of duplicating documents in circulation (additional processing documents) and the unit cost advantage of the already established electronic channels. The calculation also served as a control, which confirmed that the intention to increase the number of feedback via electronic channels (PE > 0) has an economic justification.

Conclusion

Authors performed an analysis of opinions in the literature; it was found that the authors' views vary on the issue of feedback in communication. Some authors argue that the number of communication links plays an important role in the introduction of changes in the company. Other authors argue that there is a critical mass of communication links, but the important thing is to ensure immediate feedback, which can be achieved only through a tight, narrow, immediate feedback, e. g. oral communication. In contrast, other authors argue that it is important to ensure immediate feedback, but it is absolutely necessary for sufficient security, which makes increases over time, then the effectiveness of communication. Other authors deal with the quality of the feedback, but do not pay attention to the amount of feedback.

Research has confirmed that for effective control communication is important not only in structure, quality, type and nature of feedback, but also their number and security. It was found that the use of the necessary amount of feedback depends on the situation. This quantitative relationship was described above assumptions expressed mathematically.

Suggestions and practice recommendations is that the managers in companies, should verified secure communication in the presence of desirable feedback, their immediate scope and perform approximate calculation of the reliability of information links and the potential for more effective communication with at least the use of qualified cost estimate. If the output of the theoretical calculation positive growth effect of feedback in staff management, it may be decided to strengthen them and vice versa. Managers should approximate this method to verify whether their responsibility is in a favorable ratio of communication costs and reliability of communications (determined by the amount of feedback). After meeting these assumptions is desirable objective to focus on a mechanism that exploits the potential of effective communication so that their personnel information not only accepted, but she also understood and used effectively.

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Systematic Risk in Agriculture: A Case of Slovakia

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Abstract

The paper uses the alternative Markowitz portfolio theory approach, by replacing the stock return with return on equity (ROE) and estimates the systematic risk of unquoted agricultural farms. The systematic risk is standardly measured by the mean-variance model and standard deviation of stock return. In case of unquoted firms the information regarding the market rate of return is missing. To assess the risk and return, the use of individual financial statements is necessary. The systematic risk in Slovak agriculture over the period 2009-2012 was 3% of equity or capital invested with the average return 0,048%. We calculated the systematic risk separately for two prevailing legal forms in Slovak agriculture: cooperatives and companies (JSC., Ltd.). Cooperatives represent farms with lower individual risk and lower ROE, but higher systematic risk. Companies represent farms established after 1989. These farms generate higher profit for the owner with lower systematic risk.

Key words

Agriculture, systematic risk, unquoted companies, legal form, return on equity.

JEL: R52, R58, H41.

Introduction

Yield, risk and liquidity are the main factors influencing the investment decision making process. According to the essential literature, there are many ways, how the risk can be assessed (Klieštik, Valášková, 2013). For evaluation of the riskiness of quoted companies are mainly the market data taken into consideration, however, in the case of unquoted companies the financial statements data are to be used.

Risk generally refers to deviation of the evaluated indicator, and its level depends on the volatility over a certain period. The agriculture of Slovak republic, passed during the last decade a period of substantial changes caused by the EU Common Agricultural Policy, new political regulations and quotas, or crisis influence in 2009 that have been ultimately impacting economic development in this sector. The average economic results of a farm in agriculture show very high level of volatility of financial indicators such as ROE, 4.39% in 2007, 0.4% in 2009, 2.84% in 2011, or ROA, 1.76% in 2007, 0.04% in 2009, 1.11% in 2011, (Serenčéš et al., 2014). This unstable and risky development of Slovak agriculture can be subjected to strong variability due to several reasons and factors affecting the farms` production and income.

Another important aspect of assessing the risk is the type of risk. In finance we distinguish between the individual or portfolio risk, and systematic (market) or unsystematic (diversifiable) risk. Individual risk is the risk connected with an individual investment. In this case, the investor does not diversify and invests 100% in single investment opportunity. On the other hand, portfolio risk is a risk of portfolio investment, meaning the investor diversifies his/her assets into two or more investment opportunities. Unsystematic risk is a risk that can be decreased by adding the additional investment into the investment portfolio. It is a part of the total risk that can be eliminated by increasing the number of investments in the portfolio. Remaining part of the total risk is the systematic risk, which cannot be eliminated, despite the number of investments in portfolio.

Riskiness of the agriculture sector consists of many different individual sources of risk resulting from the product prices instability, food industry requirements, biological nature of production, dependency on climatic conditions, seasonality and others. These risks are very rarely completely independent from each other, particularly when measured in terms of their impact on the income variability. For this reason, the classification of different types of agriculture risk seems

very similar, and the boundaries are not strictly specified. Huirne et al. (2004) and Hardaker et al. (2004) distinguished two main types of risk in agriculture. Firstly, the business risk, including the production, market, institutional and personal risks, and secondly, the financial risk resulting from different methods of financing the business activities, fluctuation of interest rate or loans availability. Holzmann and Jorgensen (2001) divided the risk into 6 main categories: natural, health, social, economic, political and environmental. Moreover, they crossed the typology with the dimension of systematic characteristic of different risk and determined the majority of individual agricultural risks to take a form of economic risk, which may not be diversified. Based on this fact, although, number of different divisions has been found (Musser, Patrick, 2002; Harwood et al., 1999), in our study we mainly focused on the systematic (non-diversifiable) and unsystematic risks (diversifiable).

Total risk is standardly measured, according to the Markowitz portfolio theory, by the mean-variance model and standard deviation of stock return (Brealey, Myers, 2007, Hrdý, Krechovská, 2013). However, not all businesses provide the ability to raise their capital in the form of stocks that would be traded in the stock market. These businesses represent so called unquoted companies. However, the stocks, considered in the original model, represent the equity securities, and the return on stock reflects simply the return on equity invested into the business. Therefore, it might be assumed that to be able to measure the risk of unquoted companies, the deviation of return on equity could be considered, as well.

The systematic and unsystematic risks belong to the concept of Capital Asset Prising Model CAPM (Sharpe, 1964; Lintner, 1965) that was built on mean-variance portfolio work of Markowitz (1952). While the unsystematic risk reflects the firm specific risk sources that might be eliminated by the diversification, the systematic risks remains common for all entities in particular sector and can be termed as the market risk. (Brealey, Myers, 2008). The systematic risk measurement in the CAPM, also originally considers the volatility of stock prices and expected returns on securities. Very closely related to the CAPM is the Simple index model (SIM) equation, which is virtually identical to the CAPM equation, but without equilibrium asset pricing implications (Sharpe, 1963, Hubbs et al., 2009). It means that it provides the ability to apply the model to other than security market. It empowers the assumption to measure the systematic risk of unquoted companies, using alternatively the equity ratio.

The systematic risk can vary across the industries, since industries show various resistance patterns against the risk, due to different business attributes (Lee, Jang, 2006). The entities operating within the agriculture sector belong to the unquoted companies, whose securities are not traded on the public stock exchange. The systematic risk estimation of agriculture sector requires the alternative Markowitz theory approach or SIM implication, when the input variables used in analysis are the accounting fundamentals of companies. This alternative approach was applied in the number of previous studies, such as usage of gross and net returns (Gempesaw et al., 1988), crop revenues (Mumey et al., 1992) farm equity returns (Baginski, Wahlen, 2003), book to market ratios (Fama and French 1995) or cash flow variability (Campbell,W uolteenaho, 2008; Cohen et al., 2009; Da, 2009).

The risk analysis of agriculture, using the Markowitz approach or Single index model, has been applied to the number of studies, however many of them did not have aggregate character. They mainly focused on the certain part of agriculture production, for example, Barry (1980) applied the CAPM assumptions to estimate beta for U.S. farm real estate market, Peterson and Leuthold (1987) used the portfolio approach to examine the cattle feeding problem, Prattley et al. (2007) applied the portfolio concept to find appropriate allocation of surveillance resources in animal populations, Barkley et al. (2010) estimated optimal crop diversification. Also, the more aggregate perspective, when the systematic and non-systematic risk of agriculture of whole country has been estimated, can be found. Gempesaw et al. (1988) applied the model to Delaware farm sector market portfolio, Turvey and Driver (1987) used SIM to study the systematic and non-systematic risk of Canadian agriculture, or in more recent study Libbin et al. (2004) applied the Markowitz portfolio model directly to a series of New Mexico farms. Similarly, we decided to focus our study on examining market risk and return of Slovak agriculture sector.

The main objective of the paper is to measure the systematic risk of Slovak unquoted agricultural companies by measuring the volatility of ROE over the period 2009-2012. Applying the alternative Markowitz portfolio theory approach on a dataset

of farms covering 78% of Utilized Agricultural Area (before necessary adjustments) allows to estimate the systematic risk in agriculture of the Slovak Republic.

Materials and methods

Material

We used a data from database of the Slovak Ministry of Agriculture and Rural Development (IL MoARD - PU, 2013), over the period 2009-2012. The database consists of individual farm data, including balance sheets and income statements. Data submission is obligatory for all agricultural farms. For our analysis, data were selected according to the farm legal form to subset of the agricultural production cooperatives (461) and the subset of the capital companies - Joint Stock Company (JSC) and Limited Liability Companies (Ltd.) (535). From the dataset data of the following farms were excluded:

- farms that started or quitted during the observed period 2009-2012,
- farms with negative equity (liabilities exceeding total assets),
- farms with return on equity (ROE) exceeding +/- 100% (average profit or loss exceeds equity) over the observed period.

We used then data of 996 farms, out of which there were 535 agricultural companies and 461 agricultural productive cooperatives,

Methods

We assumed that the return of the investor is based on the profit of the company and the equity invested. Therefore, we considered return on equity ROE (Eq. 1) to be equivalent to the return on stocks, generally used in the case of quoted companies.

$$ROE_i = \frac{Earnings\ After\ Taxes}{Shareholders\ Equity} \quad (1)$$

Where:

ROE_i – return on equity of farm "*i*"

Measuring volatility of return in the Markowitz portfolio theory is based on the average return over the observed period for each investment. We calculated the average return on equity $EROE_i$ (Eq. 2) for each individual farm.

$$EROE_i = \sum_{i=1}^{t} ROE_i . d_i \quad (2)$$

Where:

d_i – a weight of ROE_i over the observed period (4 years, $d_t = 0.25$)

t – number of years in observed period.

i, j – individual farms.

The individual risk of each farm (σ_i) is calculated using the standard deviation.

$$\sigma_i = \sqrt{\sum_{i=1}^{t} (ROE_i - EROE_i)^2 . d_i} \quad (3)$$

Where:

σ_i – standard deviation of the individual return on equity (individual farm risk),

ROE_i – individual return on equity,

$EROE_i$ – average individual return on equity.

The portfolio risk (σ_p) is determined by three variables:

w_i – weight of the individual investment in portfolio,

σ_i – standard deviation of the individual investment (individual risk),

σ_{ij} – covariance (relation between the ROE_i and ROE_j).

To take into account market portfolio of all agriculture farms, the weight wi of each farm is determined by farm market share, which is the share of the farm` s equity on the total equity of all farms.

The covariance represents the relationship between returns on equity of farms (Eq 4) and Σ covariance matrix (Eq. 5).

$$\sum = \begin{bmatrix} \sigma_{11} & \sigma_{12} & \sigma_{13} & \dots & \sigma_{1k} \\ \sigma_{21} & \sigma_{22} & \sigma_{23} & \dots & \sigma_{2k} \\ \sigma_{31} & \sigma_{32} & \sigma_{33} & \dots & \sigma_{3k} \\ & & \dots & & \\ \sigma_{k1} & \sigma_{k2} & \sigma_{k3} & \dots & \sigma_{kk} \end{bmatrix} \quad (5)$$

Portfolio risk is given by Eq. 6.

$$\sigma_p = \sqrt{\sum_{i=1}^{n} w_i^2 . \sigma_i^2 + \sum_{i=1}^{n} \sum_{\substack{j=1 \\ j \neq i}}^{n} w_i . w_j . \sigma_{ij}} \quad (6)$$

Where:

w_i – an individual weight of i-farm (farm`s equity) in a portfolio (total equity of all farms)

n – number of farms,

The expected return on equity of portfolio is estimated by the multiplication of k x 1 vector of individual weights of portfolio (*w*) and k x 1 vector of corresponding individual expected returns on equity (the sum of multiplication of each farm´s expected ROE and its share in the market portfolio).

$$EROE_p = \sum_{i=1}^{n} EROE_i . w_i \quad (7)$$

Where:

$EROE_p$ – expected portfolio return on equity,

$EROE_i$ – the average return on equity of individual farm.

