Czech University of Life Sciences Prague
Faculty of Economics and Management

agris on-line

Papers in Economics and Informatics

http://online.agris.cz

ISSN 1804-1930
IV, 2012, 2

International scientific journal
Prague

Agris on-line Papers of Economics and Informatics

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

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

Editorial office

AGRIS on-line Papers in Economics and Informatics
Department of Economics of FEM CULS Prague
Kamýcká 129, 165 21 Praha 6 – Suchdol
Czech Republic
Phone: +420 224 382 050, 2056
E-mail: agrisonline(at)pef.czu.cz

Publisher

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

ISSN 1804-1930

IV, 2012, 2
30th of June 2012
Prague

Agris online
Papers in Economics and Informatics

ISSN 1804-1930

IV, 2012, 2

Agris on-line Papers in Economics and Informatics

Volume IV Number 2, 2012

Agris on-line Papers in Economics and Informatics

Volume IV Number 2, 2012

Czech Republic`s Self-sufficiency in Case of Pork Meat and Its Impact on Trade Balance Development

Z. Gebeltová

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

Anotace

Tento článek analyzuje soběstačnost ve výrobě vepřového masa v České republice, predikuje její objem v roce 2013 a identifikuje faktory, které významně ovlivňovaly zvyšující se objem importů vepřového masa v ČR během doby výzkumu 2003 - 2011. Příspěvek využívá Index komparační výhody RCA pro hodnocení konkurenceschopnosti na trhu vepřového masa.

Příspěvek byl zpracován v rámci VZ MSM 6046070906 „Ekonomika zdrojů českého zemědělství a jejich efektivní využívání v rámci multifunkčních zemědělskopotravinářských systému“.

Klíčová slova

Soběstačnost, vepřové maso, konkurenceschopnost, predikce, zemědělský trh, Německo, cena.

Abstract

This paper analyzes self-sufficiency in pork production in the Czech Republic, predicts its size till the 2013, and identifies factors that were significantly influencing the increasing volume of imports of pig meat in the Czech Republic during the referred years 2003 to 2011. The paper uses Index of competitive advantage RCA for the evaluation of competitiveness on the pork meat market.

It was found out that the pig meat self-sufficiency went down – from 96.23 % in 2003 to 63.83 % in 2010. RCA index reached negative values of -15.82 in 2011, in comparison with the year 2003 when the RCA index showed value of +90.23.

This paper is a part of a research project undertaken by the authors on the topic „Economics of resources of the Czech agriculture and their efficient use in the frame of multifunctional agri-food systems”, the grant No. 6046070906, funded by the Czech Ministry of Education, Youth and Sports of the Czech Republic.

Key words

Self-sufficiency, pig meat, competitiveness, prediction, agrarian market, Germany, price.

Introduction

The area of pig breeding / stock rising is not important only in terms of pork production, but also because of significant connection to the outputs of crop production. Pork meat is important component of the Czech population´s diet. To the total consumption of meat it contributes by more than 51 %. The position of the livestock production sector has changed significantly from the entry of Czech Republic in the European Union. The pig breeding industry had undergone many changes for accepting common agricultural policy in the year 2004. Subsidies for pig breeding are not part of SAPS payments. Disregarding that pork meat production is production of sensitive commodity it is neither supported by additional national payments TOP-UP. Grants from the Rural Development Programme and those according to the Agricultural Act are not sufficient. Negative trend in pork meat production since 2004 is also due to accumulation of other factors such as rising cost of

pork production, especially the growth of feeding grain prices in the last two years. Furthermore, a reduction in breeding sows, decreased number of weaned piglets, smaller investment opportunities for farmers, increased imports of pedigree pigs and as a result, insufficient ability of producers to deliver large and standardized supplies of meat to meat processors.

Market attractiveness and market position for pigmeat on the German, Italian and French markets analysed Traill et al. (1998)

With the production of about 5 million tonnes of pig meat, Germany was in 2007 the largest pig meat producer in the European Union. (ZMP, 2008a) Germany has produced increasingly more pork meat from 2004 to 2007, which raised the self-sufficiency rate from 91.7 percent to 99.2 percent. Germany is a far more important exporter of processed pig meat than of livestock fat pigs. (Reynolds, 2010)

Russia has been a large net importer of livestock products, especially meat. In 2003, the Russian government created restrictive tariff rate quotas for imports of beef and pork and a pure quota for poultry. The annual quota for poultry was set at 1.05 million metric tons, and the low tariff quota for beef and pork at around 0.45 metric tons. In 2005-06, the government liberalized the meat import policy. (Anderson and Swinnen, 2008)

Karminski (1999) used RCA Index to analyse situation in the Hungary. The calculation is derived from the United Nations Commodity Trade Statistics Database as reported by the EU.

Nin, A., et al. (1999) derived Index of revealed comparative advantage for livestock products and for selected regions – France, Germany, United Kingdom, China, India.

The policy analysis matrix (PAM) approach was used to evaluate the competitiveness of polutry and pig production in Vietnam compared to imports from an open global market. Import and export parity prices of live pig were calculated based on Asian CIF and FOB prices. (Akter et al., 2003)

The main aim of the paper, based on introduced data sources and methodological procedures, is to analyze the impact of self-sufficiency in pork meat imports to the Czech Republic, to predict its size till 2013 and to identify factors that were significantly influencing the increasing volume of imports of pig meat to the Czech Republic during the referred years 2003 to 2011.

Partial goals of the paper can be summarized into the following areas:

- To perform structural analysis of various types of imported pig meat in the period 2003-2010. Definition of factors of the imported meat in terms of its value and quality.
- To actualize comparison of import and export prices of the most representative types of pork meat in the foreign trade and an analysis of the causes of difference.
- Prediction of trend in the foreign trade with pork meat for period 2011-2013.

Hypotheses:

H.1. Decline in self-sufficiency, respectively, with decreasing production of pig meat and stagnancy of its consumption, its imports will increase. Those are variables with high correlations.

H.2. High volumes in imports of lower quality and less valuable parts of pork meat from Germany to Czech Republic are mostly influenced by its low entry price.

This paper is based on the study of sources written by experts in the fields of pig breeding and pork meat production, namely from IAEI (Institute of Agriculture Economics and Information) (Pohlová, Trdlicová, 2010), and MoA (Ministry of Agriculture) (Machek, 2010).

Material and Methods

This paper was prepared on the basis of following documents:

- Balance tables of MoA, published in „Výhledové a situační zprávy“ no. 8/2007 and no. 12/2010 (Chapter: The development of pork meat commodity, units: tonnes of live weight).
- Custom Statistics database, accessible from the website of Czech Statistical Office (CSO). The data from reference period January 2003 – May 2011 were examined. To find information on the value of exports, imports, balance and turnover in the trade with pig meat, the view level of the four-digit harmonized system code was used. Analytical information on the price of traded items is identified on the basis of eight-digit combined nomenclature code.

Relationships and methods used:

- The scale of self-sufficiency indicates to what extent can own agricultural production cover the total consumption while stopping exports (= above 100%) or the percentage to what

exceeds domestic needs (= above 100%). (Kraus, 2003)

$$\text{self} - \text{sufficiency (S)} = \frac{\text{own agricultural production}}{\text{total domestic consumption}} * 100\ \% \quad (1)$$

- Index of competitive advantage RCA was used for the evaluation of competitiveness. It is an auxiliary index of apparent competitive advantage (Revealed Comparative Advantage). For the calculation a method has been chosen, which is expressed (Balassa, 1977)[1] as follows:

$$RCA = \frac{Ex_j - Im_j}{Ex_j - Im_j} * 100 \quad (2)$$

Legend:

Ex_j and Im_j: values of export and import of foreign agrarian trade of j-th commodity in the country. $(Ex_j - Im_{j)}$ = balance, $(Ex_j + Im_j)$ = turnover

Competitive commodities can be defined as those which reach balanced high positive values of index RCA in a given period. As well as uncompetitive commodities can be evaluated those whose values of RCA index move in high negative numbers for a long term.

In which way outstanding imports of pork meat projected are into negative of foreign agricultural balance of Czech Republic was found using the relationship:

$$\text{Balance of trade loading} = \frac{B_{it}}{B_t} * 100 \quad (3)$$

Legend:

B_{it}… Export $_{\text{i-commodity}}$ – Import $_{\text{i-commodity}}$, time period t

Bt…Foreign trade balance- agricultural commodities, time period t

Necessary condition : amount of balance B_{it}, <0;

B_t <0

The research uses software Microsoft Excel and Statistica. The regression and correlation analysis was performed on the basis of these programs which proves or disproves influence of factors affecting scale of pork meat import according to the set of hypotheses. T-test was performed within the scope of regression analysis, which tested the statistical significance of absolute term and beta coefficient for the significance level α = 0,05. If the significance p<0,05 is achieved for both members, then is the entire model statistically significant. Furthermore, a prognosis for future three years for those values defined in the goal of the paper was made by using regression equations.

Results and discussion

Domestic pork meat production (tonnes of live weight) has decreased by 36.75 % over the period 2003-2010 (Table 1). Consumption of pork meat in the period stagnated. Self-sufficiency of the Czech Republic in the production of pork meat reflected EU accession by decrease in production in 2005 by 14.06 % in comparison with year 2003. According to MOA and IAEI estimate, the self-sufficiency will decrease to about 60.6 % in year 2011 which would mean a reduction of self-sufficiency relative to year 2003 by 35.63 %. If it remains true that the pork meat will contribute to the overall meat consumption by more than 50 % and the trend of production decrease will continue, Czech consumers will consume mainly meat imported from abroad.

1 See Bela Balassa, "Trade Liberalization and Revealed Comparative Advantage," The Manchester School of Social Studies 33,2 (1965): 99-123; Liesner, H.H., "The European Common Market and British Industry," Economic Journal 68 (1958): 302-316; Vollrath, T. L., "A Theoretical Evaluation of Alternative Trade Intensity Measures of Revealed Comparative Advantage," Weltwirtschaftliches Archiv 130 (1991): 265-279.

Indicator	2003	2004	2005	2006	2007	2008	2009	2010
Production *)	576.3	547.0	472.0	449.3	463.7	431.6	370.3	366.4
Domestic consumption *)	598.9	564.6	569.9	564.0	588.9	583.0	568.9	574.0
Self-sufficiency (%)	96.23	96.88	82.82	79.66	78.74	74.03	65.09	63.83

Note: *) Production and domestic consumption = thousand tonnes, life weight

Source: Pig meat market: position report, December 2010, side 29 and July 2007, side 26, Ministry of Agriculture, Czech Republic

Table 1: Pig meat self-sufficiency – time series 2003-2010.

1. Live pigs (KN 0103)

Production of live animals (item: KN 0201 – breeding pigs, sows, piglets and slaughter pigs) is a category with minimal added value and the competitiveness is desirable in terms of economic level of our country.

From 2003 to 2007, RCA was positive in the trade with live animals, represented mainly by piglets and slaughter pigs. The trade balance was positive. Countries for export were mainly Slovakia, Croatia, Hungary and Germany. Till the year 2007, Germany was important export country for slaughter pigs. The highest natural value of exports to Germany was recorded in 2006. Czech farmers by those increased exports solved problems with unfavourable price situation on the domestic markets. Since 2007 exports of live pigs to Germany begin to significantly decline, since Germany has increased self-sufficiency in terms of pork meat to 106%. The loss of markets in Germany was compensated by exporting pigs to Hungary. The exports of live pigs in 2010 were realized by 47% in Hungary and by 41% in Slovakia. Since 2008, the balance of trade with animals is negative, according RCA coefficients (Table 2) fell the production of pigs under the level of competitiveness.

Competitive disadvantage reflects the negative balance and low turnover of trade values. Although the values of the RCA coefficients from 2010 show an improvement, it is clear that Czech farms are still well behind for low farm specialization, small scale of investment in housing and equipment. The low competitiveness is also significantly contributed by absence of broader subsidy policies for pig breeding. With increasing imports of pigs has therefore during the years changed also a structure of imported animals (Table 3). Pedigree animal import is significantly on decline in favour of import of piglets for fattening.

The largest importers of live animals into the Czech Republic nowadays are Denmark, the Netherlands and Germany. There are 21 piglets for each sow in the Czech Republic which is by 7 piglets less than in Denmark or Germany. Mortality during fattening is between 4-5 % in contrast with compared countries where it is 1 %. Daily gains on Czech farms are between 650 g and 700 g. These values are around 850-920 g per day in Denmark or Germany (Jandejsek, 2010). In Denmark, the Netherlands and Germany, there are large concentrated pig farms. These countries, which have a high-quality genetic potential and good health of pigs, require compliance with high hygiene standards in the entire pork meat production process. Two-thirds of total costs of slaughter pig production are feed costs. This item is subject to significant fluctuations depending on grain production in domestic conditions as well as abroad, the price of soybeans on the world markets etc. Due to the rise in prices of feeding grain in last two years and the above-mentioned factors, the profitability of pig breeding could continue to be low. Therefore, a drop in production of slaughter pigs and their increased import from European countries is real.

Import prices of slaughter pigs are higher than export prices as well as prices of domestic production. (Graph 1).

Processors are willing to accept this higher import price due to the need to receive stable, long-term and standardized volumes of animals. This brings

	2003	2004	2005	2006	2007	2008	2009	2010	2011
RCA	90.94	92.13	54.40	27.74	20.41	-16.93	-55.12	-30.58	-15.82

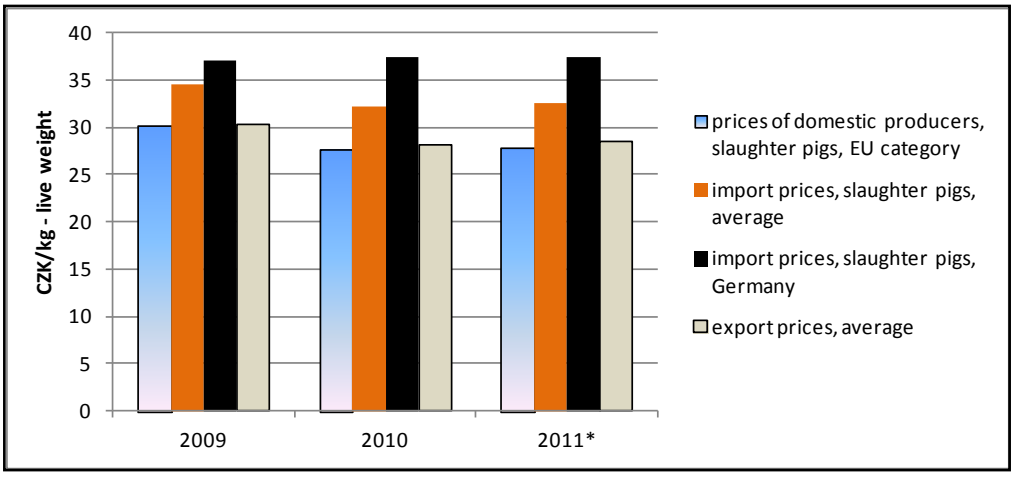
Note: * Values to May 2011
Source: Authors according Czech Statistical Office, Foreign trade database
Methodology: Formula (2)

Table 2 : Coefficient RCA (Reveal Competitive Advantage) – live pigs (KN 0103).

	2003	2004	2010	2011*
Slaughter pigs - KN 1039219 (%)	0.00	28.01	35.20	31.59
Piglets - KN 01039110 (%)	0.00	33.64	60.74	60.67
Breeding pigs - KN 01031000(%)	100	38.35	4.05	7.69
Live pigs (million CZK)	6.615	25.318	959.617	357.159

Note: * Values to May 2011
Source: Authors according Czech Statistical Office, Foreign trade database

Table 3: Live pigs - Import value and KN structure.



Note: * Values to May 2011
Source: Authors according Czech Statistical Office, Foreign trade database and TIS No.10 2011; pages 8-10.
Graph 1: Slaughter pigs: Export and Import prices, prices of domestic producers, 2009-2011, CZK/kg – live weight.

	Thousand CZK				(%)	Coefficient
	Export	Import	Balance B_{203}	Balance B_t	B_{203}/B_t	RCA (2)
2003	411 287	1 350 617	-939 330	-25 454 644	3.69	-53.31
2004	675 542	3 320 742	-645 200	-32 295 453	8.19	-16.14
2005	1 137 452	5 397 047	-4 259 595	-25 002 745	17.04	-65.19
2006	1 269 864	6 159 325	-4 889 461	-34 194 621	14.30	-65.81
2007	1 585 872	6 905 046	-5 319 174	-32 453 106	16.39	-62.65
2008	1 874 282	8 017 809	-6 143 527	-24 117 060	25.47	-62.11
2009	1 955 462	9 477 701	-7 522 239	-32 027 522	23.49	-65.79
2010	1 873 848	9 675 624	-7 801 776	-33 603 646	23.22	-67.55
2011*)	766 024	3 686 389	-2 920 365	-15 148 423	19.27	-65.59

Source: Authors according Czech Statistical Office, Foreign trade database
Note: * Values to May 2011
Table 4: Pig meat foreign trade (KN 0203) and RCA coefficient.

even additional costs associated with haulage abroad.

2. Meat of pigs, chilled and frozen (KN 0203)

2.1. Effect of pig meat imports on agrarian trade balance and prediction of meat imports by 2013

Czech products with higher added value are not competitive in the surrounding markets nowadays nor had been before the entry to European Union. The competitive disadvantage is still increasing in recent years. It is not affected only by manufacturing economy, but also by decrease in the number of live animals produced by Czech farmers and growing negative balance of trade in pork meat. Increased imports of pork meat have increasingly negative effect on Czech foreign agricultural balance. The calculations (Table 4) shows that in 2003 the negative balance of pork meat (B203) changed a total negative trade balance in food products (Bt) only by 2.39 %. This value was in range 23-25% in the years 2008-2010. If the RCA result is negative due to negative foreign trade balance, then it is necessary in terms of competitiveness to keep negative value of coefficient at lowest possible level. This is possible to achieve by balanced import and export values as well as, if possible, by higher values of turnover. RCA coefficients reach still increasing negative values because the constituents grow unevenly. Unlike the RCA coefficients of live pigs (KN 0103), which are improving from the year 2008, the pork meat RCA coefficients indicate dynamics in foreign trade as late as first five months of 2011.

Prognosis of self-sufficiency of the Ministry of Agriculture (MoA) and the Institute of Agricultural Economics and Information (IAEE) concerns decrease in self-sufficiency in pig meat for the year 2011 to 60.6 percents. By instalment of this value in the function y1, an estimation of value of total imports of pig meat in 2011 in amount 204 141.14 tonnes was found out. It would be dealt with year-on-year increase in imports by 4.18 %. Other possible values of self-sufficiency in pig meat and their impact on development of imports of pig meat is presented in the Table 5.

Results of Regression Analysis, No. 2 and 3

Dependence of pig meat import development in time in natural expression (regression No. 2) and following pig meat import analysis in time in value expression (regression No. 3).

Regression 2 determinant coefficient R^2= 0.9585, R2 is a statistic that will give some information about the goodness of fit of a model. In regression, the R^2 coefficient of determination is a statistical measure of how well the regression line approximates the real data points.

Original selected collection contained 8 values (years 2003 – 2010). Nevertheless, the model showed statistical irrelevancy because t-test results were not <0.05. Data in the model were adjusted and marginal value of the year 2003 was taken away from the input values. Other t-test confirmed that the model is statistically significant and its conclusion can be taken into consideration for data of the basic collection.

	Absolute term	Regression coefficient (Beta)	p-value (absolute term)	p-value (independent variable)	
N=8	467939.3	-4353.1	0.000003	0.000018	
	Equation of Regression		Prediction	-95%	95%
X=60.6	y1= 467939.3-4353.1x		204 141	184 817	223 466
X=59.0	y1= 467939.3-4353.1x		211 107	190 594	231 619
X=58.0	y1= 467939.3-4353.1x		215 460	194 192	236 727
X=57.0	y1= 467939.3-4353.1x		219 813	197 783	241 843
X=56.0	y1= 467939.3-4353.1x		224 166	201 365	246 966
X=55.0	y1= 467939.3-4353.1x		228 519	204 941	252 097
X=54.0	y1= 467939.3-4353.1x		232 872	208 511	257 233

Note: N=number of value – sampling collection , t-test result : p <0.05= statistically significant
Source: STATISTICA 10 Software, Czech Statistical Office, Foreign trade database and Tariff Statistics

Table 5 : Pig meat Import Dependence on Self-sufficiency degree: Statistical characteristics.

N= 7	Absolute term	Regression coefficient (Beta)	p-value (absolute term)	p-value (independent variable)	
y2 (Regression 2)	53 470 906	20 455 177	0.000988	0.000077	
y3 (Regression 3)	2 838 408	1 038 730	0.000580	0.000055	
	Equation of Regression		Prediction	-95%	95%
2011	y2=53470906+20455177x		217 112 319	197 154 531	237 070 108
2012	y2=53470906+20455177x		237 567 496	213 535 137	261 599 856
2013	y2=53470906+20455177x		258 022 673	229 798 098	286 247 248
2011	y3 = 2838408 +1038730x		11 148 247	10 203 825	12 092 670
2012	y3 = 2838408 +1038730x		12 186 977	11 049 742	13 324 213
2013	y3 = 2838408 +1038730x		13 225 707	11 890 092	14 561 322

Legend:
y2= dependent variable- pig meat import: kg, slaughter weight (natural value)
y3= dependent variable- pig meat import: thousand CZK
x= independent variable: time (2004-2010)
N= number of value – sampling collection, t-test result: p <0.05 = statistically significant
Source: STATISTICA 10 Software, Czech Statistical Office, Foreign trade database and Tariff Statistics

Table 6: Pig meat Import - main statistical characteristics, time series 2011-2013.

Hypothesis 1: Decline in self-sufficiency, respectively, with decreasing production of pig meat and stagnancy of its consumption, its imports will increase. Those are variables with high correlations.

Results of Regression Analysis, No. 1

Regression coefficient represents the rate of change of one dependent variable (y1 = pig meat import in tone: slaughter weight) as a function of changes in the other independent variable (x = self-efficiency in %); it is the slope of the regression line. The simple linear regression is counted by STATISTICA 10 Software. R^2 = 0.961782, R^2 is a statistic that will give some information about the goodness of fit of a model. In regression, the R^2 coefficient of determination is a statistical measure of how well the regression line approximates the real data points. An R^2 of 1.0 indicates that the regression

The task of regression No. 2 was to predict development of pig meat in the CR till 2013. Its results were confronted with the regression No. 1 and a degree of self-sufficiency was estimated from import values according to the prognosis No. 2. The starting point for prognosis of self-sufficiency rate was the prediction of MoA and IAEE for 2011 which sets up self-sufficiency in the height of 60.6 %. In connection with the value of self-sufficiency in height 60.6 % in the regression No. 1, a value of export was predicted which corresponds with a bottom border of estimation for the import value in the regression analysis No. 2. If this relation will be s starting point also in next years, then an estimation of the bottom border of import from the regression No. 2 will be accepted. A self-sufficiency Value for this estimation from the regression is predicted in the height of 58 – 59 %. For the year 2013, a self-sufficiency value was set up in a similar way in the height of c. 54 %.

Regression 2 determinant coefficient R2= 0,961

Value of pig meat export in value expression:

Year 2011: interval: 10.2-12.1 mld. CZK

Year 2012: interval: 11.1-13.3 mld. CZK

Year 2013: interval 11.9-14.6 mld. CZK

If the values of annual agrarian import of the CR keeps the current long-term trend of height 140 – 150 mld., then the import of pig meat in 2013 would amounted as many as 9-10 % of expenditures to the total agrarian import- In 2010 it was 6.8 %.