Results and discussion

The agricultural sector in Slovakia was transformed after 1989, when the centralized economy ceased to exist. Before 1989, Slovak agriculture consisted only of cooperatives and state farms with large acreage. After 1989, all farms turned private. Cooperatives were privatized by the issuing cooperative shares and owners became the holders of these shares. Cooperative shares represent the value that a cooperative member put in the form of intangible assets in, or the value that was produced by his work as an employee of the cooperative. Therefore, the cooperatives in Slovakia have higher equity (own equity, see table 1). Companies were established after 1989 and manage the land of failed cooperatives. Out of remaining 996 farms there were 535 companies (Joint Stock Company (JSC.), Limited Liability Company (Ltd.)) and 461 cooperatives. Table 2 summarises the main results and findings with respect to systematic risk.

By adding all the farms existing over the observed period in the appropriate weight to a portfolio, we simulated the situation what risk investor would face by buying all the farms in agriculture for the price equal to their total equity. The calculated systematic risk in Slovak agriculture over the period 2009 – 2012 was 3.000%. Although, we did not focus on the return to calculate the risk, we also had to calculate the average return (p. a.) over the observed period.

The average return (measured as ROE) in Slovak agriculture over the period 2009 – 2012 was 0.048% which shows that the profitability of the whole sector is really low. In the case of normal distribution of return in the portfolio we can interpret the calculated risk (3.000%) as a confidence interval, where the achieved return would be varying from -2.952% to 3.048% at a confidence level 68.3%.

According to theory by increasing the number of firms in portfolio the total portfolio risk should decrease. However, after dividing the data set into companies and cooperatives, the risk in case of cooperatives is higher than the calculated systematic risk. On the other hand, the risk of the companies is lower.

This is clearly opposing the theory (see figure 1). By buying all the companies doing business in the Slovak agriculture, the investor would earn average return 2.974% with risk 2.414%. This shows the higher profitability of companies compared to cooperatives. Companies are considered

		acreage in hectares	total assets in EUR	sales in EUR	number of employees	number of owners
cooperatives	mean	1439	3 155 148	1 241 342	42	163
	median	1229	2 263 039	878 541	34	102
companies	mean	1042	2 642 128	1 335 221	24	13
	median	692	1 068 682	444 248	13	2
all farms	mean	1227	2 879 580	1 291 769	32	81
	median	936	1 681 029	665 623	22	5

Source: Data of the Agricultural Paying Agency of Slovakia (2013)

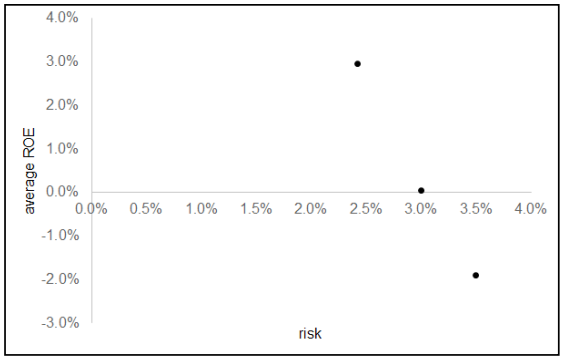
Table 1: Descriptive statistics (average values).

	Number	Average ROE	Portfolio Risk	Average Farm risk	Total equity in bill. EUR	Equity per farm in 1000 EUR
all farms	996	0.048%	3.000%	14.324%	1.509	1,515
companies	535	2.974%	2.414%	16.233%	0.602	1,125
cooperatives	461	-1.897%	3.498%	12.110%	0.907	1,967

Source: Data of the Agricultural Paying Agency of Slovakia (2013)

Table 2: Results summary.

to be more effective, which results from the fact that the companies are a new legal form driven by the private capital and more focused on increasing the owners' wealth.



Source: Data of the Agricultural Paying Agency of Slovakia (2013)

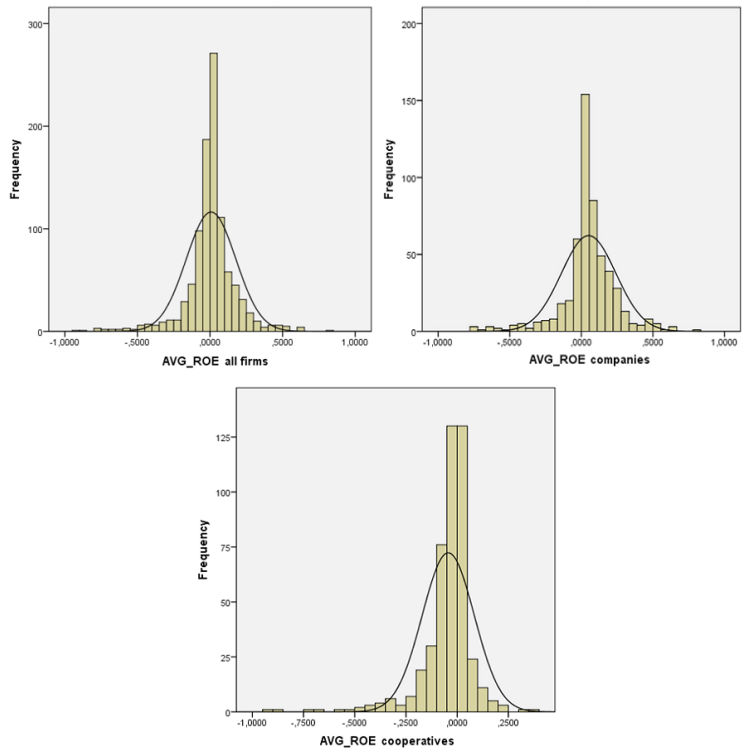
Figure 1: Systematic risk and average ROE visualisation.

The situation in the case of cooperatives is different. They as a group generate loss 1.897% of equity with even higher risk in comparison to companies (3.498%). This can be partly caused by the number of owners in the cooperatives (9 per 100 ha of agricultural land in 2012) in comparison with companies (1.2 per 100 ha of agricultural land in 2012). In addition to that, we have to consider also the differences in average farm risk values (table 1). The average risk of 996 farms without the influence of correlation was 11.324% over the observed period. With the impact of correlation the overall risk decreased to 3%. This means that the returns are not absolutely positively correlated in agriculture. By dividing the data set into companies and cooperatives the average farm risk is in favour of cooperatives. When we compare the average farm risk with the portfolio risk of companies and cooperatives, we can conclude that the individual volatility of cooperatives is lower than the individual volatility of companies, although the portfolio risk in case of cooperatives is higher. The reason is the difference in the average equity per firm, which is almost 75% higher in case of cooperatives. Since the equity is a denominator in formula 1, the same profit is in case of cooperatives achieved with lower volatility.

Observing the distribution of average ROE of individual farms we can conclude that based on the results of Shapiro - Wilk test the assumption of normality was violated. In the histograms (figure 2, 3) we compared the individual average ROE (not weighted) with the addition of each company to portfolio average ROE (weighted).

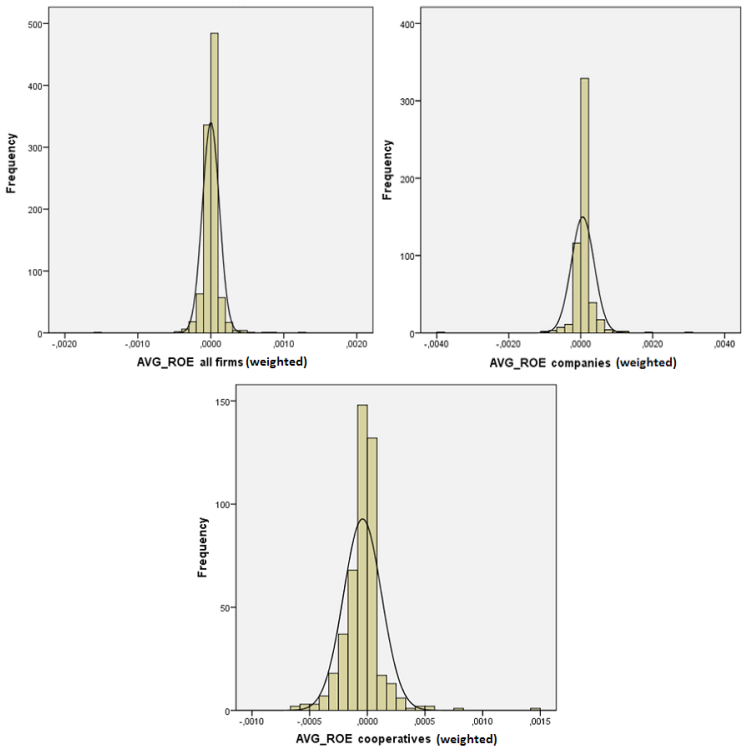
The results show the skewness is almost identical to symmetrical distribution as the skewness is -0.539 in case of weighted average ROE and -0.720 in case of individual average ROE. Therefore, calculated average ROE for the portfolio (weather individual or weighted) can be considered as suitable descriptive characteristic of a sample. Based on the histogram 67% of the farms` individual average ROE ranged from -10% to 10% over the observed period (2009 - 2012). Comparing it with the addition of single company to overall portfolio ROE we can conclude that 82% of the farms ranged from – to + 0.01%. Small farms had higher volatility than large farms, because individual ROE is more volatile than weighted. In the next step we focused on the differences in ROE based on the legal form dividing the whole dataset into two main groups: Cooperatives and Companies. The distribution of companies ROE is more volatile compared to cooperatives (Figure 2, 3). Out of 535 companies the majority of the farms (393) made profit and had positive ROE over the period 2009-2012. Only 142 (26.5%) farms suffered loss. The individual addition of small companies to the overall portfolio ROE consisting of companies only based on the comparison with the weighted ROE is again very small. Companies with higher profitability and companies with very high loss are small. In case of cooperatives out of 461 cooperatives the majority (286) was generating loss. Only 175 (38%) of cooperatives were profitable during 2009-2012. We can conclude that companies are a better legal form for the owner. But, when comparing the volatility of these two legal forms, the individual volatility based on standard deviation is higher in case of companies. On the other hand, based on figure 1, the portfolio consisting of companies only generates higher ROE with lower rate of risk. This is due to the covariance, which is in companies more negative compared to cooperatives.

With respect to systematic risk arises a question, which of the financial data is the most appropriate input variable for risk assessment. There are several ways to classify risk in agriculture. It is usually done by measuring the variability of prices (Briner, Fingert 2013, Goodwin et al., 2000, and others), yield, income, (Vrolijk et al., 2009), gross revenues (El Benni and Fingert 2013), production (Cacho et al., 1999), or any other variables. Since the Markowitz approach uses the equity return (volatility of return on stocks), analogically we decided to estimate agriculture



Source: Data of the Agricultural Paying Agency of Slovakia (2013)

Figure 2: Return on equity distribution – not weighted.



Source: Data of the Agricultural Paying Agency of Slovakia (2013)

Figure 3: Return on equity distribution – weighted.

market risk in Slovakia by considering variability of return on equity (ROE) of individual agricultural farms in one common market portfolio. Similar model has been used by Lee and Jang (2006), who measured the market risk of airline companies with the use of return on assets (ROA), or Baginski and Wahlen (2003), who focused on simple farm equity returns.

One of the negatives of using ROE is that this ratio includes Net income in nominator. Net income might have been adjusted by individual farmers in the sense of tax optimization purposes. In order to objectively evaluate the market risk and return in Slovakia also other types of risks and variables should be taken into consideration.

Applied methodology offers an opportunity to evaluate the impact of Common Agricultural Policy as one of the CAP`s goals is to stabilize the income of farmers in the EU member states (see Rizov et al., 2013; Pokrivcak, 2003).

Based on our results it is not yet possible to evaluate the impact of Common Agricultural Policy as the evaluated period covers only years 2009-2012. Also any policy implications should be stressed after the comparison of more periods and more countries as the CAP has to fulfil the needs of every member state of European Union. For Slovakia we can conclude that in the future the proportion of cooperatives on the total number of farms will decrease in favour of companies. This is due to lower ROE of cooperatives in comparison with companies and higher capital needs of cooperatives.

Conclusion

The risk in the European agriculture is decreased by Common Agriculture Policy in form of subsidies and regulations. The difficulty to measure the systematic risk of agriculture companies results from their unquoted character. The majority of farms in agriculture is unquoted, meaning to assess the market value for return and risk calculation has to rely on financial statements. One of the negatives is that these statements are used for tax purposes, and therefore can be adjusted in sense of tax optimisation.

In the paper we calculated systematic risk of Slovak agriculture using adjusted Markowitz portfolio theory. Based on the dataset of 996 farms over the period of years 2009-2012 we calculated the average return and systematic risk (average return 0.048%; systematic risk 3.000%). The results show that agriculture is a sector with low profitability. To evaluate the level of systematic risk we have to compare it with other sectors or industries. The results can also be used to compare the levels of systematic risk in different time periods. Based on such comparison we can measure the development of the overall stability of the sector. In the case of agriculture, the presented methodology can be used for evaluating the process of meeting the Common Agriculture Policy objective, the agriculture income stabilisation. In further research we will extend the observed period for periods covering EU pre-accession period of the Slovak Republic. The achieved result should imply the effects of CAP instruments on Slovak agriculture.

In the second part of the paper we observed the differences between the two main legal forms in Slovak agriculture. The profitability of companies measured by ROE is higher in comparison to cooperatives, which in average generated loss over observed period. The individual risk is in the case of companies higher, which is partly the result of the lower equity per farm. On the other hand, the portfolio risk of companies is lower than in the case of cooperatives, which is a result of more negative covariance between the returns of companies.

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Architectural Issues of a Location-Aware System Applied in Fruit Fly E-Monitoring and Spraying Control

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Abstract

In the present paper we describe an e-monitoring location-aware system, based on a real-time Wireless Multimedia Sensor Network (WMSN), integrated with a semi-automatic trapping and insect counting, based on existing traps, able to acquire and transmit data to a remote server, and a Decision Support System (DSS) that will perform the final optimization of the control treatments. In spite the tremendous technological advances in recent years, WSNs cannot meet all the requirements of ubiquitous intelligent environment mainly because scalar data such as temperature, air humidity, air pressure, etc., are not able to detect all environmental events, like insect detection. For this reasons the efforts are concentrated on the design issues of a WMSN platform, able to collect and integrate multimedia data from the field. Further, a flexible architecture needs to be adopted for integration of a WMSN to the cloud for multimedia sensor data collection and sharing using Web services.

Key words

Fruit flies, invasive species, traps, monitoring, sensors, spraying control, decision support.

Introduction

Fruit flies of the family Tephritidae consist one of the most economically important groups of insect pests threatening a multibillion (€) fruit producing industry of the Mediterranean countries. In addition, there are major invasive species such as the peach (African) fruit fly, Bactrocera zonata and others that have dispersed over the last few years either in some countries of the area or in neighbouring countries, which expand the list of pestiferous Tephritids beyond the "native" Med fruit fly, European cherry fruit fly, and the olive fly. A key issue in the productivity of the Mediterranean olive groves or fruit orchards is the accurate and timely monitoring pests' population, as well as, their control which may require repeated chemical treatments. Nowadays, the problem is faced with the development and implementation of environmentally effective, e-monitoring, and ground spraying control solutions, which will be based on prototypes, technological innovations, and knowledge transfer for specific key-pests, in order to increase the quality and quantity of available fruit to local consumers at lower prices. A judicious monitoring program usually provides an essential tool for environmentally friendly control strategy based on the reduction of chemicals, against the well established as well as invasive fruit fly species in different countries of the Mediterranean basin.

Despite the efforts to develop appropriate monitoring and control methods against these pests, their economic impact remains high. This is mostly due, in addition to other attributes, to their high mobility and also to their ability to directly damage the fruit. These two characteristics clearly indicate that monitoring in large areas coupled with rapid data transfer and decision making should be the essential components in any effort targeting the development of an effective and reliable control system. The need for wide area control of these pests has repeatedly been reported and already applied in several areas. However, the efficacy of such systems is toughly related to the knowledge of the associated spatial data and the timely delivery of the temporal data. In fact, the application of these systems in many cases suffers from inadequate geospatial and temporal information, i.e. the exact areas to be sprayed within the larger area, monitoring of fly numbers in too long intervals, inadequate integration

and interpretation of meteorological data, inappropriate spraying process and no traceability etc.

Note that early detection, and its spatial and temporal components, consists one of the most important elements of programs dealing with the control of invasive fruit flies. There are extensive and intensive surveillance projects dealing with invasive fruit flies in different parts of the globe such as the United States of America, Australia, China and Japan. This is because early detection and warning of invasive species into the region is essential for the initiation of immediate actions aiming at eradication of the insects to prevent establishment. However, there is no an integrated approach in the Med area regarding fruit flies and other invasive species. As a result, new innvasive species may spread in large areas without being noticed. It is therefore necessary to provide an easy-to-use "Rapid Alert Warning'' system, which can be adopted as a part of a federal phytosanitary policy, contributing towards developing and implementing a powerful, case-sensitive, quarantine detection network that will be part of the EU and Federal phytosanitary strategy. So far, misidentification of invasive fruit flies, such as B. zonata, may have resulted into rapid and wide distribution.

Monitoring pest insect populations remains the first key issue in agriculture and forestry protection. Conventionally, at the farm level, human operators typically perform periodical surveys of the traps randomly spreaded over the specified control area to estimate the pest population. Each trap is properly installed with pheromones and/or other chemicals that attract and captures the specific insects we may interesting in. Here, one should note that methods to cover spray broad spectrum insecticide, such as proteinaceous liquid attractants or mass trapping with food-based or synthetic attractant or bio insecticides, are still underdeveloped because of high monitoring and application costs. The traps are of certain type (e. g. Delta, McPhail, sticky type traps) and they are designed in such a way that insects are unable to leave it. Pest monitoring systems on attendants who periodically collect and count the captured pests of each trap by hand to perform pest control monitoring. This task is not only labor and time consuming, but often yielding poor results, significantly affected by observer's ability, or by surveying conditions. Additional key resources for insect detection are temperature, air humidity, air pressure, sunlight (light intensity) along with other factors that can be of less significance. Again, a traditional approach to measuring these factors in an agricultural environment meant individuals manually taking measurements and checking them at various times. Overall this approach is a labor-, time- and cost-consuming, particularly for large plantations, so it would be of great advantage to have an affordable system capable of doing this task automatically in an accurate and a more efficient way.

One option to overcome these difficulties is to use an automatic counting trap to collect pest information. Several attempts have been made so far (Guarnieri et al., 2011, Lopez, et al., 2012, Oberti et al., 2008, Tirelli et al., 2011). A brief summary about various methods and technique which were provided by various authors for detection of agricultural pests with the help of image processing is provided in Kandalkar et al., 2013. Each automatic counting trap provides directly an insect count and transmits the processed scalar data (counted pest number and environmental data) to the gateway which is connected directly to the cloud based on the available/appropriate low-power, long-range wireless network. From a network point of view, the usual approach is to set up a remote monitoring system made up of sensor node, coordinator, and server. Sensor nodes send data wirelessly to a server, which collects the data, stores it and will allow it to be analyzed then displayed as needed.

Nowadays, on-going advances in low cost CMOS/CCD image sensors, as well as in wireless communication technology provide a significant contribution in facing pest insects e-monitoring by establishing a Wireless Multimedia Sensor Networks (WMSN) able to remotely access images of the captured insects in the traps. Based on these advances this research proposes an innovative, integrated, Location-Aware System (LAS) suitable for e-monitoring and ground spraying control of some particular fruit flies. The e-monitoring system will be integrated with a Real-time Trapping and Insect Counting (ReTIC) system to support countering measures selection, a time-stamped record of insect counts, and estimate insect populations and alarm spraying levels, which enables the pest operators to determine optimal and accurate treatment timings for some specific key-pests. The LAS enables rapid prototyping of web services in an intelligent Precision Farming (PF) environment combining location sensing technologies with wireless Internet, Geographical Information Systems (GIS), WebGIS, Expert Systems (ES), and Decision Support (DS). Embedded multimedia sensor technologies

will make feasible the accurate location-, time-, and demand- specific interventions to the agricultural process by the farmer. Thus, energy saving will be achieved, but most importantly, pesticide and other chemicals usage will be reduced to a minimum. Moreover, if the infestation risk maps for a specific region indicate differences in the various part of fruit growing area, the spraying applications can be directed only in those part interested by the specific key-pest. Based on continuously updated maps of pest insect population dynamics, LAS would potentially facilitate the decision making process of the specific insect control strategies need to be followed. This approach is of great research importance in insect control; however, developers should take into consideration the hardware/software requirements as well as the power capacity required by an operative WMSN with a typical density of the order of one up to i.e. ten nodes (traps) per hectare.

In the above framework, the FruitFlyNet project aims to develop, implement, test and demonstrate an innovative, integrated, Location Aware System (LAS) for fruit fly ground spraying control, by means of four pilots in five Med-countries (Hellenic Republic, Italy, Israel, Jordan, and Spain). LAS will be optimized towards performance maximization, pollution mini- mization and energy conservation, cross-complying with minimum EU standards regarding the environment. It will be unique for many important agricultural pests applying management solutions for established fruit fly populations at different spatial scales providing a fundamental element of planned and implemented area wide integrated pest management programs. Similar developments exist, for example, in the case of olive fruit fly; Pontikakos et al. 2010, 2012 developed and implemented a LAS using meteorological data in the area of Laconia, Hellenic Republic, whereas in the case of med-fly, Cohen et al., 2008, developed a spatial decision system on citrus. The proposed LAS will be developed implemented and tested as follows: Bactrocera oleae (in Spain, Jordan and Hellenic Republic (test site), Ceratitis capitata (in Italy), Rhagoletis cerasi (in Hellenic Republic), Dacus ciliatus and Bactrocera zonata (in Israel).

In this paper we concentrate on some architectural issues the implementation of LAS is facing and related with the automation of the system. The paper is organized as follows. Following the Introduction presented in this first section, the Materials and Methods section provides some background information by means of the state of the art on the available WSN and WMSN platforms. It also includes the sensor nodes with multimedia capabilities and the WMSN architectures, as well as the communication protocols used so far. The third section provides the results and discussion. It includes some of the basic features of the underlying FruitFlyNet architecture we are developing along with the technology adopted and the tools used. Details about data acquisition, the proposed architecture and access to the cloud services is also provided in this section. Finally, in the last section the main conclusions along with the future work are presented.

Materials and methods

1. WSN: Platforms

WSN is an emerging technology gained significant importance in the last few years. Its primary function is to collect and disseminate critical data that characterize physical phenomena around the sensors targeting a number of important application scenarios, including the agricultural sector. Today WSNs are used on large scale capable of gathering information from the physical environment, processing it and transmitting the processed information to remote server or location. A sensor node is generally defined as a cheap and small piece of hardware, which consists of four main units:

- One or more sensors that detect physical phenomena and/or monitor scalar values of temperature (air, soil), humidity, pressure, light intensity, etc.
- A data processing unit which controls sensing, application logic and network transfer. It receives data from the sensors as well as it can filter, compress or correlate data from a series of measurement. The network structure, the communication process and the power management of the node are also organized by the processing unit.
- A wireless data transmission unit which is usually based on the IEEE 802.15.4 compliant or ZigBee standard because of the low-power consumption and the availability of low-cost radios.
- Although significant progress has been achieved in the area of energy consumption, today's standard power supply for sensor nodes is still the battery.

Generally sensor nodes are designed to be widely

spread without pre-configuration. A sink, is normally an embedded or a personal computer which is configured to collect, save or react according to the data. The network between the nodes and the sink is built dynamically and is considered to be self-organizing. Software development for WSNs nodes is a complex issue. Many researchers program the modes from scratch, using operating system components, specific middleware, or by higher programming abstractions. Table 1 summarizes the details of some important WSN platforms.

2. WMSN: Sensor nodes with multimedia capabilities

A WMSN is an extension of a scalar WSN. The availability of low power CMOS/CCD image sensors, as well as advancements made in digital signal processing chipsets realized the development of WMS nodes which provide separate processors to handle multimedia data. They are capable of retrieving, processing, and wirelessly transmitting/receiving multimedia content such as audio, video, and still images. Currently used processors in WMS nodes begin from simple 8 bit processors and end at embedded computer systems. Nowadays different WMS nodes are available: MeshEye, WiCa, MicrelEye, Cyclops, CITRIC, Stargate, CMUcam3, IMote2, eCAM, FireFly Mosaic. Farooq M.O. et al. 2014 provide a comprehensive review on WSNs test-beds and stat-of-the-art on WMSNs. Although these WMS nodes can be classified according to their performance, it should be noted that executing compression and coding algorithms locally (on WMS nodes), usually causes computational overhead, which in turn reduces the effectiveness of the corresponding deployed WMSN. In addition, the widespread use of image sensors can be expected only if WMSNs will preserve the low-power consumption characteristic and therefore, low-resolution image sensors are actually preferred in many WMSN applications.