2.2. Structural analysis of imports and price comparison

Before accession of the Czech Republic to the EU some of the items of foreign trade were in surplus. It was a cold meat in the following categories: whole and half pork, non-boned chilled rumps and front pig parts. In 2010, the positive trade balance reduced to the only item of pig meat: frozen whole bodies and halves (KN 02032110). The positive balance was only in the amount 19 mil. CZK. The biggest amount of chilled and frozen pig meat (KN 203) was in 2010 imported from Germany and

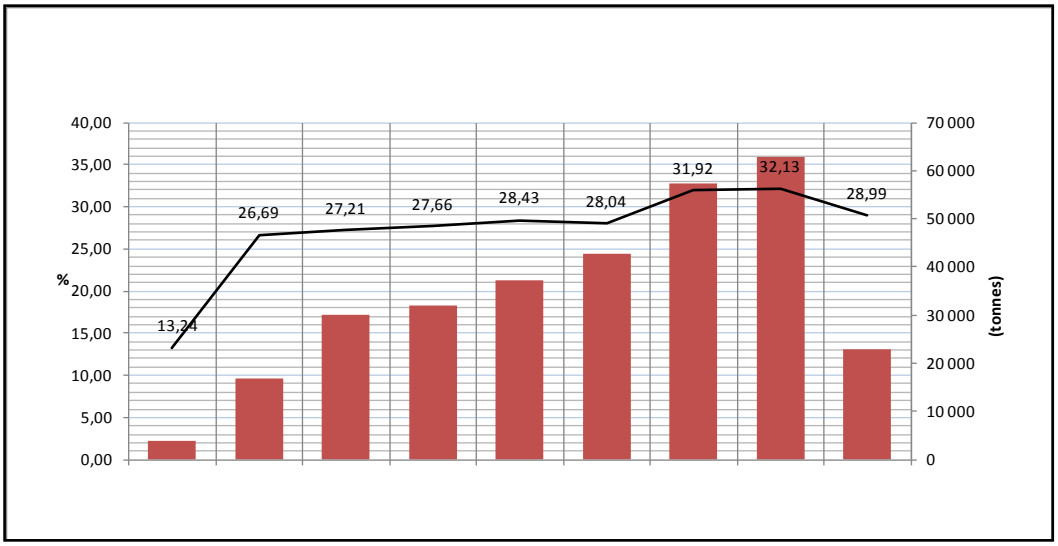
KN	**TOP Export 2010**	million tons	CZK/kg
2031110	Fresh or chilled domestic pigs carcases and half-carcases	14 062.574	39.027
2031955	Fresh or chilled boneless meat of domestic pigs	11 345.404	74.582
2032955	Frozen boneless meat of domestic pigs	2 800.133	49.825
2031190	Fresh or chilled non-domestic pigs carcases and half-carcases	1 151.411	38.880
2031990	Fresh or chilled non-domestic pigs meat : other meat	1 005.740	55.969
2031915	Fresh or chilled bellies "streaky" and cuts thereof domestic pigs	987.288	44.987
KN	**TOP Import 2010**	million tons	CZK/kg
2031955	Fresh or chilled boneless meat of domestic pigs	62 878.898	56.561
2031211	Fresh or chilled bone in, domestic pigs hams and cuts thereof	26 892.514	47.749
2032955	Frozen boneless meat of domestic pigs	25 432.944	43.551
2031110	Fresh or chilled domestic pigs carcases and half-carcases	23 522.619	40.663
2031915	Fresh or chilled bellies "streaky" and cuts thereof domestic pigs	13 121.483	45.946
2031913	Fresh or chilled loins and cuts thereof of domestic pigs	10 748.204	57.248

Source: Authors according Czech Statistical Office, Foreign trade database
Note: non-domestic pigs: wild boar, barbirusa, peccary

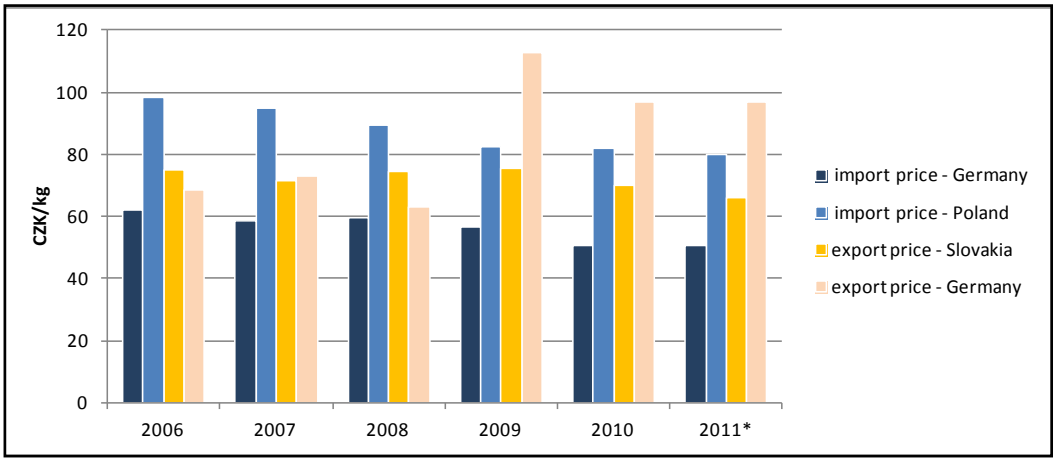
Table 7 : Top export and top import – pig meat, combined nomenclature, export and import prices.

Poland. A share of expenditures for meat import from Germany amounted 49.8 % of the total expenditures for pig meat import last year. Till May 2011, this share created 48 %. The CR has the significant positive balance of pig meat trade only with Slovakia. In the reference period 2003 – 2011, the most represented kind of imported pig meat in the CR is the category "meat from domestic pigs other, chilled, boned (KN 020318955). It is dealt with low valuable parts of pig meat like skin, navels, dewlaps and others. Since 2003 to 2010, the representation of this meat category in the imported pig meat improved by 18.96 %. Other important import components are qualitatively more significant categories of pig meat: rumps from domestic pigs, chilled, non-boned (KN 2031211) and meat from domestic pigs, chilled entire or halving (KN 2031110) (Table 7).

Less valuable pork meat is imported in the Czech Republic for further processing and it is certainly not a positive development that its percentage of the pork meat total imports steadily slightly increases in the period from 2004 to 2010 (Figure 2). It is positive that in the first five months of the year 2011, the observed value was 28.99 %, considering the



Source: Authors according to the foreign trade database of CSO
Note *) Date till 2011
Others = kind unlisted in customs statistics tariff (skin, navels, dewlaps)
Graph 2: Volume of import „other pig meat" and its ratio on the total imports of chilled and frozen pig meat in the CR in 2003 - 2011.



Source: Authors´ calculations according to database of foreign trade of CSO
Note *) Date till 2011
Others = kind unlisted in customs statistics tariff (skin, navels, dewlaps)
Graph 3: Export and import prices of meat from domestic pigs, other, fresh, chilled, boned– KN 203 19 55, CZK/kg.

N=25	Absolute component	Regression coefficient (beta component)	p-value of absol. component	p-value of independent variable	
y5	15603831	-163665	0,000004	0.001249	
	Regression function		prediction	-95%	95%
x= 45	y5= 15603831-163665x		8 238 907	6944507	9533307
x=50	y5= 15603831-163665x		7420582	6536629	8304536
x=56	y5= 15603831-163665x		6602258	5917359	6959826

Note:
y4 = dependent variable: pig meat import in thous. CZK (the 1st quarter 2003 – the 1st quarter 2011)
y5= dependent variable: pig meat import in thous. CZK (the 4th quarter 2004-the 1st quarter 2011)
x= independent variable: price of meat import KN 0203 1955 from Germany in CZK/kg
N=number of values of selective collection (the 4th quarter 2004-the 1st quarter 2011)
Source: Statistica 10 software, data: customs statistics of CSO

Table 8 : Basic statistical characteristics of pig meat export from Germany in dependence of import price together with prognosis of import amount within change in price.

same period last year by 2.96 % lower. The largest number of the above-mentioned meat type KN 0203 1955 is imported from Germany. In the fourth quarter of 2010, 8958.4 tonnes were imported (49.2 % of the total imported "other pork meat"), in the first quarter of 2011 5564.2 tonnes were imported (44 % of the total imported "other pork meat").

A comparison of imports and export prices of this meat was carried out and it was stated: The import of "other pig meat" from Germany is realized under preferable price conditions thanthe import from Poland or meat export in Slovakia (Graph 3).

Hypothesis No. 2: High volumes of imports of less-quality and valuable parts of pig meat from Germany into the CR are influenced the most just by its low import price.

Results of regression No. 4 and 5

Regression No. 4 R= 0.59 R2= 35.77 %

The original selective collection contained 33 values (the 1st quarter 2003 – the 1st quarter 2011). Nevertheless, the model showed a statistical irrelevancy because the t-test results were not <0.05. Data in the model were adjusted and values of the year 2003, which showed a considerable variation from values in following years, were taken away. Only the values, which were influenced by the effect of the CR in the EU (the 4th quarter 2010 – the 1st quarter 2011), were used. Other t-test already confirmed that the model is statistically significant and its conclusions can be enlarged to data of the basic collection.

From the value of correlation coefficient and the determination coefficient it resulted that tightness of dependence among variables is slight because $R \in (0,3\text{-}0,5)$. The share of dispersion of variables was explained by regression from 33.10 % from possible 100 %. It means: An influence of one variable on the second was proved because if $R2 \in (25\%\text{-}50\%)$, the variability was significantly explained. Growing import of less valuable pig meat from Germany is from 33.1 % determined by the import price. The hypothesis No. 2 was confirmed. The variables influenced mutually, nevertheless, there is not the supposed strong interaction.

The import meat price KN 0203 1955 from Germany get at the level 56.7 CZK/kg over the May. If the import price of the considered kind of meat from Germany will keep this trend in the following quarters and will move in the interval 50 – 56 CZK/kg, the amount of import in values 7 420.582 - 6 438.593 tonnes over a quarter is predicted according to the regression function. So, the prognosis supposes a decrease and stabilization of amount of imports of the researched kind of meat according to the mentioned price development. Imports of this pig meat can correspond with imports from 2008-2009.

Discussion and conclusion

The situation in the area of pig breeding is serious and the results of the paper confirmed conclusions presented by Machek (2011). The work analyzes the problem of self-sufficiency in terms of pork meat, monitors its causes and predicts consequences of non-competitiveness in the area of foreign trade.

The scope of livestock breeding has greatly diminished since 2003. Compared with 2010, there was a decline in the number of pigs more than 43 % and the number of sows more than 53 %. The

Czech Republic cannot compete with Germany or Denmark in the numbers of bred piglets or daily gains of slaughter pigs or in the hygienic and health level, concentration and specialization of the breeds yet.

Self-sufficiency in pig meat production has decreased by 33,81% in the period 2003-2010.

On the basis of the original prognosis of MoA and IAEI, which states that the level of self-sufficiency in the sector of pork meat will reach 60.6 % in the year 2011, new prognosis of self-sufficiency development was made using confrontation of two own regression analyses. If the situation in the field of production and consumption of pork meat develops according to the trends researched, then self-sufficiency is predicted at 54 % for year 2013.

On the basis of the made prognosis of pork meat import development in the Czech Republic it was found out that the import value can reach 11.9-14.6 billion CZK in 2013 which is 9-10 % of the total agricultural import in the Czech Republic.

Of the 9675 billion CZK total imports of chilled and frozen pork meat in 2010 Germany has taken main share in importing for 5851 billion CZK (60.6 % of all imports). Above all, the share of lower quality pork meat grows year on year. Poor quality pork meat was in 44 % cases imported for favourable price conditions. The regression analysis has proved that the amount of imports is by 33 % influenced by its price. The price is important factor, still not decisive. Other important factors are: processors' needs to get one-at-time large amount supplies which the domestic farmers cannot produce, standardization of supplies, CZK/EUR exchange rate, and cost demands cause mainly by insufficient fodder base.

In the pork meat sector in the Czech Republic, there is insufficient support from the state. Subsidies are paid according to „Principles which set conditions for granting subsidies for the maintenance and utilization of genetic resources for food and agriculture from the resources of the Czech Republic" and with the participation of the EU Rural Development Programme. In the area of sensitive commodity market stabilization, the EU could allow re-introduction of price support.

In the light of increasing energy demand, decreasing fossil fuel resources, rising consumption and purchasing power of Far East nations, land purchases in areas with inadequate and uneconomic land use, the pressure to maintain self-sufficiency in food production will grow. Food import won´t be strategically and economically effective in the future.

Summary

The main goal of the paper is, according to listed data sources and methodological approaches, to analyze the impact of self-sufficiency on the imports of pork meat to the Czech Republic and to define factors that are significantly correlating with the growing volume of pork meat imports in period 2003-2011. Structural analysis of different types of pork meat in the reference period was carried out as well as a comparison of import and export prices of the most traded pork meat types in international trade and analysis of differential pricing causes. The paper made prediction of self-sufficiency and pork meat import rates development in the period 2011-2013. The basic methods were calculations of self-sufficiency degree and competitive advantage RCA. The research uses software Microsoft Excel and Statistica. The regression and correlation analysis was performed on the basis of these programs which proves or disproves the influence of factors affecting scale of pork meat import according to the set of hypotheses. The hypothesis No. 1 was confirmed: self-sufficiency in pork meat sector has decreased by 33 % in the period 2003-2010. The correlation between the dependent variable „self-sufficiency" and the independent variable „amount of pork meat imports" was revealed. The hypothesis No. 2 was confirmed: Regression analysis had proved a correlation between the amount of imports and its prices. The price is important factor, still not decisive. According to the pork meat import development prognosis the import of pork meat may increase up to 11.9-14.6 billions CZK until 2013 in the Czech Republic. The pressure to maintain self-sufficiency in the food production is important in the light of increasing energy demand, decreasing fossil fuel resources, rising consumption and purchasing power of Far East nations, land purchases in areas with inadequate and uneconomic land use.

Acknowledgement

This paper is a part of a research project undertaken by the authors on the topic „Economics of resources of the Czech agriculture and their efficient use in the frame of multifunctional agri-food systems", the grant No. 6046070906, funded by the Czech Ministry of Education, Youth and Sports of the Czech Republic.

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

References

[1] Agrarnachrichten – Bayerisches Landwirtscaftliches Wochenblatt, Der Braten stammt zumeist aus deutscher Erzeugung (pd), (Accessed January 2011), Available at: http://www.agrarheute.com/braten.

[1] Akter, S., Jabbar, M.A., Ehi, S.K. Competitiveness and efficiency in poultry and pig production in Vietnam, , International livestock Research institute, Kenya, 2003, Working Paper No.57, ISBN 92-9146-159-8.

[2] Anderson, K., Swinnen, J. Distortions to agricultural incentives in Eastern Europe and Central Asia, World Bank, Washington DC, 2008, ISBN 13: 978-0-8213-7419-1.

[3] Balassa, B. Revealed Comparative Advantage Revinited (1977): An Analysis of Relative Export Shares of the industrial Countries, 1953 – 1971, The Manchester School, 1977, č.45 s. 327 – 344.

[4] External Trade Database, Czech Statistical Office, (Accessed March to May 2011) Available at: http://apl.czso.cz/pll/stazo/STAZO.STAZO?jazyk=EN.

[5] Explanatory notes to the Combined Nomenclature of the European Union, (2011/C 137/01), Volume 54, Official Journal of the European Union, (Accessed Marz 2011), Available at: http://eur-lex.europa.eu/JOHtml.do?uri=OJ:C:2011:137:SOM:en:HTML.

[6] Jandejsek, Z., Chov prasat v kontextu globálního pohledu na zemědělství, (Accessed June 2011), available at: www.vetkom.cz/content/f2b42c862129874105240b6fa21f8aca/jandejsek.pdf.

[7] Karminski, B., Hungary´S Integration Into European Union Market – Production And Trade Restructuring, The World Bank, 1999, Policy Research Working Paper 2135.

[8] Kraus, J et al. Výkladový slovník agrární ekonomiky, VÚZE, Prague, 2003, (Accessed June 2011), Available at: http://www.agrokrom.cz/texty/ekonomika/vuze_kraus/VYKLADOVY_SLOVNIK_CZE_GER.pdf.

[9] Machek, J. Chov prasat v ČR po vstupu do EU z pohledu MZe, Conference paper – Pig breeding 2011, (Accessed Januar 2011), Available at: http://schpcm.cz/aktuality/TV_machek.pdf.

[10] Nin, A., Ehui, S., Benin, S. Livestock Productivity in Developing Countries : An Assessment, in : Handbook of Agricultural Economics, Volume 3, 2007, Elsevier B.V., ISBN 13: 978-0-444-51873-6.

[11] Pohlová, K., Trdlicová, K. Analýza agrárního zahraničního obchodu ČR v letech 2009 a 2010, IAEI, 2010, (Accessed May 2011), Available at: http://www.IAEI.cz/left-menu/databaze/monitoring-azo/mo1012.pdf.

[12] Reynolds, N. Factors Influencing Business Relationschips in Agri-food Chains, An Analysis of Selected German Chains in European Comparison, Dissertatin, Koln, 2010, ISBN 978-3-8441-0004-4.

[13] Situační a výhledová zpráva vepřové maso prosinec 2010, MOA, Prague 2010, ISBN 978-80-7084-909-5, ISSN 1211-7692, p.29.

[14] Situační a výhledová zpráva vepřové maso červenec 2007, MOA, Prague 2010, ISBN 978-80-7084-589-9, ISSN 1211-7692, p.26.

[15] Traill, B.W., Pitts, E. Competitiveness in the Food Industry, Blackie Academic & Professional, London, Thomson Science,1998, ISBN 0-7514-0431-4.

[16] ZMP – Zentrale Markt and Preisberichtstelle GmbH, 2008a, ZMP Marktbilanz Vieh und Fleisch, Bonn, 2008.

[17] Zpráva o trhu hovězího a vepřového masa, tis č.10, SZIF, Press Information System, 2.Q.2011, Week 15-16., XV., Publisched 3.5.2011, p.10, (Accessed July 2011), Available at: http://www.szif.cz/irj/portal/anonymous/CmDocument?rid=%2Fapa_anon%2Fcs%2Fzpravy%2Ftis%2Fzpravy_o_trhu%2F03%2F1246723094656.pdf.

Agris on-line Papers in Economics and Informatics

Volume IV Number 2, 2012

Effect of Macroeconomic Variables on the Ghanaian Stock Market Returns: A Co-integration Analysis

J. K. M. Kuwornu

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

Abstract

This study investigates the effect of macroeconomic variables on the Ghanaian stock market returns using monthly data over period January 1992 to December, 2008. Macroeconomic variables used in this study are consumer price index (as a proxy for inflation), crude oil price, exchange rate and 91 day Treasury bill rate (as a proxy for interest rate). The study employs the Johansen Multivariate Co-integration Procedure. The empirical results reveal that there is co-integration between the four macroeconomic variables and stock returns in Ghana indicating long run equilibrium relationship. Further, the results reveal that; in the short run, Treasury Bill Rate significantly influences the stock returns, with and an elasticity of 0.005, implying that a 1% rise in the Treasury bill rate will lead to a 0.005% rise in the stock returns. The inflation rate is also significant at 1% with elasticity -0.135744, implying that a 1% increase in inflation rate will decrease stock returns by 0.14 %. The residual value of 0.785548 of the Error Correction Model indicates that about 79% of the deviations of the stock returns are corrected in the short run, which is quite high and encouraging for an emerging market like the Ghana Stock Exchange. In the long run, however, the stock returns are significantly influenced by Inflation rate, Crude oil prices, Exchange rate, and Treasury bill rate, with elasticities of 0.5479, -0.03021, 0.05213, and 0.00322 respectively. Crude oil price is negatively related to stock returns; 1% rise in Crude oil prices will decrease returns by 0.03%. Also a 1% increase in inflation rate increases stock returns by 0.54%; and a 1% rise in exchange rate increases stock returns by 0.052%. The effect of Treasury bill rate is highly inelastic with elasticity of 0.003. In both the short run and the long run results, inflation rate appears to be the most influential macroeconomic variable affecting stock market returns in Ghana. The results also reveal that investors are not compensated for inflationary increases in the short run, but are compensated in the long run. These results have implications for financial analysts, fund managers and policy makers.

Key words

Stock market returns, inflation rate, crude oil price, exchange rate, interest rate, Cointegration Analysis, Ghana.

Introduction

Interest in financial markets and the efforts to forecast their performance has attracted significant attention of academicians, financial analysts, and policy makers. The Ghanaian economy has over the last decade witnessed relative macroeconomic stability in terms of GDP growth, significant reduction of interest rates, and stability of the cedi/dollar exchange rate, crude oil price and inflation. This relative stability has been attributed to the growth of major sectors of the economy including the money markets and the capital markets. The drop of interest rate following declines in inflation and prime rates has shifted the attention of investors to the stock market as the better means of investments. Evidence from the Ghana Stock Exchange (GSE) indicates that the relative stability of the interest rates and other macroeconomics variables have been the contributory factor to the growth of the stock markets. The attention of most investors has been shifted from investing in Treasury bills and other financial instruments which are risk free, as a result of the stability of the interest rate. This has caused the returns on these investments to fall. As a result of this, most investors have shifted

their attention to the stock markets and so over the last decade stocks of some listed companies have been oversubscribed. Investing in stocks provides a higher return than the other financial instruments but there are also risks associated with these stocks. Most investors invest in the stock market with the objectives of maximizing their return without taken into consideration the effect of macroeconomic variables such as inflation, and exchange rate on the stock prices of companies listed. The relationship between macroeconomic variables and stock returns has been extensively studied, for instance, Chen et al., (1986) who examined US stock market. Fama (1981) report a positive relationship between stock returns and macroeconomic variables. In spite of increasing migration of capital from developed market to emerging markets and associated high returns, (see Ushad et al., (2008) and Osinubi (2004)), emerging stock markets in developing countries like Ghana have not been well studied. In 2006 for example, foreign equity accounted for 75.3% of the equity finance recorded in Ghana compared to 29.9% in 2001 according to Ghana Investment Promotion Centre quarterly report (December 2007). The growing interest and the performance of emerging markets have been attributed to the conduct of sound macroeconomic policies, privatization, stock market reforms and financial liberalization (Adams and Anokye, 2008). As African economies attempt to develop their private sectors, it is becoming clear that the growth of the stock markets can serve as an important catalyst for sustainable development and growth. The emerging stock markets in developing countries like Ghana have also attracted world attention as markets of the future with a lot of potential for investors; it has become necessary to extend this type of study to the Ghana stock market. This study might also be relevant to private investors, pension funds and governments as many long-term investors base their investment in equities on the assumption that corporate cash flows should grow in line with the economy.

The objective of this study is to examine the effect of macroeconomic variables on stock market returns using cointegration analysis. This study is a follow up of Owusu-Nantwi and Kuwornu (2011); and Kuwornu and Owusu-Nantwi (2011).

The rest of the paper is organized as follows: section two focuses on the review of existing literature; Section three presents the methodology; section four presents and discusses the result of the study while section five provides the conclusions.

Literature Review

Stock prices reflect expectations of the future performances of corporate profit. As a result, if stock prices reflect these assumptions, then they should be used as indicators of economic activities. So, the dynamic relationship between stock prices and macroeconomic variables can be used to guide a nation's macroeconomic policies (Maysami et al., 2004). Prices of stocks are determined by the net earnings of a company. It depends on how much profit, the company is likely to make in the long run or the near future. If it is reckoned that a company is likely to do well in the years to come, the stock price of the company will rise to reflect the positive expectation. On the other hand, if it is observed from trends that the company may not do well in the long run, the stock prices may decline. In other words, the prices of stocks are directly proportional to the performance of the company. In the event that inflation increases, the company earnings (worth) will also subside. This will adversely affect the stock prices and eventually the market returns.

Choudhry (2000) found a positive relationship between stock returns and inflation in four high inflation countries. Maysami et al., (2004) find a positive relationship between inflation rate and stock returns. This is contrary to other studies that suggest a negative relationship. The reason given by the authors is the active role of government in preventing price escalation after the economy continued to progress after the 1997 financial crises. Mohammed et al., (2007) studied the effect of macroeconomic variables on stock prices in Malaysia using error correctional model. The results indicate that there is a positive relationship between inflation rate and stock price. Engsted and Tanggaard (2002) find a moderately positive relationship between expected stock returns and expected inflation for the US and a strong positive relation for Denmark.

According to the "Fisher effect" expected nominal rates of interest on financial assets should move one-to-one with expected inflation (Fisher, 1930). Moreover, changes in both short-term and long-term rates are expected to affect the discount rate in the same direction through their effect on the nominal risk-free rate (Mukherjee and Naka, 1995). Therefore interest rates are expected to be negatively related to market returns either through the inflationary or discount factor effect (Abugri, 2008). Some previous studies have reported that it is not interest rate itself that is relevant but the yield and default spreads that are more likely to influence equity returns (eg., Chen et al., 1986).

However, the continued use of interest rates may be attributed to the absence of active secondary markets for bonds issues and government paper in many emerging markets (Bilson et al., 2001). Theoretically, French et al., (1987) found negative relationship between stock returns and both long-term and short-term interest rate. Furthermore, Bulmash and Trivoli (1991) found that the US current stock price is positively correlated with the previous month's stock price, money supply, recent federal debt, recent tax-exempt government debt, long-term unemployment, the broad money supply and the federal rate. However, there was a negative relationship between stock prices and the Treasury bill rate, the intermediate lagged Treasury bond rate, the longer lagged federal debt, and the recent monetary base. Abdullah and Hayworth (1983) find that stock returns are positively related with the money growth and inflation rate while interest rate reacts negatively on stock returns.