Although many reviews exist in the literature regarding the high demands on the hardware of the WMS nodes and boards in Table 2 we summarize the details of the most important WMSN platforms.

3. WMSN Architectures

Network architecture in WMSN can be broadly classified into the following three categories depending on the nature of targeting application

Device Name	Micro controller	Transceiver	Memory RAM + Flash	Data Rate (Kbps)
GWnode	PIC18LF8722	BiM k	64KB	
BTnode	ATmega128L	CC1000	64KB +180	
Mica2	ATmega128L (8 bit) 7.37MHz	CC1000	4KB+512KB	38.4
Mica2Dot	ATmega128L (8 bit) 4 MHz	CC1000	4KB+512KB	38.4
MicaZ	ATmega128L (8 bit) 7.37MHz	CC2420	4KB+512KB	250
FireFly	ATmega128L (8 bit) 8 MHz	CC2420	8KB+128KB	250
TelosB	MSP430F1611 (16 bit) 8MHz	CC2420	10KB+48MB	250
Tmote Sky	MSP430F (16 bit) 8MHz	CC2420	10KB+1MB	250
EyesIFX v2	MSP430F1611	TDA5250	10KB+48MB	
EPIC mote	MSP430	CC2420	10KB	
TinyNode	MSP430	XE1205	8KB	
Imote 2	PXA271ARM XSale (32 bit) 13-416 MHz	CC2420	256KB +32MB SDRAM	
Stargate	Intel PXA-255 XScale (32 bit), 400 MHz	CC2420 BT IEEE802.11	64MB + 32MB	250 Kbps 1–3 Mbps 1–11 Mbps
XYZ	ML67	CC2420	32KB	

Source: own processing

Table 1: WSN Platforms.

Platform	Processor	Memory RAM	Memory Flash	Camera & Resolution	Radio	Power Consum
Cyclops	ATMEL ATmega 128L MCU + CPLD 8-bit	64 KB	512 KB	Agilent Compact CIF CMOS ADCM-1700 128x128 30fps	Interfaced with Mica2 or Micaz IEEE 802.15.4	110mW – 0.76 mW
Imote2 +Cam	PXA271 XScale proc 32-bit (Imote2)	256 KB (Imote2)	32 MB (Imote2)	IBM400 camera OmniVision OV7649 640x480 30fps	Integrated with CC2420 IEEE 802.15.4	322mW -1.8 mW
FireFly Mosaic	LPC2106 ARM7TDMI MCU 32 bit 60 MHz	64 KB	128 KB	CMCUCam3 352x288 50 fps	Interfaced with FireFly mote IEEE 802.15.4	572.3 mW – 0.29 mW
eCam	OV 528 serial bridge controller J PEG compression only	4 KB (Eco)	---	CoMedia C328-7640 (includes OV7640) 640x480 30fps	Interfaced with Eco Wireless mote nRF24E1 radio RF 2.4 GHz 1 Mbps	70 mA at 3.3V
MeshEye	ARM7TDMI based on ATMEL AT91SAM7S 32 bit 55MHz	64 KB	256 KB	Agient ADNS-3060 30x30 Agient ADCM -2700 640x480 10fps	Integrated with CC2420 IEEE 802.15.4	175.9 mV - 1.78mW
Panotopes	PXA255 XScale CPU 32 bit 400MHz (Stargate)	64 KB (Stargate)	32 KB (Stargate)	Logitech 3000 USB 160x120 30fps 640x480 13fps	PCMCIA IEEE 802.11 wireless card	5.3 – 58mW
WiCa	Xetal II SIMD + 8051 ATMEL MCU 84 MHz	1.79 MB + 128 KB DRAM	64 KB	VGA color camera 640x480 30 fps	Aquis Grain ZigBee IEEE 802.15.4	600 mW max
MicreEye	ATMEL FPSLIC 8-bit	36 KB +1 MB external SRAM	--	OmniVision OV7649 320x240 15 fps	LMX9820A BT 230.4 Kbps	500 mW max
WiSN	ARM7TDMI based on ATMEL AT91SAM7S 32 bit 48MHz	64 MB	256 MB	Agilent ADCM-1670 352x288 15 fps Agilent ADNS-3060 30x30 fps	Integrated with CC2420 IEEE 802.15.4	110 mA – 3 mA at 3.3 V
CITRIC	PXA270 XScale CPU 32 bit Intel 624 MHz	64 MB	16 NB	OmniVision OV9655 1280x1024 15fps 640x480 30fps	Interfaced with Tmote Sky mote IEEE 802.15.4	1 W max
Fox+Cam	LX416 Fox Board 100MHz	16 MB	4 MB	Labtec Webcam bro QuickCam Zoom 640x480	USB BT IEEE 802.15.4 100 m	1.5W at 5V
XYZ+Cam	ARM7TDMI based on OKI ML67Q5002 (XYZ)	32 KB (XYZ)	256 KB + 2 MB on board (XYZ)	OmniVision OV7649 640x480 320x240 4.1fps	CC2420 IEEE 802.15.4 (XYZ)	238.6 mW – 2.2 mW

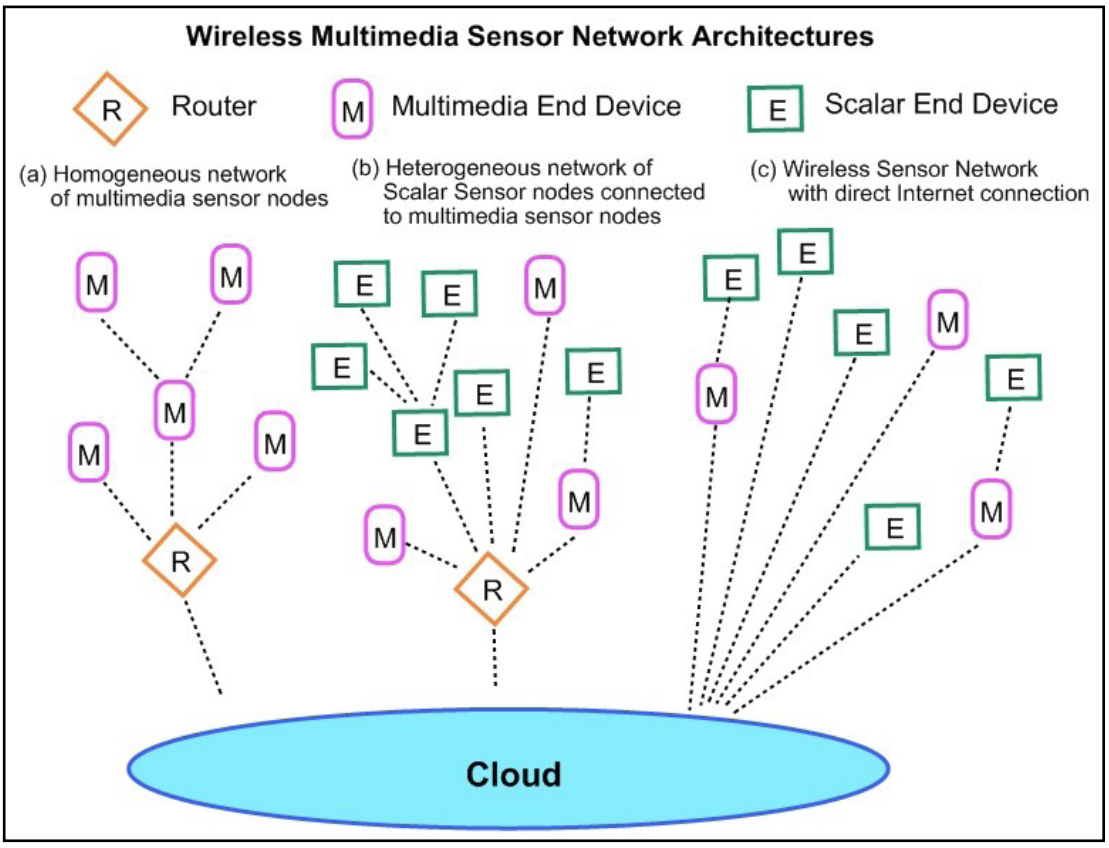
Source: own processing

Table 2: WMSN Platforms.

(Akyildiz et al., 2008, Zacharias et al., 2010).

- Single-tier flat architecture having homogeneous sensors (Figure 1 (a)).
- Single-tier clustered architecture having heterogeneous sensors (Figure 1 (b)).
- Multi-tier architecture with heterogeneous sensors support (Figure 2).

In single-tier flat architecture (Figure 1(a)), the WMSN is deployed with homogeneous sensor nodes. Note that by definition homogeneous sensor nodes are assumed to have the same sensing, computational, communication and hardware capabilities. Therefore, a homogeneous sensor network is composed of tiny, resource-constrained devices, using the same platform. The network functionality serves mainly the purpose of gathering the sensed data and sending it to a central location. All the nodes can perform any function from image capturing through multimedia processing to data relaying toward the sensor node in multi-hop topology. In particular the nodes serve two purposes either used for basic multimedia information extraction from surrounding environment or used as multimedia processing hub, which is computationally more powerful than WMS node. The multimedia information is wirelessly transferred in hop-by-hop fashion from the source nodes to sink/storage device via the gateway. This architecture offers benefits like distributed processing, easy management



Source: own processing

Figure 1 (a, b, c): Single-tier WMSN Architecture.

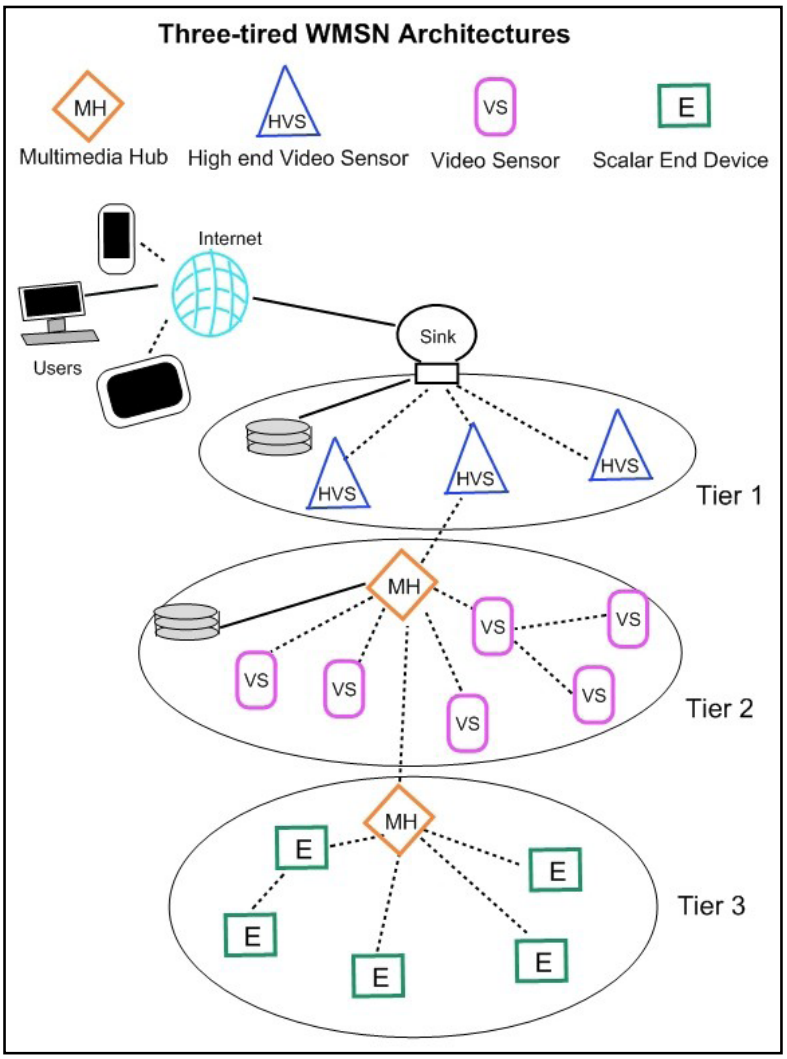
because of homogeneous nature of nodes, as well as long network life time mainly because of low-powered WMS node energy consumption.

As it was noticed earlier the IEEE 802.15.4 compliant standard or ZigBee is designed for very low-power, delay tolerant and slow networks with a very small duty cycle and the theoretical data rate which does not exceed the rate of 250 kb/s. Therefore multi-hopping, interference, and network traffic make this nearly impossible for a real-time application. A solution would be to transfer less data. In order to achieve this, the requirements on the data collection have to be checked. In many applications the data analysis result is important and not the data itself. So reducing the amount of data can sometimes already be achieved while monitoring.

Figure 1(b) represents the second type single-tier clustered WMSN architecture, composed of heterogeneous sensory nodes. The sensor nodes in the cluster gather scalar as well as multimedia information and send it to the cluster head which act as central processing unit for that cluster (having more resources and computational power as compared to other cluster nodes). The processed information is then wirelessly transmitted to sink/storage device via the gateway. The advantage of using this architecture is that it can address a range of application scenarios ranging from simple scalar application to multimedia information processing.

Based on the bandwidth problems that occur, not many existing WMSNs rely on sensor nodes with multimedia capabilities. A common design is the combination of a scalar WSN with a second network, which is triggered, to measure multimedia data. This architecture tries to overcome the restrictions of classical WSNs by the usage of computer networks. The multimedia network is mostly an Internet protocol-based computer network using the IEEE 802.11 standard. This single-tier architecture is quite easy to realize and is widely used so far (Figure 1(c)). The disadvantages of using a personal computer or even an embedded computer instead of a microcontroller are big size, high power consumption and high costs.

Finally, the multi-tier architecture is comprised of three tiers (Figure 2). The first tier is composed



Source: own processing

Figure 2: Multi-tier WMSN Architecture.

of scalar WSN nodes for performing simple tasks of gathering the scalar information from the surrounding environment. The middle tier comprised of medium resolution video sensor nodes capable of gathering multimedia information. The final tier composed of high-end vision sensor nodes for complex task like object recognition, tracking objects features etc. Every tier has a central processing hub which is basically a video node having more computational and communication resources. So the storage and the data processing can be performed in the distributed fashion at each different tier. The high-end WMS nodes gather information from the lower tier processing hubs in addition to its own gathered information from the targeted location, relayed the processed data wirelessly to the gateway for storage or to the sink. Such a network offers advantages like better scalability, high functionality, reliability and better coverage as compared to single-tier network architecture. However only limited applications have been implemented so far using this architecture.

4. Communication protocols

Generally, the communication between the sensor nodes can be achieved through one of the four protocol standards for short-range wireless communications with low power consumption. Note that from an application point of view Bluetooth (over IEEE 802.15.1) is intended for cordless mouse, keyboard, and hands-free headset, Ultra-WideBand (UWB, over IEEE 802.15.3) is oriented to high-bandwidth multimedia links, ZigBee (over IEEE 802.15.4)

is designed for reliable wirelessly networked monitoring and control networks, while Wireless Fidelity (Wi-Fi over IEEE 802.11) is directed at computer-to-computer connections as an extension or substitution of cable networks. Specifically:

- Bluetooth is intended for low data rate, short range distances (around 10 meters) with a low power supply. It is most appropriate for Wireless Personal Area Network (WPAN) communication.
- ZigBee is intended for low data rate, short range distances with a low power supply. It is most appropriate for WPAN communication. Since ZigBee may also reach 100m in some applications it is also appropriate for Wireless Local Area Network (WLAN).
- UWB is intended for high data rate, short range distances with a substantial power supply. It is most appropriate for WPAN communication.
- Wi-Fi is intended for high data rate, long range distances with a substantial power supply. It is most appropriate for WLAN communication.

The above classification justifies to a certain extend the reason of considering ZigBee, as well as any IEEE 802.15.4 compliant to be the most reliable solution for connecting sensor nodes with the coordinators in the WSN. Due to low power consumption, simple network deployment, low installation costs and reliable data transmissions, these two standards are mainly preferred, over Wi-Fi and Bluetooth. In any case, Zigbee is usually selected as the best, low-power, short-range, transmission technology for the sensor node–coordinator link, due to its openness, performance, cost, and time of implementation in many different applications. On the other hand, WiFi is usually selected in case of short–range transmission. However, this protocol requires more power consumption. For the coordinator–server link, long–range wireless network (2G (GPRS), 2.75G (EDGE), 3G (UMTS), 3.5G (HSDPA), 4G (LTE), and satellite) has been the only reasonable choice.

Results and discussion

1. *FruitFlyNet* WMSN Architecture

As it has been pointed out the network architecture in WMSN can be broadly classified into three categories depending on the nature of targeting application. In our case the WMSN architecture can take any configuration shown in Figure 1. For example, one obvious choice is to set up a multi-hop architecture with a back-end server. In this first approach, the traps are taking the role of sensor nodes (*FruitFlyNet* sensor nodes) so as to form a homogeneous WMSN. Every *FruitFlyNet* sensor node is responsible for gathering, processing and transmitting the measurement data periodically. In terms of communication the specifications require a mid-range wireless transmission protocol for the link between the *FruitFlyNet* sensor nodes and the coordinators (gateways/routers) and a long-range wireless transmission protocol between the server and coordinators. The coordinator node equips two wireless radios. One is responsible for collecting data from *FruitFlyNet* sensor node and therefore they share the same IEEE 802.15.4 compliant (ZigBee) or IEEE 802.11 (Wi-Fi) protocol. The other is a 3G radio, which is responsible for transmitting the collected data to the selected server.

An alternative to the multi-hop architecture described above and explored also in this study, is to consider every *FruitFlyNet* sensor node as a stand-alone device equipped with a 3G wireless radio that has the capability of acquiring and transmitting multimedia data (scalar environmental data and still images) to the selected server.

In all cases the server stores the incoming data stream to a database and also processes the captured images to identify the insects in the trap. Using a web browser, a user can request and view historical data as well as the last gathered “almost real-time” data from the server. The server will also provide an interface to the operator to show in real-time the population map and its trend, as well as an alarm when insect density exceeds a threshold.

2. *FruitFlyNet* Sensor Node

Any *FruitFlyNet* sensor node has to satisfy some particular requirements. First, the sensor node should be capable to carry out some on-line data processing, such as format conversion, data calculation and value calibration. Second, it should be capable of compressing the captured images on-site. Uncompressed raw images are too large to be transmitted to the gateway node using the low power IEEE 802.15.4 compliant (ZigBee) protocol and in almost all cases they are compressed before transmitting. The algorithm automatically inspects the newly taken insect images and determine their number. Under this mechanism,

the WMSN can take insect photos at a higher frequency, but the amount of data to be transferred is reduced.

The sensor node consists of:

- A novel trap based on some well-known trap designs such as delta, or sticky. McPhail traps present difficulties to adapt an image sensor in an efficient way.
- An open source embedded controller, which is based on a modular architecture responsible for the sensors data storage unit, antenna, temperature and humidity sensors and other peripheral components.
- Images acquisition is achieved with a high resolution micro camera. Alternatively, a USB web camera module that allows real-time capturing of the insects in the trap may be used.
- Scalar temperature and humidity values are acquired with a digital sensor directly connected to the controller.
- An xBee adapter and an appropriate antenna for transmitting the images and other information data to the coordinator. Thus, all the traps in the field communicate with each other using WiFi (IEEE 802.11), protocol, or the ZigBee (IEEE 802.15.4 compliant) protocol, depending on the field to be covered.
- A long-range, 3G (UMTS) communication module for transmitting multimedia data (still images and environmental data).
- A rechargeable battery connected to a solar panel and charger, responsible for the powering of the system, thus making the whole system completely autonomous.

A possible hardware solution for the development of the WMSN is based on a single-board PC, as for example the Raspberry Pi Model B/B+. The platform of Raspberry Pi has a Broadcom BCM2835 system on a chip (SoC), which includes three core: A low power ARM1176JZF-S, 700 MHz applications processor, a dual core VideoCore IV multimedia Co-processor, Graphics Processing Unit (GPU), and finally an Image Sensor Pipeline (ISP). It has 256 MB of RAM (Model A), upgraded to 512 MB (Models B and B+). The device is running Linux based OS and has several I/O ports: 2/4 USB 2.0 (Model B/B+), 1 GPIO socket, 1 Ethernet 10/100 and 1 composite video out, 1 HDMI, 1 audio female jack. The board is powered at 5V with a micro-USB plug and has a power rating of 700mA. It does not include a built-in hard disk or solid-state drive, but it uses an SD card for booting and persistent storage, with the Model B+ using a MicroSD. The main advantage on using this Rasp board is related with its capability to operate with a large variety of digital sensors via the GPIO socket or the USB ports (i.e. temperature, humidity, etc.) and plug to the same GPIO socket a RF serial communication modules like xBee that accomplish to ZigBee/Wifi protocol. It has also a dedicated slot for a cheap 5 Mpxl camera with or without IR that can accomplish the necessity to capture images from the trap.

To send captured images to, say, an FTP folder on the server and to write environmental sensing data to the DB server, it is possible to use also a WiFi 802.11 connection or a 3G/GPRS, instead of a RF connection that has low bandwidth. In case of WiFi it's possible to create a star architecture to a central omnidirectional access point connected server network (locally or in a remote site). The Raspberry WiFi connection can be achieved with an 802.11N USB dongle. In alternative, the Raspberry 3G connection can be achieved with a USB modem with an active data SIM inside. All the devices need to be powered by a solar panel with batteries and charger limiter of an adequate size.

3. Typical Network Parameters

In this section we present some typical network parameters need to be considered. Taking into account that every vendor has different specifications that can vary a lot, below we present some, the most common ones.

- Antenna range: Theoretically it can vary from 10 m to 12 km (outdoor). Note that the typical range that the vendor may provide can be significant less in case of obstacles. For the purposes of our test sites we propose that antenna range is > 70m.
- Communication Protocol: Two are the basic communication protocols that can be used; IEEE 802.15.4 compliant (ZigBee) or IEEE 802.11 (Wi-Fi). Zigbee and Wi-Fi both use the 2.4GHz ISM band and have some overlapping channels.
- Data Buffer: Each node, depending on the vendor, will have different capacity for storing data before sending them. These will range from a few KBs up to some GBs if the node can take an SD Card. We propose that nodes with SD card should be preferred especially in the case that cameras are WMSN

integrated.

- Data Transfer Rate: Each WSN can have data transfer rate from a few Kbps to some hundreds Kbps. In the case of WMSN is integrated with cameras faster rates are required.

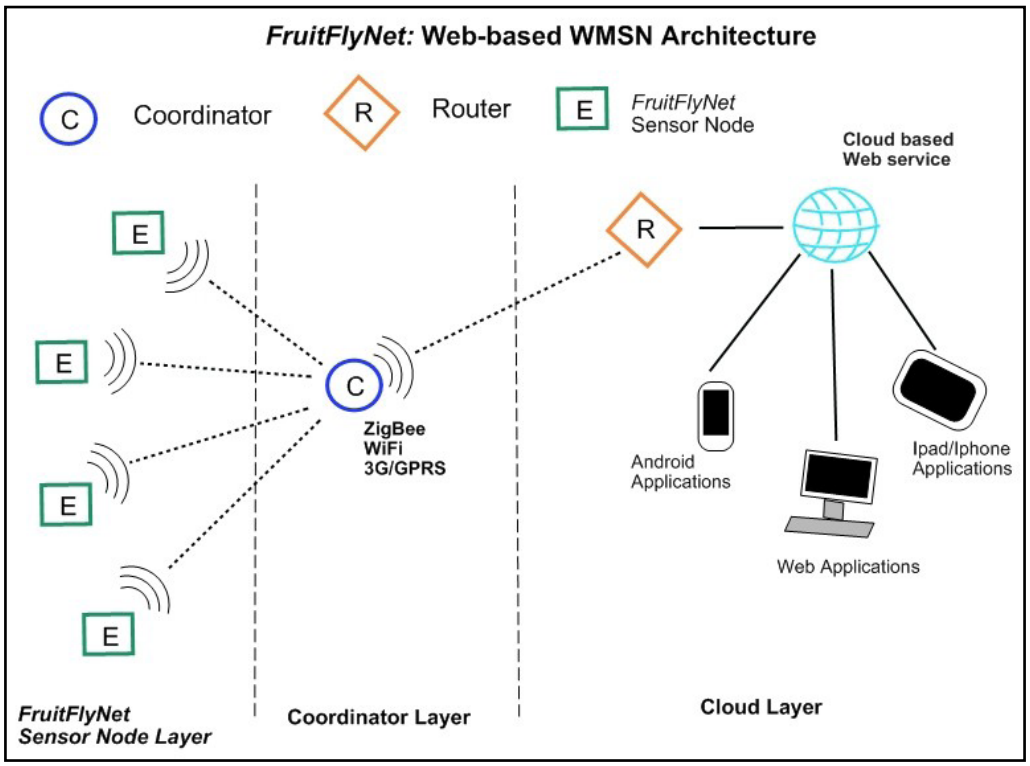
4. Access to Cloud Services

As it is well known the cloud consists of hardware, networks, services, storage, and interfaces that enable the delivery of computing as a service (Perumal. B et al. 2012). The most open and interoperable way to provide access to remote services or to enable applications to communicate with each other is to utilize cloud services. These services need to provide to users real-time data at any time and in the most flexible, powerful and cost-effective way. The access to them is generaly easy, direct, open and interoperable and in this sense, the provided communication means and Application Programming Interfaces (APIs) are easy to implement on every platform and developing environment.