The link between exchange rates and equity returns is based on a simple financial theory. Exchange rate as an indicator of a currency as a monetary variable that affect the prices of stock in a way similar to inflation variables. When the domestic currency depreciates against foreign currencies, export product prices will decrease and, consequently, the volume of the country's export will increase, assuming that the demand for this product is elastic. The appreciation of a country's currency lowers the cost of imported goods, which in most cases constitute a large part of the production inputs for emerging market countries. According to Pebbles and Wilson (1996), an appreciating currency is generally accompanied by increases in reserves, money supply and a decline in interest rates. The resulting decline in cost of capital and/or imported inputs is expected to lead to an increase in local return. Such an expectation is also consistent with Bilson et al., (2001) conclusion that a devaluation of the domestic currency has a negative relationship with return. Mukherjee and Naka (1995) also confirmed that exchange rate positively relates to Japan and Indonesia stock prices, both two large export countries. Solnik (1987) employs monthly and quarterly data for eight industrial countries from 1973-1983 to examine the relation between real stock returns, exchange rates and reports a negative relation among variables. Employing monthly data, Aggarwal (1981) examines the relationship between stock market indexes and a trade weighted value of the dollar for the period 1974-1978 and finds that the stock prices and exchange rates are positively correlated. In contrast, Soenen and Hernigar (1988) also using monthly data, report a strong negative relation between US stock indexes and fifteen currency weighted value of the dollar for the period 1980-1986. Bilson et al., (2001) tested whether local macroeconomic variables (money, goods prices and real activity) have explanatory power over stock return of 20 exchange emerging markets for the period 1985-1997. The results indicate that the exchange rate variable is clearly the most influential macroeconomic variables.

Gazi and Hisham (2010) studied the relationship between macroeconomic variables and stock market returns in the Jordian Stock Market. Using cointegration analysis, they find that the trade surplus, foreign exchange reserves, the money supply and oil prices are important macroeconomic variables which have long run effects on the Jordanian stock market. There is a negative relationship between crude oil price and stock market returns. This is also expected as increase in the price of oil will depress real economic activity, so a negative sign is justified. Interest rate does not affect the stock market.

Anokye and Tweneboah (2008) examined the role of macroeconomic variables on stock returns movement in Ghana. They used the Databank stock index to represent Ghana Stock market and the macroeconomic variables are; inward foreign direct investment, Treasury bill rate (as a measure of interest rate), consumer price index (as a measure of inflation) and exchange rate. They analyze both long-run and short-run relationships between the stock market index and the economic variables with quarterly data for the above variables from 1991 to 2006 using Johansen's multivariate cointegration test and innovation accounting techniques. They established that there is cointegration between macroeconomic variables identified and stock prices in Ghana indicating long run relationship. Result of impulse Response Function (IRF) and Forecast Error Variance decomposition (FEVD) indicate that interest rate and foreign Direct Investment (FDI) are the key determinants of the share price movements in Ghana.

Materials and Methods

Data

The empirical analysis is carried out using monthly data. The data period spans from January 1992 to December 2008 and the study was carried out using 204 monthly observations. The study employed GSE All Share Index (ASI) as a proxy for Ghana stock market returns. The macroeconomic variables are obtained in monthly intervals from the Central Bank of Ghana (BoG) and Ghana Statistical Services (GSS). The macroeconomic variables are

nominal interbank exchange rate (EXR), 91-day Treasury bill (T-bill) yield to proxy for Interest rate (TBR), crude oil price (CRO) and consumer price index to proxy for inflation (CPI). The data for the study are monthly from 1992 to 2008. All the macroeconomic data were obtained from the Central Bank of Ghana except the consumer price index which was obtained from the Ghana Statistical Services. The GSE All share Index was obtained from Ghana Stock Exchange (GSE). The brief description for each variable used is presented in the Table 1 below. In order to smooth the data all variables were converted to natural logarithm. The use of natural logarithm, rather than levels and percentage changes, mitigates correlations among the variables. Also, it helps in reducing heteroscedasticity as it compresses the scale in which variables are being measured. Selecting variables in similar studies is usually subject to criticism on the grounds of subjectivity. Fama (1981) has argued that such criticism is an unavoidable problem associated with this area of research. This study bases its selection of variables on theoretical propositions and evidence in the literature.

Four macroeconomic variables, namely, inflation (measured by the Consumer Price Index), 91-day Treasury bill rate used as proxy for interest rate and nominal inter-bank exchange rate (measured by the US$/GH¢) and crude oil price (US$ per barrel) have been selected as critical variables for this research. Our selection is influenced by the various works that have been carried out and reviewed in the literature about their relationships with stock returns, in other economies like US, Japan, Sri Lanka, India, Jordan, Pakistan and UK.

Description of Variables

Inflation Rate

Inflation is measured by changes in the Ghana Consumer Price Index (GCPI) which was collected from the Ghana Statistical Services database. High rate of inflation increase the cost of living and a shift of resources from investments to consumption. This leads to a fall in demand for market instruments which lead to reduction in the volume of stock traded. Also the monetary policy responds to the increase in the rate of inflation with economic tightening policies, which in turn increases the nominal risk – free rate and hence raises the discount rate model. High Inflation affects corporate profits, which in turn causes dividends to diminish. Consequently decreases in expected return of stocks cause stocks to depreciate in value. Conversely, low inflation implies lower cost of borrowing. Corporate performance goes up leading to increase in production and corporate profit. This results in the payment of attractive dividends by companies. The monthly inflation was computed as the natural logarithm of consumer price index at month t.

Variable	Concept	Description	Units	Source
LASI	Natural logarithm of Ghana Stock Exchange Index	Ghana Stock Exchange All Share Index	1990 = 77.65 points	Ghana Stock Exchange
LCPI	Natural logarithm of consumer price index	Consumer Price Index	Percentage per month	Ghana Stock Exchange
LEXR	Natural logarithm of exchange rate	Principal rate (Gh¢ per US Dollar)	GH¢ per US$	Bank of Ghana
LTBR	Natural logarithm of 91-day Treasury bill rate	91-day Treasury bill rate	Percentage per month	Bank of Ghana
LCRO	Natural logarithm of crude oil price	Crude Oil Price	US$ per barrel	Bank of Ghana

Table 1: Data Description and Source.

Interest Rate

The 91-Day Treasury bill rate is used as proxy for interest rate since Treasury bill serves as the opportunity cost of holding shares and as a benchmark for measuring interest rate. Chen et al., (1986), Beenstock and Chan (1988), Fifield et al., (2002), provide evidence on the relationship between interest rates and stock returns. High interest rate regimes lead to high cost of borrowing and hence a reduction in economic activity. This also affects corporate profit, future cash flow of business and dividend. According to the "Fisher effect", expected nominal rate of interest on financial assets should move one-to-one with inflation (Fisher, 1930). Moreover, changes in both short term and long-term rates are expected to affect the discount rate in the same direction through their effect on the nominal risk-free rate (Mukherjee & Naka, 1995). Therefore interest rates are expected to be negatively related to market returns either through the inflationary or discount factor effect. However, the continued use of interest rates may be attributed to the absence of active secondary markets for bond issues and government paper in many emerging markets (Bilson et al., 2001). The interest rate is calculated as natural logarithms of three month T-bill rate at month t.

Exchange Rate

In recent year, all businesses are directly and indirectly affected by international activities as a result of globalization. In other words, exchange rate changes may affect the competitive position of companies and hence industries operations. As a result, cost of goods and services, sales and cash flows may change with changes in exchange rate. Ozcam (1997) and Altay (2003) revealed that exchange rates influence stock returns. In Ghana the cedi-dollar exchange rate is important in assessing the stock market because, being the major international trading currency, any hike is translated in the cost of importing raw material, and other imports. Since Ghana's economy is also import-demand driven, changes in the exchange rate affects most sectors of the economy as well as the pricing of goods and cost of production. The exchange rate therefore affects business cash flow and profitability. Investors may also evaluate this as an important risk factor. According to Pebbles and Wilson (1996), an appreciating currency is generally accompanied by increases in reserves, money supply and a decline in interest rates. The resulting decline in cost of capital and/or imported inputs is expected to lead to an increase in local returns. Such an expectation is consistent with Bilson et al., (2001) conclusion that a devaluation of the domestic currency has a negative relationship with returns. The change in exchange rate is calculated as the natural logarithms of the exchange rate at month t.

GSE All Share Index

The study included the GSE All Share index to proxy the state of Ghana Stock Market. GSE All Share Index which is the broad market indicator of the stock market measures the overall performance of the stock market. This index is computed by the Ghana Stock Exchange. The GSE All share index is calculated as natural logarithms of GSE All share index at month t.

Crude Oil Price

Crude oil is an essential input for production and so the price of oil is included as a proxy for real economic activity. An increase in the price of oil in the international market means lower real economic activity in all sectors, which will cause stock returns to fall. The crude oil price is calculated as the natural logarithm of crude oil price at month t.

Descriptive Statistics

Table 2 presents the descriptive statistics for the macroeconomic variables. All variables exhibit a positive mean return except for exchange rate. Also the sum squared deviation row represents the net change over the sample period. It shows that the exchange rate declined by about 217%. In terms of skewness, GSE All share Index and crude oil prices have return distribution that are positively skewed. Consumer Price Index, exchange rate and 91 day Treasury bill rate exhibit a negative skewness which implies that they have a long left tail. All the variables are relatively normally distributed as indicated by the p values of Jarque Bera statistic.

The relationship to be investigated between stock market returns and macroeconomic variables is specified in equation (1) below.

$$In\ ASI_{it} = \beta_0 + \beta_{1t}\ In\ CPI_{it} + \beta_{2t}\ In\ EXR_{it} + \beta_{3t} InTBR_{it} + \beta_{4t}\ InCRO_{it} + \varepsilon_{it} \quad (1)$$

Where In is the natural logarithm, *ASI* is the GSE All share Index (return on stock portfolio i), *CPI* is the change in consumer price index, TBR_t is 91-day Treasury bill rate, EXR_t is the nominal exchange rate, CRO_t is the international crude oil price, β_0 is

Statistic	Variables				
	LASI	LCPI	LCRO	LEXR	LTBR
Mean	6.903504	4.07489	3.329112	-1.0655	3.244853
Median	6.766509	4.155852	3.171364	-0.54988	3.360722
Maximum	9.295674	5.603828	4.940427	0.193382	3.869742
Minimum	4.108508	2.02792	2.347558	-3.24419	2.256541
Std. Dev.	1.45156	1.079273	0.597055	1.036062	0.500429
Skewness	0.111867	-0.38563	0.806761	-0.54516	-0.61132
Kurtosis	2.072223	1.938091	2.654122	1.911149	2.246309
Jarque-Bera	7.742022	14.6411	23.1462	20.18243	17.53475
Probability	0.020837	0.000662	0.000009	0.000041	0.000156
Sum Sq. Dev.	427.7265	236.4605	72.36435	217.905	50.83712
Observations	204	204	204	204	204

Table 2: Descriptive Statistics of the variables.

the intercept of the regression and is the constant term representing risk free rate, β_1, β_2, β_3, β_4 are the coefficient of variables, ε_t is the error term. The procedure followed in this study is as follows. First, four macroeconomic variables were selected and the GSE All share Index and their monthly logarithmic returns over the period of study are computed. Descriptive statistics for the variables are derived after which the stationarity of the variables are checked using the Augmented Dickey Fuller test. Finally, Error Correction Modeling and Johansen Cointegration analysis are performed using EVIEWS Statistical package.

Results and discussion

ADF test indicates that the series are not stationary at levels but stationary at first differences. The fact that the series are stationary at first difference requires the use of Cointegration and Vector Error Correction Modeling (Johansen and Juselius, 1990, 1992).

Stationarity of the Time Series - Unit root tests

In empirical analysis using time series data it is important that the presence or absence of unit root is established. It is necessary to consider the nature of the processes that generate the time series data variables. This is because contemporary econometrics has indicated that regression analysis using time series data variables with unit root produce spurious regression results. As a requirement for cointegration analysis the data was tested for series stationarity and to determine the order of integration of the individual variables. For cointegration analysis to be valid all series must be integrated of the same order usually of order one (Townsend, 2001).

All data series were found to be non-stationary at levels and stationary after first differencing. LCRO and LEXC were stationary at first difference with linear trend. The results of the unit root tests are presented in Tables 3 and 4 below.

The results in table 4 reveal that the time series variables are integrated of order one. The next step in the process of analysis is to determine the existence or otherwise of cointegration in the series. This is to establish the existence of valid long-run relationships between variables.

The Johansen approach cointegration test (Johansen and Juselius, 1990, 1992) is based on the following vector autoregressive model:

$$Zt = A_tZ_{t-1} + \ldots + A_kZ_{t-k} + \mu_t \qquad (2)$$

Where Z_t is an (n×1) vector of I(1) variables (containing both endogenous and exogenous variables), A_t is (n×n) matrix of parameters and μ_t is (n×1) vector of white noise errors.

First, the Vector Error Correction Model (VECM) procedure using the Johansen method involves defining an unrestricted Vector Autoregression (VAR) using the equation above.

Likelihood Ratio (LR) tests were conducted with maximum of one lag due to the short time series.

Series	ADF test statistic	Mackinnon critical value	Lag-length	p-value	Conclusion
LASI	-0.839969	-3.584743	3	0.7978	Non-stationary
LCPI	-1.923455	0.3190	3	0.3190	Non-stationary
LCRO	3.180390	-4.004425	3	1.0000	Non-stationary
LEXC	4.747315	-4.057910	3	1.0000	Non-stationary
TBR	-2.125304	-3.581152	3	0.2360	Non-stationary

Table 3: Unit root test results at levels.

Series	ADF test statistic	Mackinnon critical value	Lag-length	p-value	Conclusion
LASI	-10.61638	-3.584743	3	0.0000	I(1)
LCPI	-8.614832	-3.581152	3	0.0000	I(1)
LCRO	-4.800080	-6.320195	3	0.0010	I(1)
LEXC	-7.817471	-4.886426	3	0.0002	I(1)
TBR	-5.442783	-3.584743	3	0.0000	I(1)

Table 4: Unit root test results at first difference.

The results for the co-integration test imply that the trace test and the maximum eigen value test selects the presence of one co-integrating vector. Thus, it can be concluded that the variables in the model are have a long run equilibrium relationship, with one co-integrating vector. The Johansen model is a form of Error Correction Model. When only one co-integrating vector is established its parameters can be interpreted as estimates of long run co-integrating relationship between the variables (Hallam and Zanoli, 1993). This implies that the estimated parameter values from this equation when normalised on the stock returns are the long run elasticities for the model. Eviews automatically produces the normalised estimates. These coefficients represent estimates of elasticities LASI with respect to LCPI, LCRO, LEXC, and TBR variables. The normalised equation is presented as follows;

$$LASI = 0.054786LCPI - 0.030205LCRO + 0.052131LEXC + 0.003219TBR - 21211.96 \quad (3)$$

If cointegration is established among the variables, then the ECM framework is the ideal basis for stock market returns analysis because it provides information about the speed of adjustment to long-run equilibrium and avoids the spurious regression problem (Engle and Granger, 1987). We can then estimate the short run elasticities as follows.

$$\Delta LASI = \delta 0 + \sum_{1}^{3}\delta_{1i}\ LCPI + \sum_{1}^{3}\delta_{2i}\ LCRO + \sum_{1}^{3}\delta_{4i}\ LEXC + TBR - \alpha ECi\text{-}1 \quad (4)$$

Where $\alpha EC_{i-1} = \alpha(LASI_{t-1} - \beta_1 LCPI_{t-1} + \beta_2 LCRO_{t-1} + \beta_3 LEXC_{t-1} + \beta_4 TBR_{t-1})$

In equation (4), the right hand side difference terms are lagged. The $\delta_{i's}$ explain the short-run effect on the dependent variable of changes in the explanatory variables. The $\beta_{i's}$ represent the long-run equilibrium effects. αEC_{i-1} is the error correction term and correspond to the residuals of the long-run cointegration. The negative sign on the error correction term indicates that adjustments are made towards restoring long run equilibrium. This method provides estimates for the short-run elasticities, that is the coefficients of the difference terms whereas the parameters from the Johansen cointegration are the estimates of the long run elasticities (e.g., Townsend and Thirtle, 1994).

Short run relationships between stock market returns and macroeconomic variables

In the short run, Treasury Bill Rate significantly influences the stock returns, with and an elasticity of 0.005.This means that a 1 % rise in the Treasury

Variable	Coefficient	Standard error	t-statistic	p -value
ΔLASI(-1)	0.037984	0.096488	0.393660	0.7139
ΔLCPI(-1)	**-0.135744**	**0.017208**	**-7.888581**	**0.0014**
ΔLCRO(-1)	0.000188	0.001048	0.179345	0.8664
ΔLEXC(-1)	0.001497	0.000800	1.870480	0.1348
ΔLTBR(-1)	**0.005418**	**0.001943**	**2.788024**	**0.0494**
Residual	**0.785548**	**0.079719**	**9.853991**	**0.0006**
C	**991.4737**	**321.0339**	**3.088376**	**0.0366**
R-Squared	0.988			
Adjusted R-Squared	0.961			
F-statistic	35.34186			
Prob(F-statistic)	0.001823			

Table 5: Error Correction Model estimates for the effect of macroeconomic variables on stock returns.

bill rate will lead to a 0.005 % rise in the stock returns. This result implies that investors do not view Treasury bill with the associated interest rates as alternative investment opportunities. Thus, increases in Treasury bill rates leads to increased investment in stocks causing stock returns to rise. This result is somewhat consistent with Engsted and Tanggaard (2002).

The inflation rate is also significant at 1% with elasticity -0.135744, implying that a 1% increase in inflation rate will decrease stock returns by 0.14 %. The negative relation implies investors are not compensated for inflationary increases in the short run. This result is somewhat consistent with Bulmash and Trivoli (1991), Chatrath et al., (1997), Zhao (1999), Omran and Pointon (2001).

The residual value of 0.785548 indicates that about 79 % of the deviations of the stock returns are corrected in the short run. This percentage of error correction in the short run is quite high and encouraging for an emerging market like the Ghana Stock Exchange.

The Adjusted R-squared value of 0.961 implies that about 96 % of the variations in the stock returns are explained by variations in the macroeconomic variables. Further, the F-statistic value of 35.34 (with a p-value of 0.001823) indicates that the macroeconomic variables jointly and significantly affect the stock returns.

Long run relationships between stock market returns and macroeconomic variables

In the long run, the stock returns are significantly influenced by Inflation rate, Crude oil prices, Exchange rate, and Treasury bill rate, with elasticities of 0.5479, -0.03021, 0.05213, and 0.00322 respectively.

A 1 % increase in inflation increases stock returns by 0.54 %. The positive relationship between inflation and stock returns is consistent with Choudhry (2000); Mohammed et al., (2007) 2007); Owusu - Nantwi and Kuwornu (2011). The positive relation implies investors are compensated for inflationary increases. The rationale for this pattern is related to the inadequacy of hedging role of stock against inflation. This rationale would be suggested for the Ghana stocks. That is, Ghana stocks cannot be used as a hedge against inflation, since the positive coefficient implies a higher expected return is required for higher inflation rate. However, this result is not consistent with the bulk of empirical evidence (e.g., Chatrath et al., (1997), Zhao (1999), Omran and Pointon (2001)) that inflation rate negatively affects stock returns. The reason given by the authors is the active role of government in preventing price escalation after the economy continued to progress after the 1997 financial crises.

Crude oil price is negatively related to stock returns. A 1 % rise in Crude oil prices will decrease returns by 0.03 %. This result is consistent with Gazi and Hisham (2010), which is not surprising since Ghana is a net importer of oil. For oil importing countries, oil price is hypothesized to impact stock returns negatively. In this respect, increases in oil prices would cause a rise in production costs and a subsequent fall in aggregate economic activity. This would ultimately cause lower stock returns.

A 1% rise in exchange rate increases returns by 0.052%, which is consistent with Mukherjee and Naka (1995). In Ghana, the effect of exchange rate on the volume of exports appears to be positive

(i.e., appreciation of the exchange rate encourages exports, via increased economic activity of firms). Thus, a positive relationship is observed between stock returns and exchange rate. The appreciation of a country's currency lowers the cost of imported goods, which in most cases constitute a large part of production inputs for emerging market countries. According to Pebbles and Wilson (1996), an appreciating currency is generally accompanied by increases in reserves, money supply and a decline in interest rates. The resulting decline in cost of capital and/or imported inputs is expected to lead to increases in economic activities and hence stock returns. This result is consistent with Bilson et al., (2001) conclusion that a devaluation of the domestic currency has a negative relationship with returns. Soenen and Hernigar (1988) also using monthly data, report a strong negative relation between US stock indexes and fifteen currency weighted value of the dollar for the period 1980-1986.

The effect of Treasury bill rate, though positive, is highly inelastic with elasticity of 0.003. This result is somewhat consistent with Engsted and Tanggaard (2002). However, a negative relationship between Treasury bill rate (i.e., interest rate) and stock market returns is expected for the Ghanaian stock market. In Ghana, Treasury bill with the associated interest rates represents alternative investment opportunities. As the interest rate rises, investors tend to invest less in stocks causing stock prices to fall. When Treasury bill rate is high, rational investors tend to invest in less risky asset with high returns and vice versa. This was the case in Ghana between 1995 and 1999. This affected the performance of the Ghana Stock Exchange.

Conclusions

This paper investigates the effects of macroeconomic variables on the stock market returns in Ghana using Johansen Multivariate Cointegration Analysis, and monthly data over the period January 1992 to December, 2008. Macroeconomic variables used in this study are consumer price index (as a proxy for inflation), exchange rate, crude oil price, 91 day Treasury bill rate (as a proxy for interest rate) and Ghana Stock Exchange (GSE) All share index.

The results reveal that; *in the short run*, stock return is significantly influenced by Treasury Bill Rate and Inflation rate. The positive relation implies investors are compensated for inflationary increases. The rationale for this pattern is related to the inadequacy of hedging role of stock against inflation. This rationale would be suggested for the Ghana stocks. That is, Ghana stocks cannot be used as a hedge against inflation, since the positive coefficient implies a higher expected return is required for higher inflation rate.

Treasury bill rate significantly influences the stock returns, with and an elasticity of 0.005.This means that a 1 % rise in the Treasury bill rate will lead to a 0.005 % rise in the stock returns. A negative relationship between Treasury bill rate (i.e., interest rate) and stock market returns is expected for the Ghanaian stock market. In Ghana, interest rates represent alternative investment opportunities. As the interest rate rises, investors tend to invest less in stocks causing stock prices to fall. When Treasury bill rate is high, rational investors tend to invest in less risky asset with high returns and vice versa.

The inflation rate is also significant at 1 % with elasticity -0.135744, implying that a 1 % increase in inflation rate will decrease stock returns by 0.14 %. The negative relation implies investors are not compensated for inflationary increases in the short run.

The residual value of 0.785548 of the Error Correction Model indicates that about 79 % of the deviations of the stock returns are corrected in the short run. This percentage of error correction in the short run is quite high and encouraging for an emerging market like the Ghana Stock Exchange.

The Adjusted R-squared value of 0.961 implies that about 96 % of the variations in the stock returns are explained by variations in the macroeconomic variables. Further, the F-statistic value of 35.34 (with a p-value of 0.001823) indicates that the macroeconomic variables jointly and significantly affect the stock returns.

In the long run, the stock returns are significantly influenced by Inflation rate, Crude oil prices, Exchange rate, and Treasury bill rate, with elasticities of 0.5479, -0.03021, 0.05213, and 0.00322 respectively.

Inflation rate is positively related to stock return. A 1 % increase in inflation increases stock returns by 0.54 %. The positive relation implies investors are compensated for inflationary increases in the short run.

Crude oil price is negatively related to stock return. A 1 % rise in Crude oil prices will decrease returns by 0.03 %. This result is not surprising because Ghana is a net importer of oil. For oil importing countries, oil price is hypothesized to impact stock returns negatively. In this respect, increases in oil prices would cause a rise in production costs and a subsequent fall in aggregate economic activity. This would ultimately cause lower stock returns.

A 1 % rise in exchange rate increases returns by

0.052 %. In Ghana, the effect of exchange rate on the volume of exports appears to be positive (i.e., appreciation of the exchange rate encourages exports, via increased economic activity of firms). Thus, a positive relationship is observed between stock returns and exchange rate. The appreciation of a country's currency lowers the cost of imported goods, which in most cases constitute a large part of production inputs for emerging market countries. This is expected to lead to increases in economic activities and hence stock returns.

The effect of Treasury bill rate, though positive, is highly inelastic with elasticity of 0.003. This result implies that investors do not view Treasury bill with the associated interest rates as alternative investment opportunities. Thus, increases in Treasury bill rates leads to increased investment in stocks causing stock returns to rise.

In both *the short run and the long run* results, inflation rate appears to be the most influential macroeconomic variable affecting stock market returns in Ghana. The results also reveal that investors are not compensated for inflationary increases in the short run, but are compensated in the long run.

The empirical results in this study have implications for financial analysts, fund managers, and policy makers.

This paper makes an empirical contribution to the ongoing debate on the effect of macroeconomic variables on stock market returns.

In view of the findings from the study, the following recommendations are provided:

Returns from investment in Ghana Stock Exchange (GSE) should be made more attractive than the rate of return from Treasury bill. This is so because investors are supposed to view treasury bills as alternative assets to stocks and would switch to the Treasury bill if the rate of returns from the Ghana Stock Exchange is lower. This requires instituting prudent measures that will bring about cost minimization and increase productivity for the listed companies. Once operational expenses are less, all other things being equal, more in terms of returns on equity can be given to the shareholders.

The listed firms should strive to make their stocks attractive to investors as the firms stocks seem to be a good hedge over a long period for investors. This means the firms should undertake projects that are viable to boost their performance over time, as investors are motivated to invest in companies with good financial performance. Once it is realized by investors that listed firms have a superior performance coupled with the fact that returns on their shares increases as inflation goes up, the shares may be preferred assets when investors have to hedge against the risk of inflation.

The effect of macroeconomic variables on stock market returns has attracted much attention in developed and emerging economies due to their implications in the financial markets. Investors may use this study as a guide in forecasting stock market viability and to decide whether it is worthwhile to invest in it.

At the policy level, this study may provide some insights on how the formulation and implementation of appropriate monetary and fiscal policies could help to stabilize the financial market. Furthermore, financial sector reform and the institution of a regulatory regime for the listed companies and the Ghana Stock Exchange will also be important.

Finally, although a rich set of macroeconomic variables are used in this study; the macroeconomic variable set employed is not exhaustive. Some other macroeconomic variables would provide more information about the stock returns - economic activity relationship.

Corresponding authors:
John K. M. Kuwornu
Department of Agricultural Economics and Agribusiness, P. O. Box LG 68,
University of Ghana, Legon, Accra, Ghana
E-mail: jkuwornu@ug.edu.gh Tel: +233 245 131 807

References

[1] Abdullah D. A. and Hayworth, S. C. Macroeconometrics of Stock Price Fluctuations. Journal of Business and Economics, 1983, 32 (1), 49-63.

[2] Abugri, B. A. Empirical Relationship between Macroeconomic Volatility and Stock Returns: Evidence from Latin American markets. International Review of Financial Analysis, 2008, 17, 396–410.

[3] Aggarwal, R. Exchange Rate and Stock Prices. A Study of US Capital Markets Under Floating Exchange Rates, Akron Business and Economic Review, 1981, 12(2), 7-12.

[4] Al- Jafari, M. K., Salameh, R. N., and Habbash, M. R., Investigating the Relationship between Stock Market Returns and Macroeconomic variables: Evidence from Developed and Emerging Markets, International Research Journal of Finance and Economics, 2011, 79, 6-30.

[5] Altay, E. The Effect of Macroeconomic Factors on Asset Returns: A Comparative Analysis of the German and the Turkish Stock Markets in an APT Framework, Martin-Luther-Universität Halle, Betriebswirtschaftliche Diskussionsbeiträge, 2003, Nr. 48/2003.

[6] Anokye, M. A. and Tweneboah, G. MPRA Paper No. 11256: Macroeconomic Factors and Stock Market Movement: Evidence from Ghana. Munich: Munich Personal RePEc Archives, 2008

[7] Beenstock, M. and Chan, K.F. Economic Forces in London Stock Market, Oxford Bulletin of Economics and Statistics, 1988, vol.50, 22-39.

[8] Bilson, C. M., Brailsford, T. J., and Hooper, V. J. Selecting Macroeconomic Variables as Explanatory Factors of Emerging Stock Market Returns, Pacific-Basin Finance Journal, 2001, 9(4), 401–426.

[9] Bulmash, S.B., and Trivoli, G.W. Time-lagged Interactions between Stock Prices and Selected Economic Variables. Journal of Portfolio Management. 1991, 17 (4), 61– 67.

[10] Chen, N. F., Roll, R, and Ross, S. A. Economic Forces and Stock Market. Journal of Business, 1986, 59, 383−404.

[11] Choudhry, T. Inflation and Rates of Return on stocks: Evidence from high inflation countries. Journal of International Financial Markets, Institutions, and Money, 2000, 11, 75–96.

[12] Engle R. F., and Granger C. W. J. Cointegration and error correction: representation, estimation and testing, Econometrica, 1987, 55, 251–276.

[13] Engsted, T., and Tanggaard, C. The Relation between Asset Returns and Inflation at Short and Long Horizons. Journal of International Financial Markets, Institutions & Money, 2002, 12, 101–118.

[14] Fama, E. F. Stock Returns, Real Activity, Inflation and Money. American Economic Review, 1981, 71 (4), 545−565.

[15] French, Kenneth R., Schwert, G., W. and Stambaugh, R., F. Expected Stock Returns and Variance. Journal of Financial Economics, 1987, 19, 3-29.

[16] Fifield, S. G. M., Power, D. M. and Sinclair, C. D. Macroeconomic Factors and Share Returns: An Analysis using Emerging Market Data. International Journal of Finance and Economics, 2002, 33 (1), 51-62.

[17] Fisher, I. The Rate of Interest, Macmillan, New York, 1930

[18] Gazi, M. H., and Hisham, A. Can Macroeconomic Factors Explain Equity Returns in the Long Run? The Case of Jordan. Draft 4-15/05/2010. School of Economics and Finance, University of Western Sydney, Australia, 2010

[19] Ghana Statistical Service Monthly Report, January, 1992 – December 2008.

[20] Ghana Stock Exchange Monthly Report, January 1992 – December, 2009.

[21] GIPC (December, 2007). Sector Profile of Ghana's Financial Service Industry. Accra, Ghana: Ghana Investment Promotion Center.

[22] Hallam, D., and Zanoli, R. Error Correction Models and Agricultural Supply Response, European Review of Agricultural Economics, 1993, 20, 151-166.

[23] Hosseini, S. M., Ahmad, Z., and Lai, Y. W., The Role of Macroeconomic variables on stock market index in China and India, International Journal of Economics and Finance, 2011, 3 (6), 233-243.

[24] Johansen, S. and Juselius, K. Testing Structural Hypotheses in Multivariate Cointegration Analysis of the PPP and UIP for UK. Journal of Econometrics, 1992, 53: 211 – 244.

[25] Johansen, S. and Juselius, K. Maximum Likelihood and Inference on Cointegration With Applications to the Demand for Money. Oxford Bulletin of Economics and Statistics, 1990, 52: 169 – 210.

[26] Kuwornu, J. K. M., and Owusu - Nantwi, V. Macroeconomic Variables and Stock Market Returns: Full Information Maximum Likelihood Estimation. Research Journal in Finance and Accounting, 2011, 2 (4), 49 - 63.

[27] Maysami, R.C., Howe, L.C., and Hamzah, M.A. Relationship between Macroeconomic Variables and Stock Market Indices: Cointegration Evidence from Stock Exchange of Singapore's All-S sector Indices. Jurnal Pengurusan, 2004, 24, 47-77.

[28] Mishra, S. and Singh H., Do macro-economic variables explain stock market returns? Evidence using a semi-parametric approach, 2010, Journal of Asset Management, 13 (2), 115-127.

[29] Mohammed, A. M. T., Wisam R., Hassama A, and Bin Amin F. M. Effects Of Macroeconomic Variables on Stock Prices In Malaysia: An Approach Of Error Correction Model International Islamic University Malaysia, Jalan Gombak-53100, Kuala Lumpur, Malaysia, 2007

[30] Mukherjee, T. K. and Naka, A. Dynamic Relations between Macroeconomic Variables and the Japanese Stock Market: An Application of vector error correction model. The Journal of Financial Research, 1995, 18(2), 223-237.

[31] Owusu-Nantvi, V., and Kuwornu, J. K. M. Analysing the Effect of Macroeconomic Variables on Stock Market Returns: Evidence from Ghana. Journal of Economics and International Finance, 2012, 3 (11), 605 - 615.

[32] Ozcam, M. An Analysis of the Macroeconomic Factors That Determine Stock Return in Turkey, Capital Market Board of Turkey, 1997, Publication Number 75.

[33] Pebbles, G., and Wilson, P. The Singapore Economy. Cheltenham, UK: Edward Elgar, 1996

[34] Singh, T., Mehta, S., and Varsha M. S., Macroeconomic factors and stock returns: Evidence from Taiwan, Journal of Economics and International Finance, 2 (4), 217 - 227.

[35] Solnik, B. Using Financial Prices to Test Exchange Rate Models: A Note, Journal of Finance, 1987, 42, 141-149.

[36] Ushad, S. A., Fowdar, S., Sannassee, R. V., and Jowaheer, M. Return Distributions: Evidence from Emerging African Stock Exchanges, The Icfai University Journal of Financial Economics, 2008, 6(3), 41-52.

Agris on-line Papers in Economics and Informatics

Volume IV Number 2, 2012

Agricultural Resource Access and the Influence of Socioeconomic Characteristics Among Rural Women in Borno State, Nigeria

C. O. Ojo, C., Y. Bila, A. C. Iheanacho

Department of Agricultural Economics, Faculty of Agriculture, University of Maiduguri, Nigeria

Abstract

Agricultural resource access and the influence of socioeconomic characteristics among women in Borno State, Nigeria was the main objective of this study. The data for the study were generated by the use of structured questionnaire which was administered to 266 respondents obtained by the use of multistage random sampling technique. The techniques used to analyze the data generated for this study were descriptive statistics and the binary logistic regression analyses. The major findings of the study showed that respondent's socioeconomic characteristics indicated high levels of illiteracy (59.4%), non-membership of cooperatives (89.8%), no extension contact (72%) and low access to credit (89.4%). Access to production resources including fertilizers, agrochemicals, family and hired laours and land ownership were low. Some socio-economic factors influenced the likelihood of women's access to production resources. These factors included cooperative membership, years of schooling, farm income, extension contact, off-farm income, family size, age, farming experience and farm size. It was recommended that agricultural development planners should work at enhancing rural women's access to socioeconomic factors which enhance their access to production resources for more efficient agricultural productivity.

Key words

Access, agriculture, Borno State, production resources, rural area, socioeconomic characteristics, women.

Introduction

The food security and agricultural development of Nigeria lies in the hands of subsistence farmers in an extensive agricultural system. Particularly striking is the fact that rural women more than their male counterparts take the lead in agricultural activities making up to 60 – 80 percent of the agricultural labour force in the country (World Bank, 2003; Mahmood, 2001) depending on the region. They also provide two thirds of the food crop (Ogunlela and Muktar, 2009). Despite women's significant contribution to Nigeria's agricultural production, women's productivity is often constrained by a lack of access to productive resources (World Bank, 2001, Odame et al., 2002 and Welch et al., 2000). Empirical studies have shown that the deprivation women face in terms of agricultural production resource access is influenced by the socioeconomic characteristics of women. These socioeconomic characters include women's level of education and credit access (Okunade, 2007), access to extension information and cooperatives (Ogato et al., 2009), farming experience, and decision making powers (Damisa and Yohanna, 2007)). The study of Ogato (2009) found that socioeconomic factors of respondents in that study affected women's ability to access resources.

The socioeconomic characteristics of respondents are important determinants of women's accessibility to production resources. In most developing countries, there is a patriarchal system of social setting where men hold the sovereign power to control households and society as a whole, while women are ascribed a lower hierarchy compared to men (Balk, 1997). The likelihood that such a system will affect women's access to socioeconomic factors has implications for women's access to agricultural production resources. This study is an attempt to investigate the effect of women's socioeconomic characteristics on women's access to production resources in Borno State, Nigeria.

The main objective of this study was agricultural resource access and the influence of socioeconomic characteristics among women in Borno State, Nigeria.

Literature Review

Okunade (2007) in a study on accessibility of agricultural credit and input to women farmers in Osun State noted that the multiple regression analysis in the study showed a positive and significant relationship between level of education and accessibility to credit and other inputs. He also showed from the study that women's access to factors of production tended to increase with increase in age and income. As is commonly the case, most women with little or no education were landless. They were thus hindered from properly pursuing access to other farm resources. Bantilan and Padmaya (2008) carried out a focus group study on "Empowerment through social capital build-up: Gender dimensions in technology up-take". The study was conducted among women in Umra and it was found that access to membership of women groups like cooperatives and other social networks tended to improve women's skills in agriculture. This finding had a bearing with the findings of Onemolease (2002) titled Extension Needs of women Cassava farmers in Iguebe and Esan North East Local Government Area of Edo State, Nigeria. In the study, access to skill in application of agrochemicals was low among women cassava farmers because the women did not belong to cooperatives. The result was the reduction of women's production efficiency. A similar study titled "Impacts of the women-In-Agriculture (WIA) extension programme on women's lives" was carried out by Odurukwe et al. (2006) in Imo State. Using descriptive statistics, it was found that women's membership of groups enhanced their access to decision making powers, and farm inputs. The implication of the foregoing is that the socioeconomic status of women is important in determining women's accessibility to agricultural production resources. Some of these socioeconomic factors observer in literature included marital status; credit and education. Others were age, decision making powers, finance and membership of cooperatives and other social networks.

Methodology

This study was conducted in Borno State, Nigeria. Multistage sampling technique was used to select 266 respondents for the study while primary data was sourced by the use of structured questionnaire and/interview schedule that was administered by trained enumerators. Descriptive statistics (The Likert scale) and logit regression model were the analytical tools used. In the Likert scale, zero mean represented "no access"; 1 represented "low access"; 2, "medium access" and 3, "high access". The scale was used to create a rank order of level of access among the resources from the least to the highest access. This was achieved by calculating the mean access and the coefficient of variation (CV) and comparing the mean values with the specified scale.

Results and discussion

The socioeconomic characteristics of respondents in the study area as presented in Table 1 revealed that 72% had no extension contact; almost 90% were none - membership of cooperatives, farm income was less than 30, 000 naira per annum for over 60% of respondents while almost 90% did not receive credit for their agricultural activities. Illiteracy was reported by almost 60% of respondents. The result also showed that most respondents (almost 60%) had family sizes of 1 – 10 people while 77% had many years of farming experience (over 10 years) indicating that they were well experienced farmers. Over 80% of respondents were aged between 25 and 48 years implying that majority of the respondents were relatively young and agile for farm work. In this study, access to resources is understood to mean the ability of a rural farmer to get sixteen socioeconomic resources and accrue benefits from them. These resources include production resources such as land, family labour, hired labour, mechanization, fertilizer, pesticide, improved seeds and membership of cooperatives Data contained in Table 2 showed the extent of women's access to these resources in the study area using the Likert scale. The rank order from the Likert scale showed that respondents had better access to some resources in comparison to others.

The better accessed resources were farm land (mean score: 1.32) and hired labour (mean score: 1.03) which according to the Likert scale indicated low access to own land and hired labour. Respondents' accesses to other resources were very limited (less than 1). On the basis of the rank order, these resources were family labour (mean score: 0.94), improved seeds (0.67), fertilizer (mean score: 0.67), Mechanization (0.59) and agrochemicals (mean score: 0.47). The result showed therefore that respondents' access to farm production resources were low. Generally, the inverse relationship between the mean access and CV was

Factors	Percentage	Factors	Percentage
Membership of Cooperatives		**Family size**	
		1-5	16.5
Non member	89.8	6-10	42.5
Member	10.2	11-15	27.8
Highest level of schooling completed		16-20	11.3
No formal schooling	59.4	21-25	0.4
primary	19.9	**Farm income/annum(₦ '000)**	
secondary	12.0	<10	7.9
tertiary	8.7	10-29	56.4
Extension Contact		30-49	17.6
No contact	72.5	50-69	13.8
1-4	12.0	≥70	4.3
5-8	6.8	**Off farm income/annum(₦ '000)**	
9-12	7.9	1-50	13.6
>12	0.8	51-100	21.4
Farming experience (years)		101-150	9.0
1-10	22.6	151-200	5.6
11-20	59.5	201-250	4.1
21-30	12.7	251-300	0.8
31-40	3.7	301-350	2.3
>40	1.5	>350	0.4
Age			
<25	3.4	**Credit (₦ '000)**	
25-36	38.0	no credit	89.4
37-48	41.7	1-10	1.5
49-60	13.9	11-20	5.6
>60	3.0	>20	3.5

Source: Field Survey, 2010

Table 1: Social factors of respondent farmers in the study area.

Resources	Frequently	Occasinally	Rarely	Not at all	*Mean	CV	SD	Rank by mean values
Farm Land	4.5	38.5	41.0	15.0	1.32	60	0.791	1
Hired Labor	6.0	30.9	23.4	39.6	1.03	95	0.974	2
Family labor	3.8	29.4	20.8	46.1	0.94	114	1.974	3
Seeds	2.3	15.5	29.4	52.8	0.67	122	0.818	4
Fertilizer	1.9	10.6	37.0	50.6	0.64	117	0.749	5
Mechaniza-tion	1.5	12.5	29.8	56.2	0.59	129	0.764	6
Insecticide	1.7	12.6	16.6	69.5	0.47	166	0.777	7

Source: Field Survey, 2010

Table 2: Respondents' access to productive resources in the study area (n = 266).

consistent. This outlook revealed a situation where the dichotomy between the percentage of those who had access and others who had little or no access to resources continued to increase as the mean access to resources decreased among the respondents. In this study, the percentage of those who had access to resources kept falling while those without access were increasing as mean was decreasing down the ranks. The least accessed resource in the study was agrochemicals while land was the most accessible. These resources directly affect agricultural output. The observed nature of access to resources in the study area has serious implications for agricultural productivity.

In Table 3, five binary logistic regression estimates were used to determine the likelihood effect of socioeconomic characteristics of respondents on access to five specified resources (fertilizer, agrochemicals, family labour, hired labour and land ownership). The result on Table 3 is a summary of the socioeconomic characteristics of respondents that significantly affected respondents' access to the specified resources. Years in school and membership of cooperatives by respondents had significant influence on the likelihood of having access to fertilizer. Years in school increased the likelihood of access to fertilizer, while membership of cooperatives reduced the likelihood of access to fertilizer.

The decrease in likelihood of accessing fertilizer by membership of cooperatives was unexpected and may be an indication that the cooperatives to which respondents belonged were ineffective in encouraging input access. The β (exp) indicated that increasing respondents' years of schooling by 1% would result in an increase of the likelihood of accessing fertilizer among women by 1.12%. On the other hand, increasing membership of Cooperatives by 1% will bring about 0.072% decrease in likelihood of accessing fertilizer among respondents. This implies that years in school had a positive effect on women's access to fertilizer in the study area. The result implies that high level of illiteracy among respondents in the study area is a hindrance to respondents' access to fertilizer and by implication, a hindrance to respondents' agricultural productivity.

Extension contact, years in school, farm income and membership of cooperatives showed significant influence on the likelihood of accessing agrochemicals among respondents. Extension

Farm input Resources	Socioeconomic resources	β	S.E.	wald	significance*	β(Exp)
Fertilizer	years of schooling	0.111	0.032	11.996	0.001	1.118
	Cooperative membership	-2.382	0.477	24.938	0.000	0.072
Agrochemicals	Extension contact	0.343	0.060	32.272	0.000	1.220
	Years of schooling	0.119	0.044	20.744	0.000	1.000
	Farm income	0.000	0.000	6.509	0.011	1.000
	Cooperative membership	-2.817	0.665	17.950	0.000	0.060
Family labour	Extension contact	0.136	0.045	9.130	0.003	1.106
	Off farm income	0.000	0.000	4.520	0.034	1.000
	Family size	0.138	0.034	16.113	0.000	0.078
Hired labour	years of schooling	0.109	0.030	13.394	0. 000	1.115
	Farm income	0.000	0.000	0.000	0.000	1.000
	Age	0.066	0.015	18.552	0.000	0.936
	Farming experience	0.054	0.023	5.486	0.019	1.055
	Farm size	0.123	0.071	3.149	0.030	1.131
Land ownership	Off farm income	0.000	0.000	7.138	0.006	1.000
	Age	0.042	0.016	6.909	0.009	1.043
	Cooperative membership	1.520	0.488	9.715	0.002	4.573
	Farm experience	-0.042	0.023	3.376	0.006	0.958
	Farm size	0.172	0.080	4.592	0.032	1.188

*variables
Source: Field Survey, 2010

Table3: Logistic regression of socioeconomic factors that affect respondents' access to resources.

contact, years in school, and farm income increased respondents' likelihood of accessing agrochemicals. On the other hand, membership of cooperatives decreased the likelihood of accessing agrochemicals. The β (exp) indicated that a 1% increase in the accessibility of these variables (extension contact, years of schooling, and farm income) increased the likelihood of accessing agrochemicals by respondents by 1.22%, 1.0%, and 1.0% respectively while membership of cooperatives decreased the likelihood by 0.006%. These variables however were generally very poorly accessible to the respondents in the study resulting in very low access to agrochemicals and hence, lowered agricultural productivity. This explains that agrochemicals application require technical skills such that extension contact and education are of great relevance if women are to use agrochemicals effectively. Since agrochemicals need to be purchased, the level of respondents' farm income is significant in determining their ability to access agrochemicals. Membership of cooperatives unexpectedly contributed to decreasing the likelihood of women's access to agrochemicals. Ordinarily, membership of cooperatives should expose women to the relevance, and means of accessing agrochemicals. A similar trend was observes in the likelihood of accessing fertilizer. This observation suggests that there may be poor organization and ineffectiveness of cooperatives in the area with regard to input acquisition and distribution. The significant socioeconomic variables that affected respondents' access to family labour were extension contact, off farm income and family size which all increased the likelihood of accessing family labour. A 1% increase in extension contact, farm income, and family size will increase the likelihood of using family labour by 1.11%, 1.00%, and 0.078% respectively. Extension contact introduces techniques to farming that sometimes require more intensive labour supply thus, requiring all available or idle family labour. In most cases, it is only when there is insufficient family labour that hired labour is used. This is because of the extra cost implication of using hired labour. Unexpectedly, off farm income was significant. This may be because off-farm income provides respondents with the means of providing incentives to family labour. Such incentives encourage the availability of family labour. Family size was also significant in determining women's access to family labour. The larger the family size, the more the people available to work on the farm. This however is limited by age of family member Table 4.1i p42 revealed that on the average, family size was ten people among the respondents in the study.

From the results on Table 3, years of schooling, farm income, age of the respondents, farming experience and farm size all increased the likelihood of respondents' access to hired labour. Hired labour increased by 1.12%, 1.00%, 0.94%, 1.06% and 1.1% respectively with 1% increment of years of schooling, farm income, age, farming experience and farm size respectively. Education tended to increase the likelihood of making agriculture a business, thus increasing the need for more efficient labour. If hired labour was to be used, in the absence of credit, off farm income enhanced farmers' enablement to pay for hired labour. As women grew older, they may need labour to make up for their waning strength when children were grown and gone from home. Farming experience also determined the extent to which respondents needed to access hired labour. Most experienced farmers knew at what stage of their farm operations hired labour was required for best output. Such farmers utilized hired labour effectively. Farm size was important in influencing the likelihood of accessing hired labour. As farm size increased, it became more difficult for the respondents alone or even the respondents and family labour alone to handle all the work on the farm, considering that farm work was often time bound. Farm income also significantly increased the likelihood of accessing hired labour because the more the farm income realizable from a production effort, the more the farmer is willing to invest in hired labour to ensure efficient labour utilization for maximum productivity and income. This is to ensure that the business could effectively pay for the hired labour. Access to these socioeconomic factors was limited in this study. The result is a reduction in farmer efficiency and output.

The model specification of the logit regression for the socioeconomic factors that affect respondents' access to own land indicated that off farm income, age, membership of cooperatives, and farm size significantly increased the likelihood of respondents owning their own farms. On the other hand, farming experience decreased the likelihood of owning farm land among the respondents. Data on Table 4.4 showed that a 1% increase in farm size, membership of cooperatives, age, and off farm income were likely to increase the likelihood of owning land by 1.19%, 4.57%, 1.04% and 1.0% as indicated by the β exp. Farming experience decreased the likelihood of owning land among respondents in the study area by 0.6%. This is because as respondents acquired more years of farming experience, with low access to education, extension, cooperatives and credit, the tendency to

resist change increases. This is likely to result in an unwillingness to aspire unto new ways of doing things like changing from being tenants to land lords. This reduces the likelihood of owning land.