There are two classes of cloud services: Simple Object Access Protocol (SOAP) and REpresentational State Transfer (REST). REST is a much more lightweight mechanism than SOAP offering functionality similar to SOAP based cloud services. In addition, it is also possible to upload the data obtained from the wireless sensor nodes based on SOAP and REST, using messaging mechanisms or social networks (Alcaraz et al. 2010).

As it has been pointed out the collected data from the *FruitFlyNet* sensor nodes are processed, stored and analyzed on a server, via an API. The integration of WMSN with the Internet and the cloud services can be achieved into three stages or layers (Figure 3): The *FruitFlyNet* sensor nodes layer, the coordinator layer and the cloud layer. The *FruitFlyNet* sensor nodes layer consists of sensors that interact with the traps. Every *FruitFlyNet* sensor node uses an IEEE 802.15.4 compliant or ZigBee platform. An alternative option is to use WiFi particularly in case uncompressed (or lossless compressed) insect images have to be transferred to the server. The *FruitFlyNet* sensor nodes form a mesh network (several mess protocols can be examined) and send the information gathered to the Coordinator.

The coordination layer is responsible for the management of the data received from the sensor network. It temporarily stores the gathered data into buffer and sends it to the cloud layer at predefined intervals. The coordinator serves



Source: own processing

Figure 3: Web-based WSN/WMSN Architecture.

as a mini server between the *FruitFlyNet* sensor nodes and the WMSN. It is based on Raspberry B/B+ board but it has more advanced computational resources compared to the FruitFlyNet sensor nodes. It is also connected to the Internet using 3G radios.

Finally, the cloud layer accommodates the web-server to connect and publish the sensor data on the Internet. This layer stores the sensor data in a database and also offers a web-interface for the end users to manage the sensor data and generate statistics. The cloud layer uses HTTP service, which provides a SOAP/REST based API to publish and access the sensor data, allowing, existing networks to be connected into other applications with minimal changes.

Conclusions

The surveillance and the monitoring of the pest population in order to timely apply bait-sprays is the most important activity for pest management. Prompt and accurate detection of pest populations may limit and reduce direct and indirect economic costs to the agricultural sector, environment and society. However, efficient surveillance and monitoring is labor intensive, economically demanding and requires a high level of expertise and accuracy. Based on LAS a new approach is proposed. Multimedia data is obtained based on a real-time WMSN that is capable to access and receive it simultaneously from various sensors in order to perceive the environmental status, make the method more accurate, provide valuable insights for the effectiveness of pest control strategies based on a pheromone sticky e-traps network, and finally assist decision actions for protecting citizens, animals, and environment. Advances in pest management using low-power imaging sensors techniques will also be tested.

This paper firstly described the physical problem of pest management control of some important fruit flies and highlighted a new approach, which was based on the development and implementation of LAS. The research was concentrated in one of the main objectives of LAS, namely, to make a significant contribution to the implementation of a resource constraint WMSN. For this reason we proceeded to a comprehensive overview and development status for existing WMSNs including hardware, software and network architecture. Based on the lessons acquired so far, the paper provided some of the basic features of the underlying FruitFlyNet WMSN architecture we were developing along with the technology adopted and the tools used. Details about the data acquisition, and integration of WMSN to the cloud for sensor data collection and sharing using web services was also provided.

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The European Union is made up of 28 Member States who have decided to gradually link together their know-how, resources and destinies. Together, during a period of enlargement of 50 years, they have built a zone of stability, democracy and sustainable development whilst maintaining cultural diversity, tolerance and individual freedoms. The European Union is committed to sharing its achievements and its values with countries and peoples beyond its borders.

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Analysis of Some Drivers of Cocoa Export in Nigeria in the Era of Trade Liberalization

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Anotace

Příspěvek analyzuje některé determinanty vývozu kakaa z Nigérie v prostředí volného obchodu. Na základě výsledků kointegrací při využití Johansenovy kointegrace a OLS regresních metod je v případě Nigérie prokázán dlouhodobý rovnovážný vztah vývozu kakaa a vysvětlujících proměnných, jakými jsou množství produkce kakaa, domácí spotřeba a cena na světovém trhu. Navíc výsledky OLS potvrzují pozitivní vztah mezi vývozem a světovou cenou kakaa, otevřeností obchodu, REER a objemem světového exportu kakaa (statisticky významné na úrovních 0,01 a 0,05). Výsledky však potvrzují inverzní vztah mezi vývozem kakaa a domácí spotřebou (statisticky významné na úrovni 0,01). Z celkových hodnocení vyplývá, že Nigérie má z hlediska vývozu kakaa komparativní výhodu. Proto by Nigerijská vláda a partneři měli vytvořit příznivé podnikatelské prostředí včetně pobídek a dotací motivujících výrobce kakaa a obchodníky, a poskytovat jim cenově dostupné půjčky, které jim umožní zabezpečit udržitelnou produkci kakaa i jeho vývoz.

Klíčová slova

Export kakaa, kointegrace, liberalizace obchodu, světová cena.

Abstract

This contribution analysis some determinants of cocoa export in Nigeria in the era of free trade. Using Johansen cointegration and OLS regression methods, the cointegration results show there exists a long-run equilibrium relationship between cocoa exports and the explanatory variables such as quantity of cocoa production, domestic consumption and the world price in Nigeria. More so, the OLS results provide a positive relationship between cocoa export and world price, trade openness, REER, and quantity of world cocoa export (statistically significant at the 0.01 and 0.05 levels). However, the results show an inverse association between cocoa export and domestic cocoa consumption (statistically significant at 0.01 level). The findings indicate that Nigeria has a comparative advantage in cocoa export. The Nigerian government and partners should create an enabling environment and some incentives to stimulate cocoa producers and traders by subsidizing farm inputs, and providing affordable loans to them to ensure sustainable cocoa production and export in the country.

Key words

Cocoa export, cointegration, trade liberalization, world price.

Introduction

The integration and expansion of world trade through the reduction of trade barriers such as import tariffs, quotas and foreign investment rules are among the significant elements of free trade. The trend of international trade has remarkably risen since the creation of World Trade Organization (WTO) as a body for trade negotiations, policies and rules.

Trade liberalization has been one among the key forces that are driving globalization in recent decades. There is no doubt to say that, both developed and developing countries have seen the export of agricultural commodities like cocoa as a vehicle for transforming agricultural development and improving the livelihood of farmers/producers and national development. However, partly due to unfavourable trade rules and the neglect of the agriculture sector of the economy, trade has not yielded the anticipated results as poverty, and hunger persists in many Sub-Saharan African countries like Nigeria.

Prior to the discovery and extraction of crude oil in Nigeria, especially before the oil boom in the 1970s, the country was solely dependent on the agriculture, especially cocoa crop as the main source of foreign earnings. Even though, agricultural exports have experienced severe neglect as crude oil presently accounts for over 90% of the Nigeria's export products; cocoa is still the largest crop export and the principal export products after oil and gas.

Historically, Nigerian cocoa products were marketed through monopoly by the Nigerian marketing board (NCB), under the direct control of the government (Cadoni, 2013). To foster trade liberalization in African countries, the World Bank (WB) and the International Monetary Fund (IMF) introduced a program, called Structural Adjustment Programme (SAP) between 1980 and 1990. The banks stressed that agricultural marketing boards in countries like Nigeria and Ghana were ineffective, and they suggested in liberalizing agriculture following to the liberalization of foreign exchange or free market pricing policies. Consequently, the government of Nigeria was the first West African country to scrap its board (abolished marketing boards in the country) in 1986, and liberalized cocoa trade in the same year (Gilbert, 2009).

Through SAP, Nigeria was expected to implement certain policy reforms as a condition for receiving financial assistance from these world's financial institutions. The policy conditions included among others: trade liberalization; privatization of state corporations; and currency devaluation. The cogent objectives for liberalization in cocoa products were to accelerate competition in the marketing chain and export, to hand off states and donors from the burden of marketing cocoa products while at the same time obtaining a higher share of the world prices for cocoa producers. They argued that, markets are more efficient and competitive than the State in resource allocation and that the appropriate role of the government should be to provide a conducive environment and investment climate for the private sector to flourish.

During the SAP period in Nigeria, currency exchange control on all currency transactions were also abolished as soon as the era of liberalization began in 1986. They argued that floating exchange rate is better than fixed exchange rate. Thus, market forces should be allowed to determine the value of domestic currency against the basket of international currencies. Several studies (Central Bank of Nigeria, 2008; Ogunleye, 2009; Umaru, Sa'idu and Musa, 2013) confirmed that real effective exchange rate (REER) is a driver of trade in products like cocoa in Nigeria especially after SAPs introduction. The Central Bank Nigeria (2008) found out that terms of trade (TOT), nominal effective exchange rate (NEER) and real exchange rate have effects on export trade in the country.

However, critics argued that these world's financial institutions also brought pains and undermined development in the developing countries more than the anticipated benefits. According to them, trade liberalization has exposed many aggro-allied industries in Nigeria into import competition from established global companies which led to the closure these firms. As a result, the country presently depends on finished products (i.e. foreign companies' process of cocoa beans to chocolate and powder) from developed countries for consumption as postulated by the dependency theory.

Some researchers have attempted to determine the drivers of cocoa exports in Nigeria and other countries. For instance, Boansi (2013) find a significant positive relationship between cocoa exports and production in Ghana. Arguably, increases in exports of cocoa beans could stimulate producers to double their efforts to increase production in the country.

Abolagba et al. (2010); Ndubuto et al. (2010) attempt to explore factors that seem to be affecting the export of cocoa from Nigeria. They found that Nigerian cocoa production positively associated with cocoa exports from the country to other parts of the world. They stressed that Nigeria has high comparative advantage in the exportation of cocoa products. Similarly, Amoro and Sheni (2013) examine the factors that appear to influence cocoa export in Cote D'Ivoire. Using OLS approach, they found a positive relationship between cocoa export and domestic cocoa outputs. Their results, however, showed an inverse connection between cocoa export and domestic consumption.

Yeboah, Shaik, Wozniak and Allen (2008) use gravity model to estimate the potential bilateral cocoa export commodities in the era of trade liberalization with 16 major cocoa producing nations to the United States of America (US). Using panel data spanning between 1989 and 2003, they found that differences between resource endowments, economic size of countries, and the sum of bilateral gross domestic product (GDP) of the U.S., as well as the exporting nations

were the main determinants of trade. They argued that, the producers' share of the world price might increase if trade is liberalized.

Nadeem (2007) investigate the dynamic effects of economic reforms and trade liberalization policy on the performance of agricultural export products in Pakistan. Using Johansen cointegration and vector error correction (VECM) methods, the results indicated that there exists a long-run equilibrium relationship between the real value of agricultural exports, competitiveness, openness and world demand for agricultural products in the country. The results also provided evidence that agricultural export development is more elastic to changes in national factors. Similarly, Daramola (2011) examined the export performance of cocoa and palm kernel in Nigeria. Using cointegration and error correction model (ECM), the results showed an association between cocoa export and quantity produced, producer price, world prices and real exchange rates in Nigeria. He also found a long run relationship between cocoa export and all the explanatory variables in the cointegration model. He stressed that the world price is a strong driver of cocoa export from the country, the world price of cocoa export is an incentive for farmers to increase production and export.