Membership of cooperatives greatly increased the likelihood of owning land by respondents because awareness of the limitations of farm lands not owned by women is increased as respondents associate with other farmers. Furthermore, off farm income is an important income source to help respondents with the wherewithal to buy their own land. Most respondents who owned land did so through inheritance. Where women are faced with the problem of inadequate land, it often informs the need to purchase land. The very low membership of cooperatives by respondents in the study area, their relatively young ages, the relatively low involvement and earning from off- farm livelihood sources will likely discourage women owning farm lands of their own in the study. Findings in this section indicated that the socioeconomic characteristics of respondents tended to limit accessibility to farm inputs.

Conclusion and recommendation

This study revealed that socioeconomic characteristics of respondents significantly contributed to women farmers' access to production resources. The stronger these characteristics are, the higher the access to production resources among farmers. Given the generally weak socioeconomic characteristics of respondents in the study area, it is therefore pertinent for agricultural development planners to take into cognizance, the need to enhance rural women's short and long term access to socioeconomic factors like education, extension services, credit facilities and membership of cooperatives. This is vital for women in agriculture to obtain enhanced access to production resources for more efficient agricultural production.

Corresponding author:
Dr. Catherine Ohunene Ojo
University of Maiduguri, P.O. Box 1069, Borno State, Nigeria.,
Phone: +2348059217708, Email: nickatie2003@yahoo.com

References

[1] Balk, D. Change comes slowly for rural women in Bangladesh. Asia –Pacific population and policy, 1997. 41, 1 - 4.

[2] Bantilan, M.C.S., Padmaya, R. Empowerment through social capital build-up: Gender dimensions in technology up-take. Experimental. Agriculture, 2008. 44, 61 – 80.

[3] Damisa, M. A., Yohanna, M.. Role of rural women in farm management decision making process: ordered probit analysis. World Journal of Agricultural Sciences, 2007, 3, No. 4, 543 – 546.

[4] Mahmood, I.U. The role of women in agriculture and poverty alleviation. Lead paper. 34th annual Conference of agricultural society in Nigeria. Agriculture in poverty alleviation, 2001.

[5] Odame, H.H., Hefkin, N., Wesseler, G., Boto, I. Gender and agriculture In: the information society intervention Service for National Agricultural research, 2002, Briefing paper No. 55. The Hague, The Netherlands: ISNAR

[6] Odurukwe, S. N., Mathews–Njoku, E. C., Ejiogu , Okereke, N. Impacts of the women-In-Agriculture (WIA) extension programme on women's lives: Implication for subsistence agricultural production of women in Imo state. Livestock Research for Rural Development, 2006, 18 No.2, 18.

[7] Ogato, G.S., Boon, E.K., Subramani, J. Improving access to productive resources and agricultural services through gender empowerment:A case study of three rural communities in Ambo district,Ethiopia. Journal of Human Ecology, 2009. 27, No.2, 85 – 100.

[8] Ogunlela, Y.I., Mukhtar, A.A. Gender isues in Agriculture and Rural Development in Nigeria: The role of women. Humanity & social sciences Journal, 2009, 4 No. 1, 19 – 30.

[9] Okunade, E. O. Accessibility of Agricultural credit and inputs to women formers of Isoya Rural Development Project. Research Journal of Agricultural and Biological Sciences, 2007, 3, No.3. 138 – 142.

[10] Onemolease, E. Extension Needs of women Cassava farmers in Iguebe and Esan North east Local Government Area of Edo State, Nigeria. Africa Development, 2002, 27, No. 1 -- 2, 116 – 126.

[11] Welch, C. J. , Alemu, B., Msaki, T., Sengendo, M., Kigutha, H., Wolff AImproving household food security; USA, 2000, BASIS Management Entity. Retrieved from www.krepublishers.com

[12] World Bank Engendering development through gender equality in rights, resources and voice. Policy research report, 2001, Oxford University press.

[13] World Bank, Nigeria: Women in agriculture, in: sharing experiences –examples of participating approaches. The World Bank group. In: The World Bank participating source book, 2003, Washington D. C.

Agris on-line Papers in Economics and Informatics

Volume IV Number 2, 2012

Czech Republic as an Important Producer of Poppy Seed

P. Procházka, L. Smutka

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

Anotace

Mák setý (Papaver somniferum L.) je důležitou olejninou, jejíž pěstování má v Čechách dlouholetou tradici. Mák pěstovaný v České republice vykazuje dobrou kvalitu, a proto získává přednost před mákem produkovaným v jiných částech světa. Česká republika je tak hlavním světovým producentem makového semene a je i nositelem evropských a světových cen. Co se týče obchodu, ČR je rovněž hlavním obchodníkem s makovým semenem a to jak v Evropě, tak i ve světě. Mák je v ČR plodinou vykazující dlouhodobě vysoký podíl exportu na produkci, protože domácí spotřeba se pohybuje pouze mezi čtyřmi až pěti tisíci tunami. Významným odbytištěm našeho máku jsou evropské státy s obyvatelstvem slovanského původu nebo ovlivněné slovanskou kuchyní a zámořské země, kde žijí slovanští vystěhovalci. Článek poukazuje na postavení ČR jakožto významného činitele světového trhu s makovým semenem. Prostřednictvím analýz poskytuje údaje o postavení české produkce a obchodu ve světě. Analyzovány jsou vedle vývoje produkce a obchodu i některé další faktory ovlivňující ekonomiku v oblasti tržní produkce makového semena (ceny, hektarové plochy, výnosy, objem produkce, objem obchodu). Cílem je charakterizovat současné postavení české produkce a obchodu s makovým semenem ve světě.

Klíčová slova

Makové semeno, produkce, obchod, import, export, svět, trh, komparativní výhoda, kilogramové ceny.

Abstract

Poppy seed (Papaver somniferum l.) is an important oilseed, whose cultivation has a long tradition in the Czech Republic. Poppy seed grown in the Czech Republic has good quality and, therefore, is preferred to poppy seeds in other parts of the world. The objective of this paper is to characterize the current position of the Czech poppy seed production and foreign trade in the world. Czech Republic is the main world producer of poppy seed and price maker of the European and world prices. With regards to trade, the Czech Republic is also the main producer and seller both in Europe and in the world. The poppy seed crop grown in the Czech Republic is mainly produced for exports, because the domestic consumption consists of only between four and five thousand tons. Major export markets of Czech poppy seed are European countries with a population of Slavic origin or those influenced by Slavic cuisine. Another important markets are overseas countries, that were settled by Slavic immigrants. The paper stresses out the position of the Czech Republic as a major player in the world market with poppy seed. The paper provides analysis of the market position of the Czech production and Czech foreign trade participation. Development of production and trade, as well as some other factors affecting the poppy seed economy, are analyzed such as prices, hectarage, yields, volume of production and volume of trade.

This paper is part of a research project carried out by the authors within the grant no. 6046070906, funded by the Ministry of Education, Youth and Sports of the Czech Republic

Key words

Poppy seed, production, trade, import, export, world market, comparative advantage, kilogram prices.

Introduction

Papaver somniferum (poppy) is cultivated as an annual crop in countries such as China, India, Czech Republic or Turkey. Poppy is grown mainly for its content of opium and oil seed. The seeds are used almost exclusively for their oil (Nergiz and Ötles, 1994; Bozan and Temelli, 2003; Özcan, Atalay, 2006). Poppy seeds contain up to 50% oil and Indian cultivars have high levels of oleic and linoleic acids (Singh et al.1990). Singh et al.(1995) have indicated the potential for this crop as a source of linoleic acid. Poppy seed oil appears to be of good quality for human consumption since it is generally rich in polyunsaturated fatty acids (Baydar, Turgut, 1999; Luthra and Singh, 1989; Krzymanski and Jonsson, 1989; Bozan and Temelli, 2003; Özcan, Atalay, 2006).

In Europe, poppy seeds are mostly used for confectionary, similar to the use of sesame seeds and are used extensively in baking and sprinkling on rolls and bread. The seeds are a good source of energy. They are also the source of a drying-oil, used for the manufacturing of paints, varnishes, and soaps, and in foods and salad dressing. Oil cake is a good fodder for cattle (Guil et al.1998; Özcan, Atalay, 2006).

Poppy seed cultivation especially for foodstuff purposes has a long tradition in the Czech Republic (details about the production see table 1). Czech poppy seed is known especially for its cleanliness as the grain is not polluted by alkaloids. This pollution occurs in case of crop varieties with high content of morphine, which is not grown in the Czech conditions. Poppy seed crop in the Czech Republic (but also in other countries) is referred to as the source of the addictive substances, therefore the cultivation of poppy must necessarily to comply with the provisions of Act No. 167/1998 Sb.. Part of this law are provisions related to the reporting obligation of persons producing poppies on a surface greater than 100 m 2 and exporting or importing the seed. In this context, it is appropriate to stress out that in many countries of the world are administrative obstacles for the cultivation of the poppy so significant that the commercial production of the poppy is almost impossible. This is according to the authors advantageous for the Czech Republic and some other producers as it is a very significant competitive advantage.

Poppy seed plays, in particular for the excellent dietetic properties, an important role in human nutrition (bakery and confectionery). Given the content of certain major alkaloids (morphine, codeine, papaverine, etc.) poppy seed is an important raw material for the pharmaceutical industry. With regards to poppy seeds, the Czech Republic controls approximately 33% of the world production and about 28% of the value and about 44% of the volume of world trade with poppy seed. In recent years, the poppy seed area increased significantly, which is confirmed by the sow of poppy seed in the period 2008 on around 70 thousands hectares. In this context, however, it has to be noted that in the years 2009 and 2010 there has been a rapid reduction in production due to the very significant drop in prices, which is due to the current dominance of supply over demand both in the European and world markets. In 2010, sown areas were on the level of about 50 thousands hectares. However, it is appropriate to emphasize that this area is significantly higher in comparison with the areas from the 1990s. The reduction in the areas caused also a significant reduction in the production of poppy seed, which in 2010 was on 25 thousand tons (which means a significant reduction compared to its peak period of 2008). The cost of production per one hectare of poppy seed, depending on the intensity of cultivation, is about 20 000 CZK. The poppy seed has no special requirements on the environment. It can be successfully grown especially in the potato areas. However, it very sensitively responds to the imbalance and variations in soil, nutrition and weather.

The theoretical yield of poppy can be between 1.8 to 2.9 tons per hectare. The cost of poppy cultivation in the CR is relatively low. This is because the technology is based upon mass production, very similar to cereal cultivation technology. Mechanization has similar equipment, albeit with many changes for the poppy harvest, drying and separation and poppy seeds. For Czech farmers, as well as business organization it is a profitable commodity as poppy seed production is largely exported. High quality standard poppy seed, minimal damage to the seeds, the minimum content of impurities, uniform color, size of lots, sales culture, promotion of Czech production, but also relatively low price have enabled Czech farmers to massively penetrate foreign markets. Czech position on foreign markets has been also strengthened by crop failures and a decrease in poppy production in Turkey and Tasmania.

	CZV - CZK	Production in tonnes	Yield tonnes per hectare	Harvest area	Czech exports in tonnes	World exports in tones	World production in tonnes	World price USD/kg
1993	46 421	6 890	0,78	8 814	5386	37588	24704	1.030462
1994	42 423	16 471	0,57	28 726	20288	61128	49485	1.04803
1995	22 345	25 053	0,73	34 308	15977	46185	70232	0.985688
1996	35 820	9 654	0,68	14 271	15190	48201	26639	0.824838
1997	41 145	9 515	0,57	16 641	10752	48800	43092	0.992561
1998	31 724	20 524	0,74	27 881	16434	67561	67856	1.052012
1999	22 452	28 509	0,63	45 462	20220	70704	79849	0.795995
2000	39 148	13 607	0,46	29 871	16028	56696	41820	0.729593
2001	26 036	21 294	0,64	33 235	15187	62435	56233	0.741315
2002	26 937	16 918	0,57	29 637	18198	65489	51383	0.743041
2003	26 853	19 544	0,51	38 147	13148	75229	89176	0.891212
2004	27 847	24 821	0,9	27 611	20946	70801	65326	1.193797
2005	28 253	36 418	0,82	44 613	28167	78514	74816	1.303755
2006	38 290	31 591	0,55	57 785	29326	85411	80673	1.490335
2007	68 822	33 101	0,58	56 914	30321	92367	60939	2.305076
2008	29 302	49 428	0,71	69 793	28082	71113	78850	3.804733
2009	22 124	33 741	0,63	53 623	30697	69212	98835	2.062104
2010	20 000	25 469	0,5	51 103	28840	67839		1.805304

Source: Ministry of Agriculture, Czech Statistical Office

Table 1: Basic characteristics of the poppy production in CR.

Methodology

Processed article defines the position of the CR as a major global producer and marketer with poppy seed. The aim is to assess the current position of the CR on the world market and to identify some important factors influencing the development of the Czech extension of world trade in poppy seed.

In terms of methodology, the analytical part of the paper is divided into the following two parts. The first part analyzes the production of poppy seeds. Analysis of the production is processed on a territorial basis, with an emphasis on analysis of production in major territories, which are Europe, Asia and Oceania. Emphasis is given to European countries - especially to the Czech Republic as the most important producer in Europe. This section of the paper analyzes the evolution of global production in the years 1961-2009, with some analysis, due to the breakup of Czechoslovakia and establishment of independent Czech Republic being focused on the period of 1993-2008 (2008 in this regard is chosen as the final year because it is a year immediately preceding the global economic crisis that also hit the global trade in poppy seed and also due to data availability). Volume production is studied in tons, whereas also differences between regions are analyzed in terms of yield and cultivated area. Basic statistical and mathematical indicators such as base index, chain index, or average are used in this section.

In the second part, the global trade in poppy seed is analyzed, while emphasizing the CR position as a leader of world trade both in terms of value and volume of trade. The analysis of the different countries importing and exporting poppy seed is conducted. Volume (in tons) and value (in USD) trade (export and import) are analyzed. In particular, kilogram export and import prices and the differences that exist between countries and regions are subjected to research. The analysis is performed again by basic statistical tools (base and chain index, averages, etc.). The final part consists of assessment of comparative advantages of individual regions in terms of their poppy seed exports. Analysis of comparative advantage is conducted through the RCA1 (revealed comparative advantage) index calculation. The concept of the RCA1 index is based on the Balassa Index (Balassa, 1965). The Ballasa index provides a simple overview of the comparative advantage distribution (e.g., Proudman and Redding, 2000; Hinloopen and Marrewijk, 2001).

Rrevealed comparative advantage index (RCA1 – global/ regional level)

RCA1 = (Xij/Xnj)/(Xit/Xnt)

where: X represents exports

i represents the analyzed country

j represents the analyzed sector of the economy (sector of industry or commodity)

n represents the group of countries or world

t represents the sum of all sectors of the economy or the sum of all commodities or the sum of all branches

The RCA1 index analyzes the exports of commodity "j" in the case of country "i" in proportion to the total exports of the given country and the corresponding total exports of the analyzed group of countries or of the whole world (Hinloopen, Marrewijk, 2001 and Utkulu, Seymen, 2004). A comparative advantage is then accepted if the RCA1 index value is greater than 1. If, however, the result of the calculated index is less than 1, it may be asserted that the given country has a competitive disadvantage in the case of the given commodity or group of commodities (Qineti, Rajcaniova, Matejkova, 2009).

Results and discussions

The production of poppy seed in the world

World production of poppy seeds is increasing (Table 2). While in the early sixties of the 20th century, the world produced about 50 thousand tons annually, in 2009, the world production stands at about 100 thousand tons. If we analyze the evolution of global production of poppy seed, it is clear that the output behaves in a very unstable manner. Average annual growth rate of production calculated by geometric average over the period 1961-2009 ranged to about +0.9%. During the analyzed years, production fluctuated in the range of 23 thousand tons (1968) and about 100 thousand tons (2009). Production varies greatly. Strong momentum has taken the world production poppy seeds in the nineties of the 20th century. In the years 1993-2009 the growth rate of world production rose to about 8% annually. As to the territorial structure of world production poppy seeds, it can be stated that dominance can be recognized in Europe. Europe's share of world output (world production is without production of Oceania - Oceania data are not available) has long

Production (tonnes)	**1961**	**1971**	**1981**	**1991**	**2008**	**2009**	Share on global production 1961	Share on global production 2009	Share on global production 1961-2009	Rate of growth 1961-2009	Rate of growth 1993-2009
World	52752	35818	28509	43516	78850	98835				1.009	1.08
Europe	33052	20842	15067	20978	66266	62441	62.66%	63.18%	64.24%	1.015	1.077
European Union	16332	12463	9975	9267	65330	57729	30.96%	58.41%	49.91%	1.03	1.079
Eastern Europe	24691	13679	8328	14811	55363	38938	46.81%	39.40%	42.68%	1.017	1.107
Czecho-slovakia	13400	6192	3755	10876	x	x	25.40%	0.00%	29.70%	N/A	1.119
Czech Republic					49248	32692	0.00%	33.08%	17.96%	N/A	1.14
Asia	19700	14976	13442	22538	12584	36394	37.34%	36.82%	35.76%	0.991	1.1
Western Asia	18700	13976	11442	22538	12584	36394	35.45%	36.82%	33.62%	0.992	1.1
Turkey	18700	13976	11442	22538	10384	34194	35.45%	34.60%	32.73%	0.988	1.086
Western Europe	4790	2392	5209	4976	9867	11791	9.08%	11.93%	15.97%	1.015	1.023
Spain				300	6500	7000	0%	7.08%	1.8%	1.033	1.087
France	456	190	2000	800	5000	6500	0.86%	6.58%	4.99%	1.052	1.063
Hungary	6821	5472	3773	3335	3300	3458	12.93%	3.50%	8.49%	0.985	1.016
Germany	2816	786	2625	3200	2800	3294	5.34%	3.33%	6.18%	1	1
Romania	4100	1900	800	600	1600	1956	7.77%	1.98%	4.37%	0.98	1.203
Austria	1056	138	206	442	1567	1504	2.00%	1.52%	1.70%	N/A	1.074
Slovakia					1215	832	0.00%	0.84%	0.82%	N/A	0.953

Source: FAOSTAT, own computation

Table 2: Development of global production poppy seeds.

been at over 60%. Asia and Oceania, as with other major producers accounts for approximately 35%. As for Europe, the world production is dominated mainly by Eastern Europe (the share in world production in 1961-2009 to more than two-fifths). The proportion of western and southern Europe in world production in the period was about 16% and 4.4%. As for Asia, there is a dominant producer fields western Asia - Turkey in turn comes from about 30% of world production of poppy seed. As Oceania, there are the dominant producers of Australia - especially Tasmania.

In terms of Europe and the world, the dominant producers are found in the following countries (share of world production in the period 1961-2009 - according to FAO): the former Czechoslovakia (30%), France (5%), Hungary (8.5%), Germany (6.2%), Romania (4.4%), Austria (approx. 2%). However, the above data are only averages for the reporting period. Over the past 50 years, the situation has changed dramatically and is currently (2009) as follows. These countries are dominant starting with the CR (33%), Turkey (34.6%), France (6.6%), Hungary (3.5%), Germany (3.33%), Romania (1.92%) and Austria (1.52%) and Slovakia (approx. 1%). In terms of growth rate the highest rate in the years 1993-2009 points to the following producers: Romania (20% / year), Czech Republic (14% / year - however we are currently witnessing a significant stagnation), Turkey (8.6% / year) , Austria (7% / year) and France (6% / year). The Czech Republic during the years has significantly strengthened its position in the world market and, together with Turkey represents approximately 2/3 of world production. A very important factor influencing the production of poppy seed is harvested area (Table 3).

In the world, the harvested are is roughly 140 thousand hectares. It oscillates very significantly depending on the world price and other factors such as weather, administrative regulation, stocks, etc. In the years 1961-2009 harvested area oscillated between 30 thousand and 160 thousand hectares. The distribution of harvested areas in the world more or less corresponds to the level of world production. According to FAO (2009), majority of the harvesting areas for the production of poppy seed is located in Europe at about 80%.

In terms of the major producers, most of them are currently located in the EU (about 90 thousand hectares). In other European countries the harvested area represents the range of 1 thousand to 2 thousand hectares. Outside Europe, the next major harvests are located in Oceania and Asia. Next big player is then mainly Turkey, where the poppy seed harvested at approximately 49 thousands hectares. In Europe, the states with the most important harvest areas: the Czech Republic, France, Hungary, Germany, Romania, Austria and Spain. Particularly significant is the Czech Republic, which takes approximately 38% of the world crop areas. In 1993-2009 the highest rate of growth in crop area recorded in the following countries: Romania, Republic, Austria, Turkey, France and Spain. If we analyze the development of harvest areas is also worth emphasizing that the harvest area tend to change very much as has been said above. It is not a stable condition. For example, if the current EU-27 harvested area in the years 1961-2009 oscillated between about 14 thousands

Area Harvested (Ha)	item	1961	Share	1993	Share	2009	Share
World	Poppy seed	100 698		35 631		140534	
Europe	Poppy seed	61 998	61.57%	28 690	80.52%	91501	65.11%
European Union	Poppy seed	35 605	35.36%	27 060	75.95%	88377	62.89%
Czech Republic	Poppy seed		0.00%	8 814	24.74%	53623	38.16%
Asia	Poppy seed	38 700	38.43%	6 941	19.48%	49033	34.89%
Turkey	Poppy seed	38 700	38.43%	6 941	19.48%	48893	34.79%
France	Poppy seed	445	0.44%	4 000	11.23%	10000	7.12%
Hungary	Poppy seed	18 821	18.69%	3 755	10.54%	3928	2.80%
Germany	Poppy seed	4 507	4.48%	4 000	11.23%	5283	3.76%
Romania	Poppy seed	8 400	8.34%	200	0.56%	3291	2.34%
Austria	Poppy seed	1 166	1.16%	551	1.55%	2186	1.56%
Slovakia	Poppy seed		0.00%	4 300	12.07%	1904	1.35%

Source: FAOSTAT, own computation

Table 3: Harvested area for poppy.

Yield (t/Ha)	item	1961	1971	1981	1991	1993	2001	2007	2009	Average	Standard Deviation	
Austria	Poppy seed	0.91	0.95	1.02	1.03	0.97	0.86	0.74	0.688	0.92	0.09	9.30%
Germany	Poppy seed	0.62	0.64	0.54	0.71	0.7	0.68	0.74	0.6235	0.66	0.07	10.20%
Czech Republic	Poppy seed	0	0	0	0	0.78	0.62	0.58	0.6096	0.65	0.09	14.40%
Hungary	Poppy seed	0.36	0.51	0.47	0.59	0.69	0.74	0.7	0.8803	0.54	0.14	25.70%
World	Poppy seed	0.52	0.75	0.53	0.78	0.69	0.57	0.56	0.7032	0.62	0.08	13.20%
Slovakia	Poppy seed	0	0	0	0	0.58	0.48	0.3	0.4369	0.48	0.09	18.90%
France	Poppy seed	1.02	0.63	0.4	0.44	0.5	0.43	0.53	0.65	0.54	0.13	24.70%
Turkey	Poppy seed	0.48	1.05	0.75	0.83	0.44	0.47	0.37	0.6993	0.6	0.15	24.70%
Romania	Poppy seed	0.49	0.31	0.1	0.86	0.5	0.72	0.52	0.5943	0.58	0.29	49.70%
Czecho-slovakia	Poppy seed	0.64	0.75	0.36	0.79	0	0	0	0	N/A	N/A	N/A

Source: FAOSTAT, own computation

Table 4: Development of hectare yields in chosen regions.

hectares to almost 100 thousands hectares. Standard deviation of harvested areas range from average for the EU27 in the period was around 48%. In case of the CR it was for example 70%, then even in France78%, Turkey 60%, 41% in Hungary, etc. A very important factor affecting the level of supply poppy seed is yield per hectare (Table 4). Although the potential poppy yields are estimated at levels from 1.8 to 2.9 t /ha, real yields are on average much lower. In the period 1961-2009, the average yield remained at a level of about 0.48 to 0.92 t / ha, depending on the region. The highest yields of long reaches of Austria, the lowest in France, Turkey and Romania in the CR then on average between 0.6 to 0.7 t / ha. It should be noted however that the yield per hectare is very unstable over time. Standard deviation is in the range of about 13% of the average annual production in the world. From the introduced regions, the ones with highest volatility are Romania (49%), Turkey (24%), France (24%) and Hungary (25%).

The development of foreign trade in poppy seed

Poppy share of world agri-trade is about 0.02%. In the period 1961-2009 the volume and value of world exports of poppy seeds significantly increased, whereas the main growth was recorded in the period 2000-2007. During the period 2008 and 2009, the decrease in trade value and volume was recorded. The value of exports grew at an average annual rate of 13% and in 2007 reached some 213 million USD. The volume of exports grew by about 6.6% per year and in 2007 reached some 92 thousand tons. Details about the value and volume of world exports are included in Table 5 or Table 6.

However, it is worth mentioning that in the years 2008-2009, due to the interplay of several factors (high reserves, bad weather, poor production quality, etc.) the value of world trade in poppy seeds diminished to the value of approximately 142 million USD in 2009. In the Table below, countries that control more than 95% of the value of world exports of poppy seed.

Over the long-run, most of the value involved in poppy trade is in the following countries Czech Republic, Turkey and the Netherlands. Share of these countries in world exports reached only in 2009 about 70%. The Czech Republic and Turkey which are also the countries with the highest level of comparative advantage in world trade in poppy seed (see RCA1 value index - Table 7). The countries that achieve long-term comparative advantage in terms of world trade in poppy seed are: CR, Turkey, Netherlands, Austria, Poland, Hungary, Australia, Slovenia and Bulgaria. If we look at the results of the analysis in terms of both the value of the exports, and in terms of index values RCA1 we clearly see huge differences.

Export Value (1000 $)	1993	1995	1997	1999	2001	2003	2005	2007	2009	Share in trade 2009	Rate of growth 1993-2009
World	38733	45524	48437	56280	46284	67045	102363	212913	142 723		1.129447
Czech Republic	7971	13734	8535	12822	10354	11714	31728	88184	39 458	28%	1.187306
Netherlands	10361	6082	7251	3844	5923	9383	17496	44456	47 493	33%	1.109636
Turkey	7754	10174	17189	22149	19035	32290	28609	35266	16 224	11%	1.114263
Australia	3845	5350	4351	4931	3683	5257	5828	7160	4 775	3%	1.01201
Austria	166	553	460	671	739	1070	2607	6667	9 729	7%	1.267878
Poland		373	1255	562	1108	0	3629	5958	1 890	1%	1.237856
Spain	1387	165	221	225	102	2	1153	5084	5 754	4%	1.097223
Germany	1127	577	2336	1665	1144	1152	888	3444	1 890	1%	1.089878
United Kingdom	38	58	85	56	62	214	2021	2310	2 512	2%	1.340962
Indonesia	0	0	0	0	1	217	3	2292	x	x	0.680942
France	1910	1193	3114	1950	1224	2017	3360	2210	1 866	1%	1.010475
Hungary	645	519	241	136	349	690	0	2019	992	1%	0.991951
Ethiopia						52	0	1120	x	x	x
China		24	15		28	409	370	948	1 345	1%	1.204582
Belgium					229	303	501	725	473	0%	1.072255
USA	95	292	136	90	135	206	269	553	683	0%	1.134078
Lithuania		761	316	85	65	106	469	503	260	0%	1.169765
Bulgaria	0	50	0	0	0	5	0	460	616	0%	x
India	63	68	72	66	136	120	308	406	607	0%	1.083875
Slovakia	350	837	98	105	20	208	568	378			0.945531

Source: FAOSTAT, own computation

Table 5: Geographical structure of world exports in USD.

Export Quantity (tonnes)	item	1993	1995	1999	2003	2005	2007	2009	Share in trade 2009	Rate of growth 1993-2009	Rate of growth 1993-2009
World	Poppy seed	37588	46185	70704	75229	78514	92367	69 212		1.066327	1.129447
Czech Republic	Poppy seed	5386	15977	20220	13148	28167	30321	30 697	44%	1.131372	1.187306
Turkey	Poppy seed	4995	10016	23672	34480	14647	14934	14 008	20%	1.08137	1.109636
Netherlands	Poppy seed	10285	4122	3845	9394	10643	13762	3 498	5%	1.02102	1.114263
Indonesia	Poppy seed	0	0	1	217	7	8530	x	x	1.149117	1.01201
Spain	Poppy seed	1612	294	345	5	3848	5523	2 697	4%	1.371023	1.267878
Australia	Poppy seed	5654	4432	6383	7248	4728	3611	2 895	4%	0.96848	1.237856
France	Poppy seed	3220	1244	5384	5223	4062	3390	1 991	3%	1.003682	1.097223
Poland	Poppy seed		216	372	0	4181	3068	909	1%	1.392511	1.089878
Austria	Poppy seed	68	116	448	645	2847	1784	4 243	6%	1.262842	1.340962
Ethiopia	Poppy seed				114	0	1316	x	x	1	0.680942
Germany	Poppy seed	711	375	1180	1096	592	1039	1 206	2%	1.027466	1.010475
United Kingdom	Poppy seed	23	33	23	183	1465	1008	1 428	2%	1.309986	0.991951
Hungary	Poppy seed	650	449	120	908	0	861	627	1%	0.981434	x
China	Poppy seed		29		620	440	781	878	1%	1.116337	1.204582
USA	Poppy seed	118	291	135	258	175	501	773	1%	1.108802	1.072255
India	Poppy seed	18	33	25	105	241	325	215	0%	1.229583	1.134078
Belgium	Poppy seed				220	355	219	238	0%	0.983612	1.169765
Sri Lanka	Poppy seed				0	0	209	0	0%	1.002436	x
Bulgaria	Poppy seed	0	20	0	10	0	194	314	0%	1.26203	1.083875
Lithuania	Poppy seed		309	76	104	340	162	154	0%	0.984361	0.945531

Source: FAOSTAT, own computation

Table 6: Geographical structure of world exports in tonnes.

Export	RCA1	Export	RCA1
Czech Republic	75.32917	Slovakia	0.739075
Turkey	22.19027	Spain	0.673794
Ethiopia	4.48642	Indonesia	0.533664
Netherlands	2.705371	United Kingdom	0.415634
Austria	2.59023	Sweden	0.290929
Poland	1.912268	Germany	0.246495
Hungary	1.3904	Ukraine	0.221892
Australia	1.246591	France	0.154679
Slovenia	1.173791	China	0.140626
Bulgaria	1.156158	India	0.099786
Latvia	0.901334	Belgium	0.085782
Lithuania	0.780982	Denmark	0.085468
Sri Lanka	0.74296	United States of America	0.024561

Source: FAOSTAT, own computation

Table 7: Geographical structure of world trade in poppy seed in 2004-2008 (i.e., in the period before the crisis of the world economy).

The Czech Republic, Turkey and the Netherlands are the main pillars of world trade in poppy seed. In the period 1993-2009 the proportion of those countries in world trade fluctuated between 65-80%. In the period despite a decline in the years 2008 and 2009, clearly the highest level of growth dynamics of the value of exports can be attributed to the Czech Republic valued at approximately 19% per year. In the case of the Netherlands and Turkey, the growth rate is slightly below 11% per year (calculation of growth rates of trading volume are negatively affected by fluctuations USD exchange rate). An interesting feature of world trade in poppy seed is the development of prices. This analysis reveals very significant differences in export unit prices for individual countries and territories. For example, whereas in 2009, the Netherlands exports are around $ 4.7/kg, France exports poppy seed at $ 0.94 per kilogram. Volatility of poppy seed poses a major problem for the stability of market and trade.

The Table 8 clearly shows a high proportion of the average value of deviations from the average price per kilogram in 1993-2007 for all selected countries. Already in the period before the crisis, it was quite obvious that the kilogram poppy prices are very volatile. Unstable export prices can be observed especially in the case of Slovakia, Spain, India and the Czech Republic. On the contrary, the most stable prices can be found in Germany, the USA and Turkey. The following Table 9 provides data on the kilogram prices of exports and imports of those countries which act as major exporters, importers and also poppy seed in the world.

As stated above both export prices and import and poppy seed oscillate dramatically. For individual unit prices of selected countries, exports oscillate on average in the range of about 24 to 40%. In the case of imports for each selected country average prices oscillate between 26 to 36%. It is interesting to see how individual exporters while comparing their prices with world prices. While countries are very much involved in business operations (the Netherlands, Poland, Austria, Germany), the realized export price is above the average world prices. Countries like Australia and the Czech Republic are dominant players in the field of production and trade. Poppy is on average traded at a price lower than the world average and also ranks among the countries whose rates oscillate kilogram most. It is then interesting to note that while the Czech Republic and Australia for the import of poppy seed have their own import prices far above the average realized prices of imports in the world. All countries which are re-exporting are able to buy poppy seed at prices significantly lower (often at a price that is below the world price), than for what it is then exported to the world market. This implies that these countries are highly skilled traders and are able to handle the market better than is the case of the Czech Republic.

Unit price – export USD/kg	1993	1995	1997	1999	2001	2003	2005	2007	2009	Average Price	Standard Deviation	Standard Deviation Share on Price
Slovakia	1.44	0.98	1.31	0.95	0.91	1.17	2.41	4.67	2.38	1.61	0.81	50.16%
Austria	2.44	4.77	1.71	1.5	1.3	1.66	0.92	3.74	2.29	2.07	0.76	36.72%
Germany	1.59	1.54	1.42	1.41	1.32	1.05	1.5	3.31	2.18	1.62	0.38	23.73%
Denmark	1.6	1.34	1.11	1.61	1.17	1.93	2.77	3.24	2.46	1.75	0.56	32.18%
Netherlands	1.01	1.48	1.23	1	0.97	1	1.64	3.23	4.64	1.36	0.4	29.38%
Czech Republic	1.48	0.86	0.79	0.63	0.68	0.89	1.13	2.91	1.29	1.03	0.4	38.57%
Turkey	1.55	1.02	1.08	0.94	0.76	0.94	1.95	2.36	3.39	1.27	0.36	28.37%
World	1.03	0.99	0.99	0.8	0.74	0.89	1.3	2.31	2.06	1.08	0.27	24.71%
United Kingdom	1.65	1.76	2.58	2.43	2.14	1.17	1.38	2.29	1.76	1.95	0.45	22.97%
Australia	0.68	1.21	0.9	0.77	0.83	0.73	1.23	1.98	1.65	1.02	0.32	31.82%
Poland	2	1.73	2.03	1.51	0.27	1	0.87	1.94	2.08	1.52	0.54	35.35%
India	3.5	2.06	2.18	2.64	1.37	1.14	1.28	1.25	2.82	1.89	0.74	39.02%
United States of America	0.81	1	0.74	0.67	1.09	0.8	1.54	1.1	0.88	0.98	0.23	23.38%
Spain	0.86	0.56	1.03	0.65	0.84	0.4	0.3	0.92	2.13	0.95	0.38	40.30%
France	0.59	0.96	0.62	0.36	0.34	0.39	0.83	0.65	0.94	0.64	0.24	36.87%

Source: FAOSTAT, own computation

Table 8: Kilogram price of poppy seed exports.

Unit price – export USD/kg	1993	1995	1997	1999	2001	2003	2005	2007	2009	Average Price	Standard Deviation	Standard Deviation Share on Price
Czech Republic	1.48	0.86	0.79	0.63	0.68	0.89	1.13	2.91	1.29	1.03	0.4	38.57%
Netherlands	1.01	1.48	1.23	1	0.97	1	1.64	3.23	4.64	1.36	0.4	29.38%
Germany	1.59	1.54	1.42	1.41	1.32	1.05	1.5	3.31	2.18	1.62	0.38	23.73%
Australia	0.68	1.21	0.9	0.77	0.83	0.73	1.23	1.98	1.65	1.02	0.32	31.82%
Austria	2.44	4.77	1.71	1.5	1.3	1.66	0.92	3.74	2.29	2.07	0.76	36.72%
Poland	2	1.73	2.03	1.51	0.27	1	0.87	1.94	2.08	1.52	0.54	35.35%
Turkey	1.55	1.02	1.08	0.94	0.76	0.94	1.95	2.36	3.39	1.27	0.36	28.37%
World	1.03	0.99	0.99	0.8	0.74	0.89	1.3	2.31	2.06	1.08	0.27	24.71%
Unit price – import USD/kg	1993	1995	1997	1999	2001	2003	2005	2007	2009	Average Price	Standard Deviation	Standard Deviation Share on Price
Czech Republic	1.23	1.55	0.67	0.82	0.92	1.06	1.65	2.78	1.59	1.29	0.43	33.20%
Netherlands	1.2	0.94	0.57	0.58	0.52	0.56	0.76	2	3.85	0.86	0.31	36.26%
Germany	1.57	1.15	1.05	0.93	0.87	0.94	1.4	2.79	1.92	1.3	0.4	30.39%
Australia	1.57	1.68	0.9	1.11	0.95	2	1.67	2.77	2.16	1.39	0.45	32.29%
Austria	1.31	1.1	1.01	0.86	0.89	0.99	1.26	3.07	1.46	1.24	0.4	32.02%
Poland	0.84	0.43	0.7	0.63	0.65	0.77	1.03	2.42	1.27	0.9	0.31	33.89%

Source: FAOSTAT, own computation

Table 9: Unit prices of export and import of poppy seeds in the world and selected countries.

Analysis of value, volume and territorial structure of world import poppy seeds

While the territorial structure of exports is relatively very closely concentrated, the territorial structure of imports is much less concentrated. The main importers while also include a limited number of countries, are no longer as dominant as in the case study of export markets. The share of the twenty most important importers of world import value is about 90%. The most important importers of poppy seeds in the world include Germany, Russia, Netherlands, Poland, Austria, India and the US. Share of these seven countries in the world is importing more than 70% of total inflow of poppy seed. Among the importers with the highest import growth dynamics belong in particular Romania, Russia, the Czech Republic, India, Great Britain, Austria, Ukraine, Poland and the Netherlands. In this regard it should be noted that the list is dominated by a number of countries which are also exporters of poppy seeds and the production is not in par with their level of exports. This is evident in the case of the Netherlands. Therefore, it should be noted that the poppy trade is greatly influenced by re-exports. Effect of re-exports is the most obvious case that is happening in the Netherlands as well as in the case of Austria, Poland and others. Detailed information on the evolution of territorial structures and values of world import of poppy seeds can be found in the following Tables No. 10 and No. 11.

Recent developments in the market with poppy seeds

The market for poppy is characterized by a very turbulent environment, as demonstrated above by the data summarizing the development in the world market as well as in the Czech market with poppy in 1961-2009 respectively in the period 1993-2009. In recent years (2009, 2010 and the first half of 2011), significant changes in the world emerged. To the forefront of production and trade new countries emerged and other countries have lost their positions. Among the fastest growing producers belong undoubtedly Asian countries especially Turkey. On the contrary, the countries of Central and Eastern Europe as producers in recent years considerably lose their position. This is especially

Import Value (1000 $)	1993	1995	1997	1999	2001	2003	2005	2007	2009	Average
World	39897	42531	43323	54894	44793	61483	83457	174543	132825	1.111176
Germany	11874	8578	8519	9140	7620	6820	10126	26418	15926	1.058784
Russian Federation	214	5000	4000	1336	3762	6346	9514	24898	12090	1.404603
Netherlands	4696	5050	3336	4058	2930	4585	6994	16319	12014	1.093051
Poland	3700	2286	6692	7447	8487	8635	11304	16095	8450	1.110725
Austria	2152	1765	1286	2625	2265	3745	4853	16032	12327	1.15424
India	1239	918	525	3953	472	7309	5362	12733	30588	1.18107
United States of America	5717	8058	6553	6384	4698	4784	6621	10842	6918	1.046774
United Kingdom	885	1164	625	446	626	833	2423	7938	2907	1.169647
Denmark	2043	1780	1285	1983	1487	1897	2864	6771	3693	1.089357
Czech Republic	385	200	574	734	1474	841	1166	4639	2652	1.25178
Belarus				765	654	169	1233	3543	1801	1.061616
Slovakia	86	3	1232	909	1321	1862	1599	3331	1891	1.068294
Ukraine					500	77	2675	2703	478	1.128102
France	1857	381	258	332	456	474	884	2113	1718	1.037766
Romania	9	31	148	186	270	505	1334	1871	775	1.464062
Canada	675	1055	817	971	769	654	1057	1785	2111	1.071931
Lithuania		418	868	495	465	437	823	1687	810	1.06409
Croatia	313	415	279	356	331	559	634	1262	594	1.056067
Sweden	686	1290	883	1224	1251	1695	2549	1201	1521	0.967954
Israel	651	660	404	485	486	361	441	1168	1026	1.042637

Source: FAOSTAT, own computation

Table 10: Geographical structure of world imports in USD.

Import Quantity (tonnes)	1993	1995	1997	1999	2001	2003	2005	2007	2009	Average
World	35359	42267	52134	86311	61608	77698	86049	82830	62001	1.062689
Russian Federation	99	2900	5800	2400	8387	13177	16408	14668	4841	1.429067
Germany	7560	7469	8124	9805	8762	7223	7212	9460	8299	1.016143
Pakistan	392	1025	4101	2807	2091	3097	5235	8534	x	1.246126
Netherlands	3929	5365	5879	6938	5659	8137	9258	8162	3117	1.053609
India	3525	2093	1231	4468	477	9089	6506	6888	10358	1.049013
Poland	4391	5303	9567	11820	13158	11206	11020	6660	6649	1.030202
United States of America	5162	6122	5238	6192	4742	5021	4926	5497	3901	1.004501
Austria	1640	1608	1274	3059	2544	3787	3850	5220	8429	1.086216
United Kingdom	680	883	569	430	699	883	1828	3318	2059	1.119874
Denmark	1786	1620	1425	1792	1768	1492	1329	1867	1386	1.003173
Czech Republic	312	129	852	899	1608	796	707	1670	1672	1.200709
Ukraine					402	76	2685	1360	280	1.090958
Belarus				418	606	169	932	1094	794	1.036756
Slovakia	56	1	912	1253	1610	1773	1026	846	963	0.746104
France	1505	257	178	319	778	416	845	726	522	0.949261
Canada	711	1146	870	1155	1010	865	875	673	1032	0.996084
Romania	4	18	283	384	665	891	1120	649	504	1.438369
Lithuania		326	604	542	567	479	672	587	544	1.059892
Kazakhstan		56			150	311	427	485	369	1.154329
Israel	600	700	380	450	607	410	310	428	580	0.97616

Source: FAOSTAT, own computation

Table 11: Geographical structure of world imports in tones.

true for the Czech Republic region, where only a year on year 2008-2009, there was a decline in production by about 34% and subsequently in 2009-2010, the decline continued. In recent years, especially the European market with poppy seeds stagnated. This is due to fluctuations in prices and in particular, in general, low purchase price of the poppy. Then, there is a problem in an ever-tightening legislation significantly affecting the size and especially the economy of growing poppy seed. Finally, it negatively impacts the high stock levels. Its influence has also generally decreasing demand for food in a traditional bastion of consumption, which is Central and Eastern Europe. The poppy is also under strong competitive pressure from Asian poppy, where the production is not regulated like in Europe.

Conclusions

Poppy seed is a very interesting complement to the global agricultural market. Although its share of world agricultural production and trade is negligible, the poppy seed market character is very interesting. It is one of the few crops that are produced within the relatively narrow group of countries, which then supply their production of the world. For example, in 2009 the volume of world production of poppy seed reached some 100 thousand tons and the volume of world trade was moving at about 70 thousand tons (the volume of trade was affected by stocks from previous years). However, the majority of the production of poppy seed is not consumed in the country of origin, but is realized on the world market. As for the balance of Czech production and subsequent use of poppy seed in the Czech Republic, it is clear that the Czech Republic in recent years greatly increased the level of production, which increased from about 17 thousand tons to about 50 thousand tons. In addition to output growth, also growth in exports has been noted, which rose over the same period from about 15 thousand tons to about 30 thousand tons. Imports also rose in this period and were rising at about 2 thousand tons per year. Given that the Czech industry annually consumes about 5

thousand tons of seed, it means that in 2002-2009, the Czech Republic began to accumulate significant reserves. During this period, inventory levels increased from 140 tons to about 16 thousand tons. This situation, which was typical not only for the Czech market has resulted in the rapid decline in poppy seed prices in the domestic market but also in the world market. World production and trade of poppy seed in time greatly oscillated, which has a very negative impact on market stability. Prices of both exports and imports for each country are changing very often in both directions. World production is greatly influenced by fluctuating poppy seed yields, which were far below the potential production of this crop. World production is greatly influenced mainly by the price level from the previous period and the stock. Low prices then tend to occur in lower sowing areas, which also happened in 2009 and, for example in the Czech Republic; sown area was reduced from 70 thousand to about 53 thousand hectares.

Currently, world production and trade are controlled by a very narrow group of countries. In case of production dominant share have the Czech Republic, Turkey, Tasmania, France, Hungary and Germany. In the case of trade the dominant position can be attributed to the CR, the Netherlands and Turkey. Based on the above it is necessary to emphasize the position of the CR, which controls about 33% of world production and about 28% of the value and about 44% of world trade in poppy seed. It therefore follows that the Czech Republic belongs to the most important players. However, the Czech Republic has only limited influence on the world market. Czech exports are realized below the world price. Currently there are difficulties to sell their output because of a stagnant world market and mainly also due to high stocks from previous years.

Processed data show that the level of production is directly dependent on the size of a poppy seed crop area and yield per hectare. Results show a degree of dependence between harvest areas and declared prices of exports from the previous period. This can be expected in the coming years when poppy production in the Czech Republic decreases. Lost production will then be compensated by high levels of the stocks that are currently moving according to Ministry of Agriculture at more than 10 thousand tons. As for the Czech exports, in terms of the volume, it shows a high degree of dependence on the volume of world exports (the result is influenced by the fact that the Czech Republic numbers come from a significant percentage of the volume of poppy, which is traded in the world.

Regarding the current situation, we can say that mass production technology used, high quality poppy seeds, minimal damage to the seeds, the minimum content of impurities, uniform color, size of lots, sales culture, promotion of Czech production, enabled Czech businessmen to penetrate heavily foreign markets. All of that together with crop failures and a decline in poppy sown area in Turkey, Oceania and other countries have strengthened the Czech position on the world market. Growing poppy was profitable despite falling commodity prices on world markets. In the long term, average exports from CR account for 80-90% of production. Due to the high supply, which currently exists in the world market, price fell down. In the future it is expected that the Czech Republic will continue to maintain its privileged position on the world market, but there is a certain reduction in production, which is already evident because if we compare harvested area between the 2008/2009 and 2009/2010 we find that it dropped from about 70 thousand hectares to about 51 thousand hectares.

Acknowledgment

This paper is part of a research project carried out by the authors within the grant no. 6046070906, funded by the Ministry of Education, Youth and Sports of the Czech Republic.

Corresponding author:
Ing. Petr Prochazka, PhD.
Department of Economics, Faculty of Economics and Management
Czech University of Life Sciences in Prague
Kamycka 129, Prague 6, 16521
Phone: +420 224 38 2131
E-mail: pprochazka@pef.czu.cz

References

[1] Balassa, B. Trade liberalization and 'revealed' comparative advantages (1965): The Manchester School of Economic and Social Studies. 1965, Vol.32, No.2, pp. 99/123. ISSN: 10490078.

[1] Baydar, H., Turgut, I. (1999): Variations of fatty acid composition ascending to some morphological and physiological properties and acological regions in oil seed plants. Turkish Journal of Agriculture and Forestry. 1999, 23, No. 1, pp. 81-86. ISSN 1303-6173.

[2] Bozan, B., Temelli, F. (2003): Extraction of poppy seed oil using supercritical CO2. Journal of Food Science. 2003, 68, No. 2, pp. 422-426. ISSN: 1750-3841.

[3] CZSO. Měsíční výkaz o cenách zemědělských výrobků, [on-line]. cit. 06/08/2011. Available: http://www.czso.cz/csu/klasifik.nsf/i/ceny_zem_1_12_2011.

[4] Guil, J. L., Martinez, J. J. G., Isasa, M. E. (1998): Mineral nutrient composition of edible wild plants. Journal of Food Composition and Analysis. 1998, 11, No. 2, pp. 322-328. ISSN: 0889-1575.

[5] Hinloopen, J., And Marrewijk, C. (2001): On the empirical distribution of the Balassa index. Weltwirtschaftliches Archiv / Review of World Economics. 2001, 137, No. 1, pp. 1-35. ISSN: 1610-2886.

[6] Kryzmanski, J., Jonsson, R. (1999): Poppy. In: Robbelon, G., Downey, R.K., Ashri,A.(eds.), Oil Crops of the World. Their Breeding and Utilization. New York, NY:McGraw-Hill, Inc., 1999. p. 389.

[7] Luthra, R., Singh, N. (16989): Changes in fatty acid composition accompanying the deposition of triacyglycerols in developing seeds of opium poppy (Papaver somniferum L.). Plant Science. 1989, 60, No. 1, pp. 55-60. ISSN: 0168-9452.