Akanni, Adeokun and Akintola (2004) determine the impacts of trade liberalization on the major agricultural products such as cocoa, palm kernel, groundnut and palm oil in Nigeria. They found out that free trade associated with these export commodities. They argued that, stakeholders should formulate policies that would stimulate investment in cocoa and other products to increase annual output, export and earnings.

Yusuf and Yusuf (2007) examine some drivers that determine the export performance of three principal agricultural products (cocoa, rubber and palm-kernel) in Nigeria in the era of liberalization. Using error correction model (ECM), the results showed that each of the three variables in the equation was cointegrated. Their results indicated that there exist both short run and long run equilibrium relationships between the dependent variables and their determinants. They called for the promotion of agricultural exports as an integral tool to reduce the burden of Nigeria's dependence on oil exports.

Darkwah and Verter (2014) analyze some determinants of cocoa production in Ghana for the period 1990-2011. Using Johansen cointegration and OLS regression approaches. The cointegration test indicated a long run equilibrium relationship between cocoa bean production, the world price and cocoa export. Their OLS results showed a positive association between cocoa production and cocoa export. Conversely, the results revealed a negative relationship between cocoa production and world prices. They argued that, Ghanaian government had fixed the price of cocoa in order to protect producers from the price shocks on the international market. Consequently, farmers were likely to respond to the world price signals in the opposite directions.

Those studies did not include all the variables used in this study. More so, in view of the significance of cocoa as a principal crop export and a major source of foreign earnings from non-oil exports in Nigeria, it is imperative to determine cocoa export factors. Thus, the importance of this study. This article is an attempt empirically to verify some determinants (cocoa output, the world price, trade openness, real exchange rate) which appear to be driving cocoa exports in Nigeria for the past two decades.

This contribution is structured as follows: section 1 presents an introduction, and some empirical evidence related cocoa exports. Part 2 presents a theoretical framework, while part 3 presents the trend of cocoa production and export in Nigeria. Part 4 presents materials and methods, while part 5 presents empirical results and discussion. Finally, part 6 concludes the study.

Theoretical framework

Because cocoa production is based on the climatic condition, it could easily be linked to the international trade theories such as the comparative and absolute advantage models as well as the Heckscher – Ohlin trade theory (factor endowment theory) which explained why countries involve in trade.

The absolute advantage trade theory was coined by Adam Smith (1776) who is regarded as the father of modern economics. Smith defined absolute advantage as the process by which a country can produce a particular good at a lower cost than the other country. Therefore, a country that trade across national borders should specialize in producing goods that it has an absolute advantage over another. Smith maintained that; all countries would benefit if they practice free trade and specialize in what they could produce cheaply. Smith assumed that every country had an absolute advantage over another. What if a nation

has an absolute advantage in producing everything? Comparative advantage theory has answered this question.

The comparative advantage theory was propounded by David Ricardo (1817), who stressed that countries would mutually benefit from each other even if one has an absolute advantage over the other in producing of all the goods that they are trading. Ricardo postulated that the country should specialize in producing goods that it has the highest output relatively at the lowest cost in comparison with the other country. The theory was based on, among other assumptions; only two countries (e.g., Nigeria and Czech Republic) involve in the trade; trade only two products (e.g., cocoa and wheat); no trade barriers and there is a balance of trade.

Heckscher – Ohlin trade theory was coined by Eli Heckscher and Bertil Ohlin based on the theory of comparative advantage. The theory is also called 'factor endowment theory' because it stressed that the pattern of production and trade across the national borders would depend on the factor endowments. The theory maintained that the international trade takes place due to the differences in the comparative costs of factors of production that arise, due to the abundant or insufficient resources (cocoa) within countries. The theory argued that the country should produce and export products that it has cheap factor(s) of production and import products or inputs that are scarce locally (Blaug, 1992). Due to the favourable tropical climatic condition which a significant endowment factor for cocoa farming, Nigeria has taken the advantage and concentrated on producing and exporting cocoa products to parts of the world.

Paul Robin Krugman (1984) provides the first theoretical explanation of the role of agriculture in national development and its effects on export product. The theory argued that the expansion of agricultural export could lead to a significant increase in the demand for the nations' outputs, which in turn might lead to increase of real output.

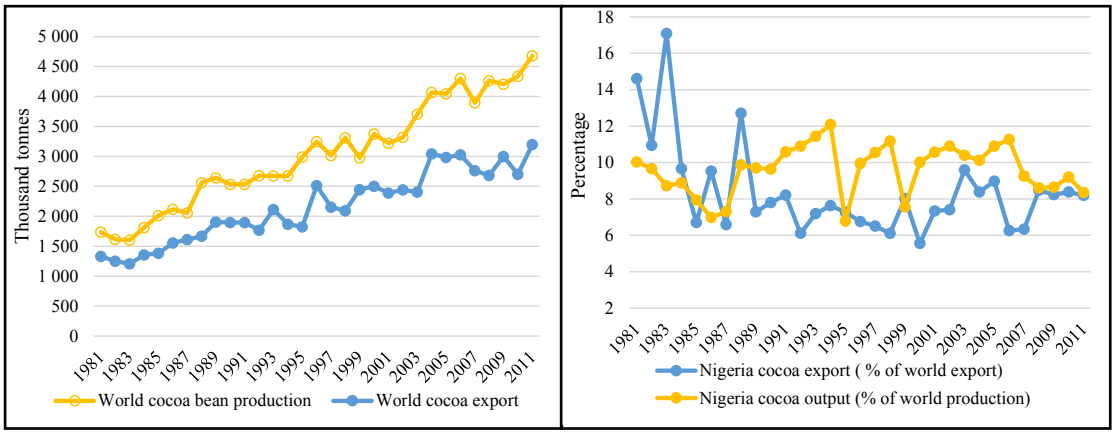
The exchange rate is an important in cross-border trade. Difficulties that arise in the measurement of the real effective exchange rate (REER) in countries like Nigeria may hamper international trade because most countries would like to manipulate their exchange rates all in a bid to make their products appear more globally competitive. According Catão (2007), establishing whether a currency is undervalued or overvalued has always been problematic, just as changes in terms of trade and differences in macroeconomic policies may constitute dire consequences to trade liberalization.

Cocoa production and export from Nigeria

Statistical data available from FAO (2013) as presented in figure 1 shows the trend of annual cocoa production and export in the world (measured in tonnes) and the share Nigeria cocoa production and export as a percentage of world cocoa production and export for the period 1981-2011. As shown in figure 1, within three decades, annual cocoa bean output in the world has drastically increased from 1.7 million tonnes in 1981 to 4.7 million tonnes in 2011. In the same direction, the annual world cocoa export has also increased from 1.1 million metric tonnes to 3.2 million metric tonnes within the period between 1981 and 2011, making an average of 4.6% annual export growth rate. This increment could partly attribute to trade liberalization in cocoa commodities. Despite the fact that trade barriers still exist in primary agricultural products, cocoa crop is liberalized as the major processors are western companies.

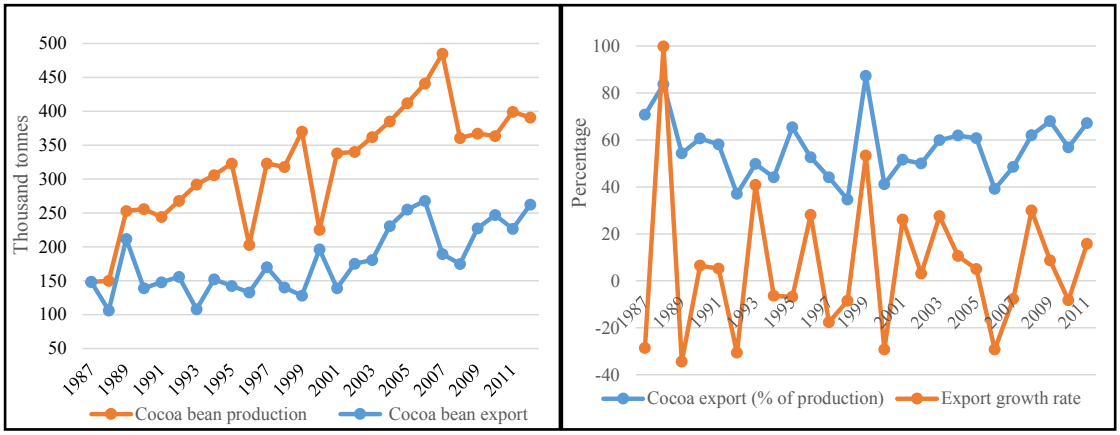
Nigeria is the fourth largest cocoa producer in the world after Ivory Coast, Indonesia and Ghana, and the third largest exporter of the cocoa crop after Ivory Coast and Ghana. It implies that, Nigeria is a major supplier or competitor of the cocoa crop in the world. This is partly because of the favourable tropical climatic conditions in the country and other top producing countries.

Despite the fact that, many raw agricultural commodities from the developing countries faced trade restrictions, data available indicated there is trade liberalization in raw cocoa bean products. Figure 2 shows that Nigeria recorded over 55% average annual cocoa export as a percentage of domestic cocoa bean output between the period 1987 and 2011. On a yearly basis, the country reported the highest of cocoa export as a percentage of production with 87.3% in 1999 and lowest with 35% in 1998. The major cocoa export destinations are Western Europe and North America where cocoa processing industries are located. However, as shown in figure 1, Nigeria's cocoa (cocoa, beans) export as a percentage of world export has fluctuated and decreased from 12.6% in 1981 to 8.5% in 2011. This partly because other countries are exporting the product more than Nigeria. More so, cocoa export was neglected by the Nigeria government as the country concentrated more on crude oil export than non-oil products like cocoa.



Source: Authors' analysis based on FAOSTAT, 2013

Figure 1: World cocoa bean production and export ('000 t) and percentages in Nigeria, 1981-2011.



Source: Authors' analysis based on FAOSTAT, 2013

Figure 2: Cocoa production and export ('000 t) and export (% of production) in Nigeria, 1987-2011.

Cocoa is the largest agricultural export commodity in Nigeria. Figure 2 shows a fluctuating quantity of cocoa production and export in the country between 1987 and 2011. Cocoa production in the country has increased from 150 thousand tonnes in 1987 to 391 thousand tonnes in 2011. Nigeria cocoa export even though slightly fluctuated, it has steadily increased from 106 thousand tonnes to 262 thousand tonnes between 1987 and 2011. The fluctuation of the quantity of cocoa export from Nigeria could be attributed to the world price, exchange rate, domestic production and supply for export, neglect of cocoa related activities, etc. For instance, both cocoa domestic and world price over the years were far from consistent.

Historically, as compared to large scale grains like wheat and corn, world cocoa prices have been less prone to severe price shocks. Arguably, this may *"be due to the difference in scale of global production and consumption, as well as differing degrees of speculative investment;"* thus, it is likely to exacerbate volatility in the primary commodity prices (World Cocoa Foundation, 2014, p. 9). Reflecting, inter alia, changes in global cocoa prices, partly due to the variations in the global value relative to the national currency, and a particular national market structure and conditions, competition, and quality. Although world market prices have increased over the years, real farm gate prices in several producing countries did not reflect this upward trend. The difference between world cocoa *"prices and producer prices in countries could be attributed to the aforementioned factors that affected producer price fluctuations"* (International Cocoa Organization, 2012, p. 8).

Materials and methods

Data sources

This study used mainly secondary data such as books, article journals and annual statistical data from various institutions. For the empirical analysis, annual time series data between 1990 and 2011 were obtained from various reliable sources such as the Food and Agriculture Organization (FAO) of the United Nations, United Nations Conference for Trade and Development (UNCTAD) database, and the International Monetary Fund (IMF) world economic outlook database.

Model specification

The model specified the annual quantity of cocoa export (tonnes) as a dependent variable, which is being explained by the quantity of cocoa output (tonnes), domestic consumption (tonnes), the world price (US$), quantity of world cocoa export (tonnes), trade openness, and real effective exchange rate.