[8] Ministry Of Agriculture. Vize českého zemědělství po roce 2010, [on-line]. cit. 06/07/2011. Available: http://eagri.cz/public/web/file/ 56419/VIZE.pdf.

[9] Nergiz, C., Ötles,, S. (1993): Chemical composition of Nigella sativa L. Seeds. Food Chemistry. 1993, 48, No. 3, pp. 259-261. ISSN: 0308-8146.

[10] Özcan, M., M., Atalay, C. Determination of seed and oil properties of some poppy (Papaver somniferum L.) varieties. Grasas y aceites. 2006, 57, No. 2, pp. 169-174. ISSN: 0017-3495.

[11] Proudman, J., Redding, S. (2000): Evolving Patterns of International Trade. Review of International Economics. 2000, 8, No. 3, pp. 373-396. ISSN: 1467-9396.

[12] Qineti A., Rajcaniova M., Matejkova E. The competitiveness and comparative advantage of the Slovak and the EU agri-food trade with Russia and Ukraine. Agric. Econ. – Czech. 2009, 55, No. 8, pp. 375-383. ISSN 0139-570X.

[13] Singh, S. P., Khanra, K. R, Dixit, B. S., Srivastava, S. N. (1990): Fatty acid composition of opium poppy (Popover somniferum L.) seed oil. Indian Journal of Agricultural Sciences. 1990, 60, No. 1, pp. 358-359.ISSN: 0019-5022.

[14] Singh, S. P., Khanna, K. R., Shukla, S., Dixit, B. S., Banerji, R. (1995): Prospects of breeding opium poppies (Papaver somniferum L.) as a high-linoleic acid crop. Plant Breeding. 1995, 114, No. 1, pp. 89-91. ISSN: 1439-0523.

[15] UN FAO. The State of Food and Agriculture. FAO, Roma, 2009. ISBN 978-92-5-105980-4.

[16] Utkulu, U., Seymen, D. Revealed (2004): Comparative Advantage and Competitiveness: Evidence for Turkey vis-à-vis the EU/15. Paper was presented at the European Study Group 6th Conference, ETSG 2004.

Agris on-line Papers in Economics and Informatics

Volume IV Number 2, 2012

The Role of Transgenic Crops in the Future of Global Food and Feed

H. Řezbová, O. Škubna

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

Anotace

Tento příspěvek se zabývá problematikou geneticky modifikovaných (transgenních) plodin. Hlavním cílem příspěvku je analýza trendů nejdůležitějších skupin transgenních plodin s ohledem na jejich využití jako zdroje potravin a krmiv. Základními analyzovanými skupinami plodin jsou sojové boby, kukuřice, bavlník a řepka. Základními metodami, užitými v příspěvku, jsou řetězové a bazické indexy a regresní analýza časových řad. Na základě regresní analýzy je stanovena predikce vývoje ploch GM plodin na další čtyři období (2012-2015). Vymezením trendů je možné stanovit nezbytnost implementace GM plodin do zemědělských systémů ve všech zemích (včetně EU). Závislost světového agrárního trhu na geneticky modifikovaných (transgenních) plodinách je nesporná a predikce potvrzují další navýšení důležitosti tohoto sektoru.

Klíčová slova

Transgenní plodiny, GMO, trendy, produkce, potraviny, krmivo.

Abstract

The paper is aimed on the problematic of biotech crops planting (GM, transgenic crops). The main aim of this paper is to analyze the trends in the main biotech crops planting groups in the sense of their use for food and feed in the future. The selected groups of biotech crops analyzed in this article are soybeans, maize (corn), cotton and rapeseed (canola). The used methods are chain and basic indexes and regression analysis of times series/ trend data - for predicting on next four years (2012-2015). The trends are able to determine the necessity of implementation the biotech crops planting into the agricultural systems everywhere (also in EU) and it is without the questions if the impact are mainly positive or negative. The dependence of world agricultural commodity market on the biotech crops is undeniable and the prediction acknowledges that the importance is increasing. Pieces of knowledge introduced in this paper resulted from solution of an institutional research intention MSM 6046070906 „Economics of resources of Czech agriculture and their efficient use in frame of multifunctional agri-food systems“.

Key words

Transgenic crops, biotech crops, GMO, trends, production, food, feed.

Introduction

Global population reached a historical milestone of 7 billion on 31 October 2011. As the population of the world continues to increase, it will be accompanied by an increase in the demand for food. The global acreage under cultivation is no longer increasing because of global climate change or for environmental reasons, and so the only way to increase the food supply is to increase crop yields. GMO production technology may therefore be one way of increasing crop yields and food supply. In such circumstances, food prices will not need to be raised (Chen, Tseng, 2011).

The UK Foresight report ‘The Future of Food and Farming’ (Government Office for Science, 2011) analyses the predicted pressures on the global food system up to 2050.

More productive GM crops could actually lead to better coexistence between intensive agriculture and biodiversity (Dewar et al, 2003; National Research Council, 2010) and future biotechnologies could be more effective.

GM crops are already contributing to increased yields, greater ease and predictability of crop management, a reduction in pesticide use and fewer post-harvest crop losses (Trait, Barker, 2011).

Biotechnology has been the most rapidly adopted agricultural technology in history. In the United States, 94 percent of the soybean crop, 90 percent of cotton and 88 percent of field corn (maize) are

now bio-engineered, known as genetically modified organisms, GMOs[1] . (NASS Report, 2011).

In 2011, biotech soybean occupied three-quarters of the 100 million hectares of soybean globally, biotech cotton almost 80% of the 30 million hectares of global cotton (64% in the year 2010), biotech maize over 30% of the 159 million hectares of global maize (29% in 2010) and biotech canola (also called rapeseed) more than one-quarter of the 31 million hectares of global canola - 23% in 2010 (ISAAA Releases, 2011). This information is significant argument for the propagators of biotechnologies. The results of the reports all around the world about the trends of biotechnology in agriculture are clear – the share of GMO (genetically modified organisms) is increasing in each indicator, in the amount of hectare, in the amount of volume and also in the amount of consumption and of the share on the foreign trade.

Across the globe, experts Galvão (2010) and Parente (2010) expect to see a marked increase in corn (maize) and canola GMO varieties in the next few years, which currently make up 30 and 23 percent of those crops, respectively. Developing nations, including China, India, Brazil, Argentina, South Africa and Mexico are now using GMO varieties in nearly 62 percent of their acreage. With further dramatic growth of GMO use predicted in these countries, the use of GMOs worldwide is projected to grow at a much faster rate in the next five to 10 years than in the United States. In China, for instance, hundreds of new biotech companies have recently emerged (Zhu et al., 2009). Adoption of plant biotechnology continues to grow worldwide as confirmed by the International Service for the Acquisition of Agri-Biotech Applications (James, 2010) announcement that 15.4 million farmers in 29 countries grew biotech crops on 148 million hectares in 2010. This is a 10 percent increase over 2009. This represents 9.4% of the world's arable land, an area equivalent to over five times the size of the UK. The majority of existing commercial genetically modified (GM) crops have been designed to express transgenic proteins with a limited spectrum of biological activity, e.g. insect resistance and herbicide tolerance (Codex, 2003), (Chassy et al., 2004) and (Chassy et al., 2008).

Genetically modified crops – primarily canola, cotton, maize and soybeans modified for insect-resistance and herbicide-tolerance – presently widely used have earned the label of sustainable intensification in global agriculture through the vital role of science (Raven, 2010). Ruttan (1999) has developed a simple three-stage classification of the goals of agricultural biotechnology development starting with stage one where the goal is lifting the yield ceiling of cereals. The second stage focuses on enhancing the nutritive value of cereals such as golden rice, which increases the Vitamin A intake, and reduces child blindness. The third stage focuses on the development of plants as nutrient factories to supply food, feed and fiber. The critics of biotech crops include Altieri (2001), Greenpeace, Oxfam, Global Justice Ecology Project, Vandana Shiva, Zerbe (2004). Critics emphasize the potential health and environmental risks and the dominance of multi-national corporations in research and decision making in developing countries.

The European Union (EU) is one of the small group of countries standing against these trends. The European Commission is strictly for high level of control in this field of agricultural sector. The single steps in legal regulations are the clear proof. In the EU, seven countries (Spain, Czech Republic, Romania, Portugal, Germany, Poland and Slovakia) planted MON 810, a genetically modified maize variety from Monsanto, on a commercial basis in 2008. The total acreage for the seven countries increased from 88,673 hectares in 2007 to 107,719 hectares in 2008 (James, 2008), with Spain being by far the most important adopting country in Europe (Gomez-Barbero et al., 2008 a,b). However, in 2009, the EU acreage decreased by 9 % compared to 2008, partially due to a German ban on MON 810. According to James (2009) the decrease was associated with several factors, including the economic recession, decreased total plantings of hybrid maize and perceived disincentives due to onerous reporting of intended plantings of MON 810 (Kaphengst, 2011) In France and Germany, national cultivation bans for genetically modified Bt maize (MON810) were enacted in 2009. Both countries have suspended the approval issued according to EU law. In the meanwhile, stricter co-existence regulations apply in almost all EU member states (GMO Compass, 2009).

The main aim of this paper is to analyze the trends in the main biotech crops planting groups in the main producer countries. The partial aim is to analyze the impact on world agricultural commodity market in the possibility to operate without these crops. The selected groups of biotech crops analyzed in this article are soybeans, maize (corn), cotton and rapeseed (canola).

[1] in this contribution is term biotech crops equivalent GMO crops

Material and methods

Data used in this paper comes from the following sources: ISAAA Briefs No. 1-43: Global Status of Commercialized Biotech/GM Crops: 1996-2011 (author Clive James), National Agricultural Statistics Service (NASS, 2010-2011) - Agricultural Statistics Board, U.S. Department of Agriculture, FAOSTAT database (2011, direct access), CÉLERES AMBIENTAL (Brazil database) and FEFAC Statistical Yearbook 2009, 2010: Feed & Food.

The first used statistical methods are the Fixed Base Index Numbers and Chain Base Index Numbers. For Fixed Base Index Numbers (usually just called Index Numbers), the Base is given the value 100 and everything after that is given relative to the Base, going above 100 for higher values or below 100 for values which drop below the original. For Chain Base Index Numbers, each value is given an Index based on the previous value being used as the Base.

The second used statistical method is simple regression analysis of times series/ trend data, for predicting on next four years (2012-2015). Linear prediction is a mathematical operation where future values of a discrete-time signal are estimated as a linear function of previous samples. Linear regression can be used to fit a predictive model to an observed data set of y and x values. Simple linear regression predicted values of one variable.

The data are pairs of independent and dependent variables $\{(xi,yi): i=1,...,n\}$. The fitted equation is written $y = ax + b$, where y is the predicted value of the response obtained by using the equation. Regression coefficient represents the rate of change of one variable (y = million hectares) as a function of changes in the other (x = year); it is the slope of the regression line. The simple linear regression is counted by STATISTICA 10 Software.

The trends are able to determine the necessity of implementation the biotech crops planting into the agricultural systems everywhere (also in EU) and it is without the questions if the impact are mainly positive or negative.

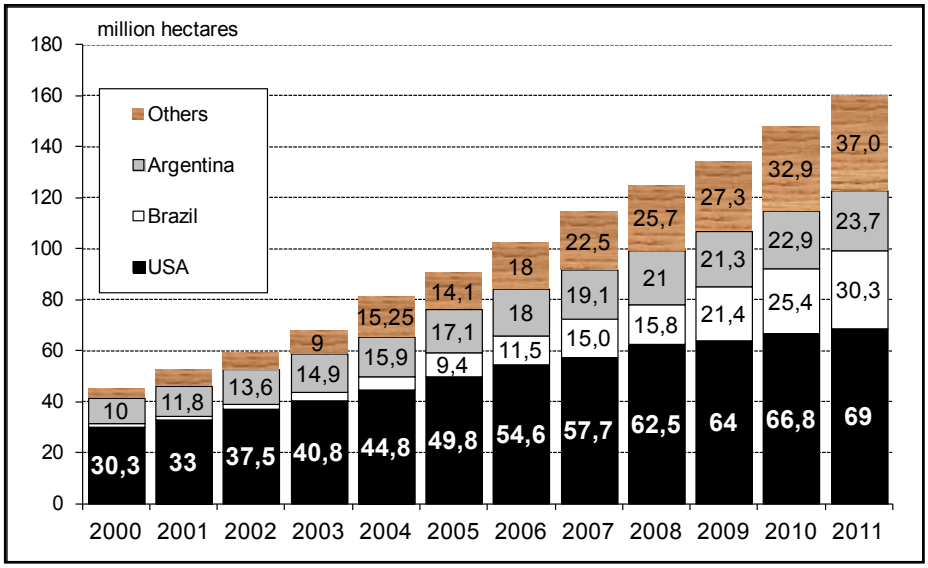
Results and discusion

1. Basic overview

The growth from 1.67 million hectares of biotech crops in 1996 to 160 million hectares in 2011 is an unprecedented 96-fold increase, making biotech crops the fastest adopted crop technology in the history of modern agriculture. Global acreage of biotech crops continued its strong growth in 2011 for the sixteenth consecutive year – a 8 %, or 12 million hectare increase, notably the third largest increase in 16 years, reaching 160 million hectares, – up significantly from a 10% growth or 14 million hectares increase and a total of 148 million hectares in 2010 (James, 2011). Of the 29 countries planting biotech crops, it is noteworthy that 19 were developing and 10 where industrial countries. The top nine countries each grew more than 2 million hectares - in decreasing order of acreage they were: USA (69.0 million hectares), Brazil (30.3), Argentina (23.7), India (10.6), Canada (10.4), China (3.9), Paraguay (2.8), Pakistan (2.6) and South Africa with 2.13 million hectares.

There is considerable potential for increasing the biotech adoption rate of the four current large acreage biotech crops (maize, soybean, cotton, and canola), which collectively represented almost 160 million hectares of biotech crops in 2011 from a total global potential of 320 million hectares; thus, there are approximately 160 million hectares for potential adoption (James, 2011). Developing countries grew close 50% (48,875%) of global biotech crops in 2011 and will exceed industrial countries acreage in 2012. In 2011, the growth rate for biotech crops was much faster in developing countries, 11% or 8.2 million hectares, versus 5% or 3.8 million hectares in industrial countries. The five lead developing countries in biotech crops are China and India in Asia, Brazil and Argentina in Latin America, and South Africa in Africa.

Total world area of GM crops is divided into main producing countries; it is illustrated in Graph 1. Till the 2009 were two states with the largest acreage USA and Argentina, from this year is on the second position Brazil. Brazil is perceived as the driving force for biotech crop investment in the future. From the view of share, in the year 2000 the USA produced nearly 67% of biotech crops, Argentina around 22% and Brazil was almost around zero % - all other countries around 11%. The share of the USA at the total biotech crops area is decreasing – in 2010 43,1%, the same situation is in Argentina – in 2010 14,8%, but other countries share grew to nearly 40% (from this group is important Brazil – more than 18,9%, Canada – around 6,5%, India – 6,5% and China – 2,4%; other countries – Paraguay, Pakistan, South Africa and Uruguay have each less than 2%). From the view of the growth rate the rapid increase in share can be seen only by Brazil and by some states from the group “Others” – for example India.



Source: Global status of commercialized biotech/GM crops: 2000-2011. ISAAA Briefs, ISAAA: Ithaca

Graph 1. Area (million hectares) GM crops in main producing countries.

	1996	2008	2009	2010	2011	Crops 2011: structure in %
Soybeans	0.4	65.8	69.2	73.3	75.4	47.1%
Maize	0.5	37.3	41.7	46.8	51.0	31.9%
Cotton	0.8	15.5	16.1	21.0	24.7	15.4%
Rapeseed	0.2	5.9	6.4	7.0	8.2	5.1%
Total	1.67	125	134	148	160	100%
Soybeans : Chain Index	x	12.3%	5.2%	5.9%	2.9%	x
Soybeans : Base Index	x	164.5	173	183.25	188.5	x
Maize : Chain Index	x	6%	12%	12%	9.0%	x
Maize : Base Index	x	74.6	83.4	93.6	102.0	x
Cotton : Chain Index	x	3.3%	3.9%	30.4%	17.6%	x
Rapeseed : Chain Index	x	7.3%	8.5%	9.4%	17.1%	x

Source: Global status of commercialized biotech/GM crops: 2010,2011. ISAAA Brief No.42,43, ISAAA: Ithaca, NY Fefac (2010). Based on USDA; IAAS; CÉLERES AMBIENTAL® Brazil, own calculation

Table 1. Distribution of Biotech Crops, by Crop, million hectares.

The distribution of the global biotech crop area for the four major crops is illustrated in Table 1 for the period 1996 to 2011. It clearly shows the continuing dominance of biotech soybean occupying 47.1% of the global area of biotech crops in 2011; the entire biotech soybean acreage is herbicide tolerant RR®soybean. Biotech soybean retained its position in 2011 as the biotech crop occupying the largest area globally, occupying 75.4 million hectares in 2011, 2.9% higher than 2010 and biotech maize had the second highest area at 51.0 million hectares and also had the third highest year-to-year growth rate for any biotech crop at 9%. Biotech cotton reached 24,7 million hectares in 2011 and grew at the highest of all biotech crops at a rate of 30.4% between 2009 and 2010 (17,6% between 2010 and 2011). Rapeseed reached 8.2 million hectares in 2011 with an 17.1% global growth rate and planted in Australia for the first time in 2009.

Table 1 shows the Fixed Base Index Numbers and Chain Base Index Numbers of described GMO crops. The share is increasing for each commodity, but the important is the dynamic in last four analyzed years (2008 – 2011), because it shows

the trend for next years. The Chain Base Index Numbers is higher for maize (9% between 2010 and 2011) than for soybeans (nearly 3% between 2010 and 2011). Soybeans are also single crop with falling dynamic in last four years. Other two crops are also increasing – rapeseed slowly (the main reason is given by approach to GMO rapeseed in the most of states where it is planting) and cotton with big jump in 2010 (30.4% against 2009). The limits which can determine the dynamic of growth is partially possible to see in the Graph 3.

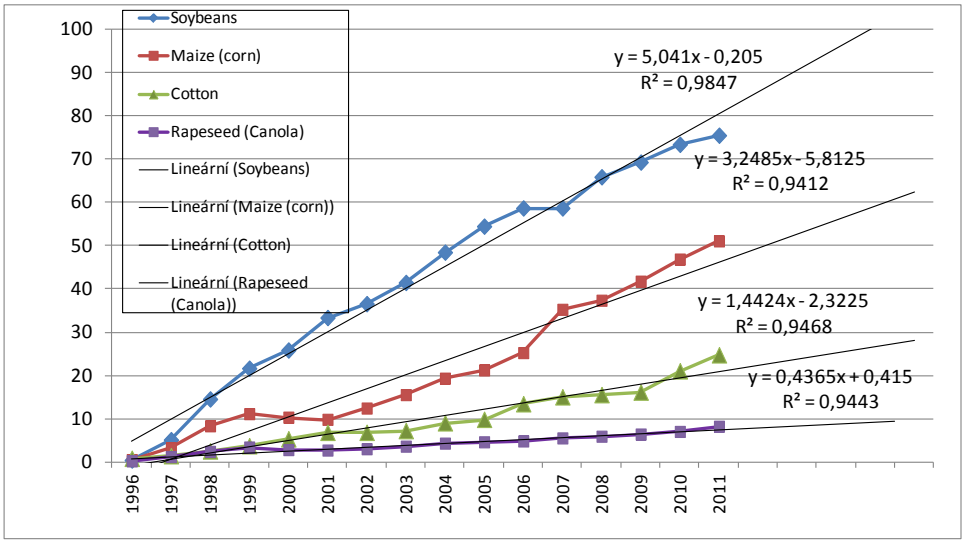
Roundap Ready sugarbeet is an important relatively new biotech crop first commercialized in the USA and Canada in 2007, and an increased adoption rate of 59% in 2008, and 95% in 2009 when acreage reached more than 1 million hectares (in 2011) – this makes it the fastest adopted biotech crop since the genesis of commercialization in 1996. Roundup Ready sugarbeet varieties have been planted in 10 U.S. states: Colorado, Idaho, Michigan, Minnesota, Montana, Nebraska, North Dakota, Oregon, Washington and Wyoming. Canadian growers planted more than 37,000 acres in two provinces, Ontario and Alberta. (Monsanto, 2011).

RR alfalfa, first grown in 2006, occupied 102,000 hectares equivalent to approximately 5% of the 1.3 million hectare seeded in the USA in 2009, with no further planting taking place in 2009 until the restraining order on planting is rescinded in the USA. Small acreage of biotech virus-resistant squash and papaya continue to be grown in the USA and China also grows about 4,500 hectares of PRSV resistant papaya and 447 hectares of Bt poplar.

Regression line, calculate in the Graph 2 is linear (y = ax + b) and the regression coefficient is the constant (a or Beta). Regression coefficient represents the rate of change of one variable (y = million hectares) as a function of changes in the other (x = year); it is the slope of the regression line.

The highest value of regression coefficient includes soybeans line, Beta = 5.041, i.e. year-to-year prediction growth is 5.041 million hectares. In 2015 can be achieved 100.62 million hectares of biotech soybeans (see Table 2, paragraph: Year 2015 prediction).

The second highest value of regression coefficient includes maize line, Beta = 3.24853, i.e. year-to-year prediction growth is 3.24853 million hectares. In 2015 can be achieved 59.16 million hectares of biotech maize. The third highest value of regression coefficient includes cotton line, Beta = 1.44235, i.e. year-to-year prediction growth is 1.44235 million hectares. In 2015 can be achieved 26.52 million hectares of cotton. The lowest value of regression coefficient includes rapeseed (canola) line, Beta = 0.43647, i.e. year-to-year prediction growth is 0.43647 million hectares. In 2015 can be achieved 9.14 million hectares of rapeseed (canola).



Source: Global status of commercialized biotech/GM crops: 1996-2011. ISAAA Briefs, ISAAA: Ithaca, NY, own calculation, comment:term "lineární" means linear

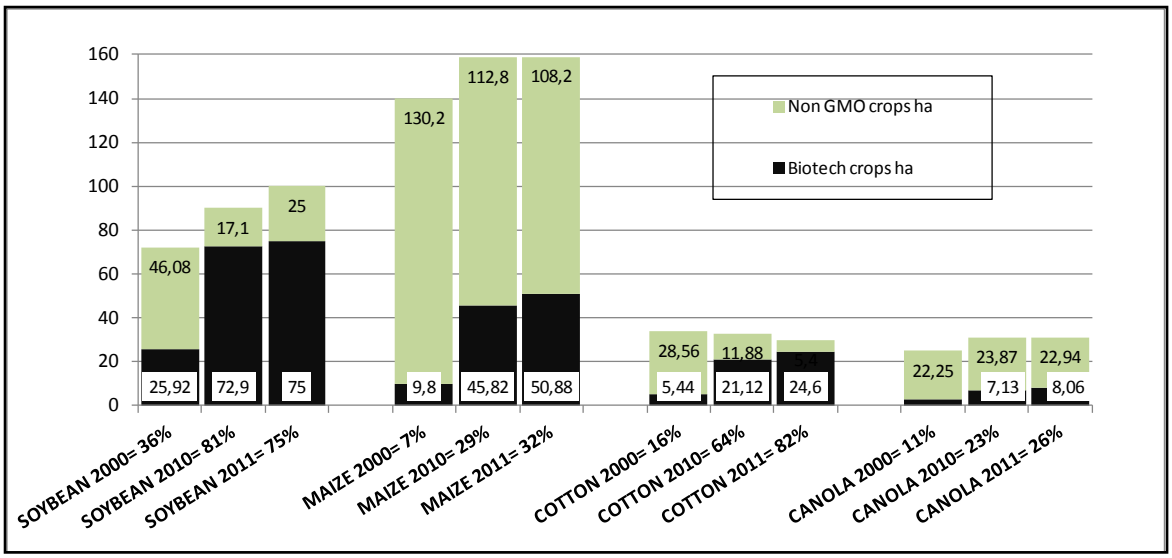
Graph 2. Distribution of Biotech Crops, by Crop, million hectares, regression analysis of times series.

	Absolute term	Beta coefficient	p-value (Beta coef.)	F (1,14)	Year 2015 prediction	-95% prediction	-95% prediction
Soybeans	-0.20500	5.04103	0.00000	902.78	100.62	96.16	105.07
Maize	-5.81250	3.24853	0.00000	223.93	59.16	53.39	64.93
Cotton	-2.32250	1.44235	0.00000	249.39	26.52	24.10	28.95
Canola	0.41500	0.43647	0.00000	237.52	9.14	8.39	9.90

Source: STATISTICA 10 Software, Data :Global status of commercialized biotech/GM crops: 1996-2011. ISAAA Briefs, ISAAA: Ithaca, NY

Note: In statistical significance testing, the p-value is under 0.015 by all Biotech Crops. The results are statistical significant.