The multiple regression model is specified here below:

$$QCEX = f(QCP, DCON, WP, QWCEX, TOPEN, REER) \quad (1)$$

Thus, the econometric model 1 is mathematically specified as follow:

$$\ln QCEX_t = \beta_0 + \beta_1 \ln QCP_t + \beta_2 \ln DCON_t + \beta_3 \ln WP_t + \beta_4 \ln QWCEX_t + \beta_5 \ln TOPEN_t + \beta_6 \ln REER_t + \varepsilon_t \quad (2)$$

where;

ln$QCEX_t$ is the natural log of annual quantity of cocoa export (tonnes), lnQCP_t is the natural log for the quantity of cocoa production (tonnes), ln$DCON_t$ is the natural log of domestic consumption of cocoa products (tonnes), lnWP_t is the natural log for the world price of cocoa beans (US$), ln$QWCEX_t$ is the natural log for aggregate of world cocoa export (tonnes) proxied for competitiveness, lnTOPENt is the natural log of trade openness index ((Exports+ Imports)/Nominal GDP)*100), is an indicator of trade liberalization, ln$REER_t$ is the natural log of real effective exchange rate measured for the value of domestic currency as against foreign currencies, is the error term, β_0 represents constant, while β_1, β_2, β_3, β_4, β_5, and β_6 are coefficients of each variable in the model.

These variables in the model are selected because they appear to be the major drivers of cocoa export in Nigeria in recent years. For instance, it is assumed that the more the quantity of the cocoa bean is produced the more it would be available for export. High rate of cocoa consumption in Nigeria might reduce export, an increase of the cocoa price on the world market may induce traders to increase its export. Due to lack of time series data, some variables that are also likely to have an impact on the cocoa export in Nigeria are not selected.

Stationarity test: Because, annual time series data is prone to spurious regression results when *x* and *y* series are non-stationary (random walk). A variable is said to be stationary (not random walk) when its mean and variance are constant over time. Time series data is the difference to produce other sets of observations such as the first-difference and the second-difference values. The order of integration using Augmented Dickey- Fuller (ADF) and Philips-Perron (PP) unit root tests (Muhamed, 2008) as presented in model 4.

X level	x_t	
X 1st - differenced value	$x_t - x_{t-1}$	
X 2nd – differenced value	$x_t - x_{1-2}$	(4)

Cointegration test: Cointegration approaches are used to determine if there exists a valid long-run relationship between two or more variables in the model. For the result to be valid, two conditions must be satisfied: the data series for each variable involved ought to be integrated into the same order, and, there must exist a stationary linear combination. Several studies (Hendry, 1986; Johansen, 1988), have suggested a number of cointegration methods.

In order to determine the number of Cointegration vectors, Johansen (1988) used two tests: trace and the maximum Eigenvalue tests. Trace statistic, tests the null hypothesis of no cointegrating vectors ($r = 0$) against the general alternative of one or more cointegrating vectors ($r > 0$), while maximal Eigenvalue statistics tests the null hypothesis of r cointegrating vector(s) present against the specific alternative of ($r + 1$) cointegrating vector(s) present. These test statistics are computed as:

$$LR_{trace}(r/n) = -T\sum_{i=r+1}^{n} \ln(1-\hat{\lambda}_i) \quad (5)$$

$$LR_{\max}(r/n+1) = -T\ln(1-\hat{\lambda}) \quad (6)$$

Model 5 test for trace, whereas model 6 tests for maximal Eigenvalue statistics. Where $\hat{\lambda}$ is

the estimated values of the characteristic roots obtained, and *T* is the sample size or number of observations in the model.

Results and discussion

1. Unit root test

The order of integration using both ADF and PP unit root tests is shown in table 1. The test results show that only two variables (QCEX and QWCEX) fail to reject the null hypothesis of a unit root in levels, but become stationary after first difference. Given that all the variables in the model have become stationary, we proceed to run Johansen cointegration and ordinary least squares (OLS) regression models.

2. Johansen test for cointegration

The model selection for cointegration is usually computed using an information criterion method, known as lag-order selection criteria. We have chosen lags 1 and proceed to run the Johansen cointegration test Based on the evidence provided by the information criterion,

Table 2 presents the results of both Johansen trace and maximal Eigenvalue tests for cointegration among the variables in the models. Both Maximal Eigenvalue and Trace tests indicate for the rejection of the null hypothesis of no cointegration vectors at the 5% significance level (statistic is greater than 0.05 critical value). An alternative hypothesis is accepted that there is a long run equilibrium relationship between the all the variables in the model. It implies that the all the variables are moving together in the long run.

When a cointegration is established, it can be viewed as an indirect test of long run causality. We, therefore, conclude that variables in the models are likely to be driving cocoa exports in Nigeria in the long run. When a cointegration is established, it is advisable to run Vector error correction model (VECM). However, we have opted to run ordinary least squares (OLS) regression analysis.

Variable		**ADF Stat**	**Order of integration**	**PP Stat**	**Order of integration**
lnQCEX	Level	**-2.116**	1(1)	-2.033	1(1)
	First diff	-7.436***	1(0)	-8.476***	1(0)
lnQCP	Level	-2.674	1(1)	-2.576	1(1)
	First diff	-8.166***	1(0)	-9.376***	1(0)
lnDCON	Level	**-3.970** ***	1(1)	-4.286***	1(1)
lnWP	Level	-0.698	1(1)	-0.845	1(1)
	First diff	-3.748**	1(0)	-3.711 **	1(0)
lnQWCEX	Level	-1.643	1(1)	-1.328	1(1)
	First diff	-7.218 ***	1(0)	-9.087 ***	1(0)
lnTOPEN	Level	-3.986 **	1(0)	-4.308 ***	1(0)
lnREER	Level	-1.284	1(1)	-1.268	1(1)
	First diff	-4.468	1(0)	-4.508 ***	1(0)

Note: McKinnon (1991) critical values are: -2.630 for 10%, -3.000 for 5% and -3.750 for 1% level
Source: Own work

Table 1: ADF and PP tests for unit root (constant term only).

Hypothesized No. of CE(s)	*Trace Test*		*Maximum Eigenvalue test*	
	Statistic	0.05 critical value	Statistic	0.05 critical value
None	166.3418	124.24	52.4106	45.28
At most 1	113.9312	94.15	44.4741	39.37
At most 2	69.4571	68.52	30.2443	33.46
At most 3	39.2128	47.21	17.3006	27.07
At most 4	21.9122	29.68	13.9120	20.97
At most 5	8.0002	15.41	7.9723	14.07
At most 6	0.0279	3.76	0.0279	3.76

Source: Own work

Table 2: Johansen cointegration test results (constant only).

3. Diagnostic test for OLS regression model

Table 3 present results of diagnostic tests. The results of the tests seem to satisfy the prior econometric test as all the P. values of the diagnostic tests in table are greater than 0.05 level. More so, all the results of the tests show that the model is linear and correctly specified. It also shows that the variability of a variable has minimum variance, and they are not heteroskedasticity, and the error term is normally distributed. The variables used in the model are not autocorrelated. Given that all the classical assumptions of the linear regression model were fulfilled, we have continued with the OLS estimation method. The OLS regression result is presented in table 4.

4. OLS regression model results

As shown in table 4, it appears that the estimated model is a "good fit" given that the Adjusted R-squared is about 73% is accounted for the variability in the dependent variable in the model. More so, the p. value and F. statistics in the model indicated that all the variables in regression model jointly influence cocoa export from Nigeria (statistically significant at the 0.01 level).

Even though the quantity of cocoa production appears to have a positive connection with cocoa export in Nigeria, it is statistically insignificant (see table 4). The result also shows an inverse relationship between cocoa export and domestic consumption (DCON), statistically significant at 0.01 level. It thus means that, a 1% increase in domestic cocoa consumption may decrease cocoa export from Nigeria by 0.13%, holding other variables constant (see table 4). This result is in consonance with the works of Amoro and Sheni (2013) who also found a negative relationship between cocoa export and domestic consumption in Ivory Coast.

Nevertheless, the result indicates that the world price (WP) has a positive influence on cocoa export from Nigeria to other parts of the world

Test	*Test- statistic*	*P. value*
Non-linearity test (squares)	8.39385	0.210645
Ramsey's RESET	0.077797	0.92558
White's test for heteroskedasticity	14.44	0.273494
Breusch-Pagan test for heteroskedasticity	2.89066	0.82244
Test for normality of residual	2.29511	0.317412
Breusch-Godfrey test for first-order autocorrelation	3.74415	0.0734584
Test for ARCH of order 1	0.0403926	0.840715
Test for ARCH of order 2	1.1857	0.55275

Source: Own work

Table 3: Diagnostic test.

Dependent variable: lnQCEX				
Variables	**Coefficient**	**Std. Error**	*t-ratio*	*p-value*
const	-0.018032	0.0278387	-0.6477	0.52695
lnQCP	0.061907	0.10723	0.5773	0.57228
lnDCON	-0.129427	0.0423554	-3.0557	0.00801***
lnWP	0.378955	0.1515	2.5014	0.02444**
lnQWCEX	1.10249	0.258926	4.2579	0.00069***
lnTOPEN	0.698914	0.163789	4.2672	0.00067***
lnREER	0.544038	0.218398	2.491	0.02494**
R-squared	0.80822			
Adjusted R^2	0.7315			
F (6, 15)	10.53575			
P-value (F)	0.0001			

Note: The asterisks (**, ***) denote statistically significant level at 5%, and 1% respectively
Source: own work

Table 4: OLS, using observations 1990-2011 (T = 22).

(statistically significant at the 0.05 level). It implies that, all things being equal, a 1% increase in the world price, cocoa export from Nigeria is likely to increase by 0.38%. This result is in consisted with the findings by Daramola (2011) who also found a positive relationship between cocoa export and the world price in Nigeria. Arguably, the world price is a strong driver of cocoa export in the country.

Similarly, the results provide a strong positive relationship between cocoa export and quantity of world cocoa export (QWCEX), statistically significant at 0.01 level. A 1% increase of aggregate world cocoa export is likely to induce Nigeria to export cocoa by 1.1%. Nigeria is the fourth largest cocoa producer in the world and the third largest exporter of the cocoa crop after Ivory Coast and Ghana. Due to the favourable tropical climatic conditions (factor endowment), Nigeria has a comparative advantage in cocoa production and export.

Table 4 also shows that trade openness index (TOPEN) has a positive influence on cocoa export from Nigeria (statistically significant at 0.01 level). Holding other variables constant, a 1% increase in the level of trade openness proxied for liberalization, Nigeria is likely to increase the quantity of cocoa export by 0.70%. Trade openness indicates the size of Nigeria in the international trade or the integration of the country into the global economy. It implies that as trade openness index increases, cocoa export may also increase in the country.

In the same direction, the result in table 4 also show that real effective exchange rate (REER) has positive influence cocoa export in Nigeria, statistically significant at 0.01 level. This implies that, holding other variables constant, a 1% increase in the real effective exchange rate might boost cocoa export from Nigeria to other parts of the world by 0.54%. This result is consistent with the empirical works of Daramola (2011) who also found a positive association between cocoa export and the real exchange rates in Nigeria. The country adopted floating exchange rate regime upon the introduction of SAP in 1986 as among the tools for liberalization. Arguably, this could drive cocoa export if the value domestic currency is stable as against the basket of international currencies.

Finally, we conclude that variables in the model such as the world price, domestic cocoa consumption and trade openness indicate to have influence on cocoa export from Nigeria to other parts of the world. Due to lack of comprehensive data, other variables that are likely to have an impact on cocoa export in the country were not incorporated in the model. Future research should incorporate other variables like domestic producer price, annual rainfall to determine their impact on cocoa bean export in the country.

Conclusion

The aim of this contribution was to analyze some drivers of cocoa export in Nigeria in the era of trade liberalization for the period 1990-2011, using Johansen cointegration and OLS regression methods. Johansen cointegration results show there exists a long-run equilibrium relationship between cocoa exports and the explanatory variables such quantity of cocoa production, domestic consumption, real effective exchange rate and the world price in the country.

More so, the OLS regression results provide evidence that the explanatory variables in the model are the key drivers of cocoa export in Nigeria. The findings show a positive relationship between cocoa export and world price, trade openness, real effective exchange rate, and quantity of world cocoa export in Nigeria production (statistically significant at the 0.01 and 0.05 levels). However, the results show an inverse association between cocoa export and domestic production (statistically significant at the 0.01 level). This implies that the more the cocoa domestic consumption the less the quantity of cocoa that is available for export.

The Nigerian government should create an enabling environment and some incentives by increasing cocoa farm gate prices, subsidizing farm inputs, and providing affordable loans to smallholder cocoa farmers and traders to ensure sustainable cocoa bean production and export in the country.

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