Table 2. Main statistical characteristic of Biotech Crops distribution.



Source : Global status of commercialized biotech/GM crops: 2011. ISAAA Brief No.42, ISAAA: Ithaca, NY, own calculation

Graph 3. Global Adoption Rates (%) of Main Biotech Crops (million hectares), 2000 and 2011

The conclusions made from simple linear regression are statistically significant and correct, but there is necessary to compare the linear trends to real world situation. How it is written bellow, the important is the total acreage and the share of biotech crops. For example to achieve the 100 million hectare of biotech soybeans in 2015 means to exceed the total present acreage. But it is relatively possible (see Graph 3) and there is also second significant reason for exceed acreage of biotech soybeans – the positive approach to GMO in the main world producing countries. Growth of soybean is thus determined by fulfilled capacity in USA, Argentina and Brazil. From these reasons the realistic is prediction by corn and cotton. Growth in biotech rapeseed is determined by EU politics, EU is main world producer of rapeseed.

According to database FAOSTAT, in the 2010 total area harvested of soybeans reached 99.5 million hectares. Main producer were USA (30.9 million hectares, 31 percent of soybeans world area), Brazil (21.75 million hectares, 22 percent), Argentina (16.77 million hectares, 17 percent), India (9.8 million hectares, 10 percent) and China (9.19 million hectares, 9 percent of soybeans area. In the 2010 total area harvested of maize reached 158.6 million hectares. Main producer were USA (32.2 million hectares, 20 percent of maize world area), China (31.2 million hectares, 10 percent), Brazil (13.8 million hectares, 9 percent), India (8.3 million hectares, 5 percent) and Mexico (6.2 million hectares, 4 percent of maize world area). In the 2010 total world area harvested of cotton reached 33.1 million hectares and total area harvested of rapeseed reached 30.9 million hectares (Fefac, 2009).

	2002	2007	2008	2009	2010	2011
USA: Soybeans	74	92	92	91	93	94
USA: Maize	32	60	80	85	86	88
USA: Cotton	71	87	86	88	92	90
Argentina : Soybeans	95	99.5	99.5	99.5	99.5	99.5
Argentina : Maize	30	65	83	85	85	88
Brazil : Soybeans	60	64	65	71	76	79
Brazil : Maize	n.a	n.a	12	43	74	78

Source : Fefac (2009, 2010). Based on USDA; IAAS; CÉLERES AMBIENTAL® Brazil

Table 3. Plantings of GMOs in major countries as % of total acreage.

2.Biotech crops for food and feed

In the world, 29 % of soybean production is used as food and industry, 71 % is used for livestock feed. The increased volume of imported soy entering Europe primary comes from Argentina and Brazil. In 2007, Argentina and Brazil supplied nearly four-fifths (79.3 percent) of the 32.3 million metric tones of imported feed going to the EU. While these two countries are the key exporters, a large share of the exported soybeans grown in Paraguay and Uruguay are shipped through the soybean export terminals.[2] Average EU consumers, who eat 41 kilos of pork, 22 kilos of poultry and 9 kilos of beef annually, consume almost 56 kilograms of hidden biotech soy.

Soybeans, soymeal, maize, wheat, rapeseed and rapeseed meal are used in livestock feed. Yet not all the ingredients for livestock feed used in the EU, either prepared by commercial firms or on-farm, are solely sourced within the EU market (Nowicki, P. et al. 2010). Among the imported ingredients are maize and soy as well as the products derived from them (e.g. maize gluten feed and soy meal). The import of protein feed is a particularly sensitive issue where countries (including EU Member States) do not have the capacity to meet domestic needs of either soy or/and maize, and therefore depend on the capacity of a few key suppliers.[3] Aminy those countries/regions are the EU but also China, which together represent over half of world demand for imported livestock feedstuffs.

During the last three marketing years (2007/08 to 2009/10), the EU imported on average 34.1 million metric tons of soymeal equivalents[3], which accounted for 30% of the total tradable amount in the world market. As regards maize, the EU imported on average 7.9 million metric tons per year and over the same period - 9% of the total tradable amount (USDA-FAS, 2010a and 2010b)[4]. The global demand of crop protein, however, is being amplified around the world by the rapid economic growth of developing countries, which are catching up to the more mature economies (e.g. China imports of soybean increased by 43% during the last three marketing years; see USDA-FAS, 2010a and 2010b). It is in this context that the prospect for EU demand is to be considered.

European feed imports surged since the WTO went into effect. Since 1995, soy meal imports from outside the European Union to the 15 member states prior to 2004 (EU-15) grew 57.1 percent to 20.2 million metric tonnes in 2007. Total maize imports nearly doubled to 21.6 million metric tonnes. Soy exports from Latin America fueled deforestation. Four-fifths of EU soymeal imports came from Brazil and Argentina. The demand for more soybeans has been a key catalyst for clearing 44.5 million acres of forests in these two countries.

3. Biotech crops for fuel and fiber

Cotton is the main biotech crop produced for fiber. Leaders in this regard are the USA, India and China. In India, field area rose from 7.6 to 8.4 million hectares. In 2009, 87 per cent of Indian cotton production was based on GM cotton. (GMO Compass, 2009)

The USA were for a long time the main world producer of GM cotton, around the year 2004 the other world production was exceeded USA and from this time till now is great increase in biotech cotton worldwide – for example in 2000 was USA

[2] Eurostat. "Food: From Farm to Fork Statistics." 2008 at 13.

[3] Argentina, Brazil, Paraguay, Serbia, Ukraine and the USA are the primary EU sources for soy and/or maize.

[4] USDA-FAS (2010a). Grain: World Markets and Trade. Circular Series FOP 9–10, September 2010.
USDA-FAS (2010b). Oilseeds: World Markets and Trade. Circular Series FOP 9–10, September 2010.

share 72%, in 2008 17%. In 2010 the share of cotton on the whole area of GMO crops was around 14.2% - area of 21 mil ha. (ISAAA Brief, 2008)

Brazil is good example of fast adoption of biotech cotton in the agricultural production. Generally is the total area in time decreasing, but the yield is growing up (nearly 2 million ha in 1990 and now less than 1 million ha, but total production from around 0.7 million MT in 1990 – the lowest was in the middle of nineties (around 0.3 mil MT) – to nearly 1.5 million MT presently. There is no possible to make the result that the total production is increasing on the ground of increasing the share of biotech Cotton. How is in Kaphengst report (2010) in each of five analyzed countries is the yield of biotech cotton higher than in conventional cotton, but the differences are significant – less than 1% in USA till 50% in India. The Bt cotton is in Brazil used from 2004 and today it is on the area of around 0.2 mil ha.

This crop is also the object of one of the first studies about the influence of planting GMO on soil quality. The Navdanya study (2009) is the first that has looked at the long term impact of Bt cotton on soil organisms is a wake up to regulators worldwide. It also shows that the claims of the Biotechnology industry about the safety of GM crops are false. The soil, its fertility, and the organisms which maintain the fertility of soil are a vital aspect of the environment, especially in the context of food and agricultural production. A recent scientific study carried out by Navdanya (2009), compared the soil of fields where Bt-cotton had been planted for 3 years with adjoining fields with non GMO cotton or other crops. At this rate of described soil degradation, in a decade of planting with GM cotton, or any GM crop with Bt genes in it, could lead to total destruction of soil organisms, leaving dead soil unable to produce food.

Generally for fuel can be used all described crops in this article. The principles of biofuels are based on liquid extracts from the crops – the oil for biodiesel and the ethanol for bioethanol. Nowadays there is no GM crop planting especially for burning. The use of GM crops is thus for combustion motors. The main share of planted biotech crops processed on fuel is in the USA. The biofuels are widely supported in developed countries (the natural conditions only in the same type of country as for example is Brazil let get enough energy from the crops (sugar cane) for successful competition of biofuels with fossil fuels) and thus the consumption is mainly in these countries. From this reason is relevant example of using biotech crops for fuel the USA. The highest share used for biofuel has maize (and 86% of maize acreage is GMO), around 21% in domestic market, but more than 17% is exported and there is also potential for fuel production. From the total domestic soy consumption (soybean oil is the main feedstock for biodiesel production in the USA) only 3% are used for biodiesel, but from the domestic soybean oil consumption is the share of 14% (and 93% of maize acreage is GMO). (Food&Fuel, 2008)

Conclusion

In the context of the main trends in world production of analyzed crops, the question of EU ability to protect the consumption of food, feed, fiber and fuel against the biotech crops is important. For example: the EU is depending on soya import, mainly for feed – it is the result of agrarian policy without the signals of any change of this situation in the near future – so, EU has to import soybeans and soybean meal, and if they will probably be worldwide in next few years nearly from 100% GMO, there will not be any other possibility for EU than to accept biotech crops as the standard part of agricultural production. Now, around 75% of soy import to EU is from Brazil and Argentina. In the field of crops for feed, the dependence of EU on the import from GMO acceptable country is significant. The second important part of agrarian commodity import is for fuel – the import from Brazil is the most fundamental (sugar cane for bioethanol, but it is not GMO yet), as well as the import of soybeans and other oils, but the segment of biodiesel is based on rapeseed produced in EU (about 65%), the share of soya oil is about 14% and palm, sunflower and other oils (each less than 10%) (Gelder at al., 2008). The question of biotech crops for fiber is the question about cotton – this part in the relation of import to EU is not solved in this contribution, but the presumption is that it is imported in the processed form as textiles and clothes. The impact of world biotech crops production in the field of food in EU seems to be not significant presently, because of strict EU policy against GMO, but in this field is valid also the presumption from the beginning of this conclusion.

Worldwide, in the near future the development in biotech crops is expected mainly in Africa (South Africa, Egypt) and in some states in Asia (Pakistan) and Latin America (Brazil, potential in Mexico) – it relates to the share of biotech crops on total acreage in these countries. ISAAA predicts the doubling of acreage of biotech crops (more than 300 mil. ha) and the share in arable land in the world of about

20%. The amount of GM crops has also been increasing – new types of rice, sugar cane, sugar beet, potatoes, etc.

Acknowledgements

Pieces of knowledge introduced in this paper resulted from solution of an institutional research intention MSM 6046070906 „Economics of resources of Czech agriculture and their efficient use in frame of multifunctional agri-food systems“

Corresponding author:
Ing. Helena Řezbová, Ph.D.
Department of Economics, Faculty of Economics and Management
Czech University of Life Sciences Prague
Kamýcká 129, 165 21 Prague 6, Czech Republic
Phone: +420 2 2438 2087
E-mail: rezbova@pef.czu.cz

References

[1] Altieri, M.A. (2001). Genetic Engineering in Agriculture: The Myths, Environmental Risks and Alternatives, Food First. Oakland, CA., ISBN 0-935028-93-5.

[2] CÉLERES AMBIENTAL® , Brazil database, [Online], Available : http://www.celeres.com.br/1/index.html [20.1. 2012- 5.5. 2012].

[3] Codex (2003) Alinorm 03/34: Joint FAO/WHO Food Standard Programme, Codex Alimentarius Commission, Appendix III, Guideline for the conduct of food safety assessment of foods derived from recombinant-DNA plants (CAC/GL 45-2003), 25th Session, Rome, Italy, June 30–July 5, 2003, pp. 47–60. [Online], Available: http://www.codexalimentarius.net/download/standards/10021/CXG_045e.pdf> [20.1.2012].

[4] Chassy et al., Chassy, B., Hlywka, J.J., Kleter, G.A., Kok, E.J., Kuiper, H.A., McGloughlin, M., Munro, I.C., Phipps, R.H., Reid, J.E. (2004). Nutritional and safety assessments of foods and feeds nutritionally improved through biotechnology (prepared by Task Force of the ILSI International Food Biotechnology Committee). Comp. Rev. Food Sci. Food Safety 3, 38–104. [Online], Available: <http://members.ift.org/NR/rdonlyres/27BE106D-B616-4348-AE3A-091D0E536F40/0/crfsfsv3n2p00350104ms20040106.pdf> [15.4.2012].

[5] Chassy et al., (2008). Recent developments in the safety and nutritional assessment of nutritionally improved foods and feeds. Comp. Rev. Food Sci. Food Safety 7 (2008), pp. 50–113.

[6] Chen, Ch.Ch., Tseng, W.Ch. (2011). Do Humans Need GMOs? A View from a Global Trade Market, Journal of American Academy of Business, Cambridge, AgBioWorld Vol. 8 (1), p.147 [Online], Available: http://www.agbioworld.org/biotech-info/articles/biotech-art/need-GMOs.html [11.4.2012].

[7] Gelder, J. W., Kammeraat, K., Kroes, H. (2008). Soya consumption for feed and fuel in the European Union, Profundo, economic research. [Online], Available: http://www.foeeurope.org/agrofuels/FFE/Profundo%20report%20final.pdf, [18.3.2012].

[8] Dewar, A.M..(2003), May M.J., Woiwod, I.P., Haylock, L.A., Champion, G.T., Garner, B.H., Sands, RJN, Qi A, Pidgin, J.D. ‘A novel approach to the use of genetically modified herbicide tolerant crops for environmental benefit’ Proceedings of The Royal Society of London Series B-Biological Sciences, Vol.270, Issue 1513, p.335-340, London, ISSN: 0962-8452.

[9] FAOSTAT database (2011). [Online], Available: http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor [20.1. 2012-5.5. 2012].

[10] FEFAC Statistical Yearbook 2009. Feed & Food, European Feed Manufacturers' Federation, 2010, Bruxelles, Arnaud Bouxin, [Online], Available: http://www.fefac.org/file.pdf?FileID=32696 [20.1. 2011- 5.5. 2012].

[11] Food&Fuel (2008). Working Paper. United Soybean Board, [Online], Available:http://www.soyconnection.com/soybean_oil/pdf/foodvsfuel_soy_biofuels.pdf [25.3.2012].

[12] Galvão, A. (2010). The impact of decisions related to the use of products of biotechnology in agriculture. Environmental and Economic Benefits of Biotechnology in the Brazilian Agriculture, Proceedings of the Conference, September 28th, 2010, US Embassy, London, [Online],Available :http://photos.state.gov/libraries/unitedkingdom/164203/conference_28sept2010/Anderson_Galvao-Celeres-AgBiotech_in_Brazil.pdf [27.3.2012].

[13] GMO Compass. Website supported by the European Union within the European Commission's, part Agri-Biotechnology, [Online], Available: http://www.gmo-compass.org/eng/agri_biotechnology/gmo_planting/257.global_gm_planting_2009.html [27.3.2012].

[14] ISAAA Brief 39 – 2008. Executive Summary, [Online], Available: http://www.isaaa.org/resources/publications/briefs/39/executivesummary/default.html [06.03.2012].

[15] ISAAA Releases 2009. Report about the Global Status of Biotech Crops, [Online], Available: http://www.whybiotech.com/?p=1801 [06.03.2012].

[16] Kaphengst,T., Nadja, B., Evans, C., Finger, R., Herbert, R., Morse, S., Stupak, N. (2010). Assessment of the economic performance of GM crops worldwide. Report to the European Commission, March 2011. [Online], Available: http://ec.europa.eu/environment/funding/pdf/calls2009/specifications_en09010.pdf, [26.03.2012].

[17] Navdanya (2009). Monsanto's Bt Cotton Kills the Soil as Well as Farmers, study', [Online], Available: http://www.globalresearch.ca/index.php?context=va&aid=12432 [06.03.2012].

[18] NASS (2010), National Agricultural Statistics Service, Agricultural Statistics Board, U.S. Department of Agriculture, June 30, 2010, [Online], Available: http://usda.mannlib.cornell.edu/usda/current/Acre/Acre-06-30-2010.pdf [05.03.2012].

[19] NASS Report (2011), Ackerage, National Agricultural Statistics Service, Agricultural Statistics Board, United States Department of Agriculture (USDA), ISSN 1949-1522 [Online], Available : http://usda01.library.cornell.edu/usda/current/Acre/Acre-06-30-2011.pdf [20.3.2012].

[20] Nowicki, P. et al. (2010). Study on the Implications of Asynchronous GMO Approvals for EU Imports of Animal Feed Products, Final Report (Contract N° 30-CE-0317175/00-74), [Online], Available: http://ec.europa.eu/agriculture/analysis/external/asynchronous-gmo-approvals/summary_en.pdf [27.03.2012].

[21] James, C. (2011). Global status of commercialized biotech/GM crops: 2011, ISAAA Brief No.42, ISAAA: Ithaca, NY., ISBN 978-1-892456-49-4, [Online], Available: http://www.isaaa.org/resources/publications/briefs/42/executivesummary/default.asp [07.03.2012].

[22] Parente, P. (2010). Bunge Brazil. Proceedings of the Bunge Investor Day, September 23th, 2010, Paranaguá, [Online], Available: http://www.bunge.com/public/pdfs/PedroParente.pdf [22.04.2012]

[23] Raven, P. (2010). Does the Use of Transgenic Plants Diminish or Promote Biodiversity? New Biotechnology 27, pp. 601–606.

[24] Ruttan, V.W. (1999). Biotechnology and agriculture: a skeptical perspective. AgBioForum 2 (1), pp.54–60.

[25] Tait, J. and G. Barker, G. (2011). Global food security and the governance of modern biotechnologies. EMBO reports, Vol.12., p.763-768, [Online], Available: http://www.nature.com/embor/journal/v12/n8/full/embor2011135a.html [22.4.2012].

[26] Zerbe, N. (2004). Feeding the famine? American food aid and the GMO debate in Southern Africa, Food Policy 29, pp. 593–608.

[27] Zhu Hong-de, XIE Fu-ti, FEI Zhi-hong et al. (2009). Breeding of New Soybean Variety Kenjiandou 41 with Early Maturing and High Oil Content and It's Cultivation Techniques for High Yield, Journal of Heilongjiang, August First Land Reclamation University; 2009-02.

Agris on-line Papers in Economics and Informatics

Volume IV Number 2, 2012

The Evaluation of Use and Quality of Public E-services among Enterprises

M. Ulman, J. Jarolímek, A. Vasilenko, E. Kánská

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

Anotace

Článek se zabývá metodou hodnocení kvality elektronických služeb české státní správy. V článku je popsáno měření eGovernmentu provedené pro Evropskou komisi v roce 2010 a je porovnána současná úroveň využití elektronických služeb mezi zeměmi evropské sedmadvacítky a Českou republikou. Nejvíce využívané elektronické služby v České republice byly ohodnoceny v průzkumu mezi 452 podniky. Hodnocení bylo provedeno na základě metody CBG (Communication between Business and Government), která byla vyvinuta na Katedře informačních technologií na Provozně ekonomické fakultě České zemědělské univerzity v Praze. Výsledky šetření jsou srovnány s předchozími průzkumy a s průzkumy Českého statistického úřadu a Eurostatu.

Klíčová slova

Hodnocení kvality, státní správa, veřejná správa, metoda CBG, elektronická služba.

Abstract

The paper deals with the quality evaluation of electronic services. The European Commission eGovernment benchmarking effort is reviewed and the current level of use of basic electronic services for enterprises is compared between EU 27 member countries and the Czech Republic. Then, the most frequently used services are evaluated among 452 enterprises in the Czech Republic. The evaluation was based on a method CBG (Communication between Business and Government) that has been developed at the Department of information technologies at the Faculty of Economic and Management at Czech University of Life Sciences (CULS) in Prague. Results of the survey are compared to prior surveys, Czech Statistical Office and Eurostat surveys. Pieces of knowledge introduced in this paper resulted from solution of an institutional research intention MSMT 6046070906 „Economics of resources of Czech agriculture and their efficient use in frame of multifunctional agri-food systems“.

Key words

Evaluation of quality, state authorities, public administration, CBG method, electronic service.

Introduction

Quality benchmarking and evaluation in eGovernment is highly researched area. The beginning stage of sheer excitement about implementing electronic services for citizens and companies by governments was transformed then into the stage of critical reviews of real benefits of eGovernment.

Lacks of financial resources in governmental budgets all around Europe and in other parts of world puts pressure to also eGovernment projects. The real usage and demand of users of public e-services are weighted and become major factors of eGovernment benchmarking and evaluation efforts. There is a need for evaluation efforts that assess effectiveness of eGovernment systems (Wang and Liao, 2007). Such evaluation efforts can enable government agencies to determine if they are capable of doing the required task and delivering services as expected (Gupta and Jana, 2003). However, while information systems (IS) success models have been widely investigated, the factors which best measure the success of eGovernment IS need further investigation (Floropoulos et al., 2010).

Despite more than ten years of research on eGovernment, some authors claim that there is a need for new models to meet the contemporary and future challenges of eGovernment. It must better understand the relation between technology, organization and government values (Grönlund, 2010).

Czech government has been methodically coordinating quality management in public administration (Špaček and Nunvářová, 2009) through several strategic initiatives such as Bill on Standardization of Selected Public Services (2002), Strategy for support of public services availability and quality (2004) where 69 public services are suggested for standardization and the latest is Efficient Public Administration and Friendly Public Services – Strategy on Realization of Smart Administration in the Period 2007 – 2015 ("Smart Administration strategy" approved in 2007). However, the use of quality instruments such as CAF, Balanced Scorecard, model of excellence and other, are voluntarily and the Czech government is not directive in that.

The number of enterprises in the Czech Republic that used at least once the Internet for interaction with public authorities is quite high – 95 % of enterprises in 2010 (CZSO, 2011), which was 19 % higher than in EU-27 countries where the rate was 76 % (Eurostat, 2011). In 2009, 82 % of enterprises in the Czech Republic used the internet to search for information on public administration web sites and 79 % to download form from the website. Sending forms by e-mail was conducted in 61 % of enterprises and full electronic treatment of procedure was used at almost half of enterprises (48 %) (CZSO, 2011). While in EU-27 countries, there was an average of 68 % of enterprises obtaining information from public authorities' websites, 68 % enterprises downloading forms from public authorities' websites, 60 % of enterprises using the Internet to return completed forms, and 13% using the Internet for e-procurement with public authorities (Eurostat, 2011). Overall use of e-services by enterprises in the Czech Republic is close to the top, but the lower uptake of particular applications must be investigated and increased.

The connectivity to the Internet with the fixed broadband access is also important factor influencing the usage of eGovernment on-line services and their supply and quality (Arduini et al., 2011). In 2011, CZSO (2011) claimed that almost 89 % of Czech enterprises accessed the Internet with the fixed broadband connection, and 25 % of mobile broadband users among enterprises. The EU-27 average in broadband (mobile or fixed) was 89 % of enterprises (Eurostat, 2011). In both surveys, the cohort of enterprises included enterprises with 10 or more employees, but the NACE categories 01-03 (agriculture, forestry and fishing) and 05-09 (mining and quarrying) are omitted. Some other minor categories, such as education, human health and social work activities, other activities and arts, entertainment and recreation are not represented in these surveys as well. The Czech survey included financial and insurance firms (NACE 64-66), but Eurostat did not.

The first objective of this paper is to review the CBG method in compliance with EU benchmarking framework for basic e-services for enterprises. The second objective is to examine the current level of use and quality of basic e-services for businesses in the Czech Republic. Possible solutions of issues and future research activities are also proposed here.

Material and methods

The use and quality evaluation of electronic services among Czech enterprises and public authorities is run by the group of authors from the Department of Information Technologies at the Faculty of Economics and Management of the Czech University of Life Sciences (CULS) in Prague since October 2010.

The original form of the evaluation was focused on the quality of the selected set of electronic services for communication of state agencies of the Czech Republic with privately owned companies and among agencies themselves (Ulman et al., 2011) and (Ulman and Kubata, 2011). The evaluation was made from the user's point of view. The respondents evaluated seventeen electronic services in the questionnaire survey. The selection of services included only those services that were provided by the state authorities (ministries and courts), not online services served by local authorities and self government agencies. The evaluation criteria were set by the CBG method that utilized a simple quality model based on ISO standard and evaluated given characteristics of quality of electronic services. Data gathered in the survey were processed with the basic statistical procedures.

The first round of survey was conducted in fall 2010 and answers from 253 respondents were obtained (Ulman et al., 2011). The second round of evaluation was done in the period February 2011 and March 2011 and 177 answers were got (Ulman and Kubata, 2011). The third round was

taken between October 2011 and January 2012 and 848 respondents were involved. In all surveys, both public authorities and enterprises were asked.

Between the second and third survey, the list of electronic services for B2G communication was evaluated and revised. For those services that were found as the most frequently used by users the evaluation of given quality characteristics indicators was done here.

Design of the quality indicators model of e-services

There are many models for the software quality assessment. The most frequently used approach is according to the ISO 9126 software quality model and the ISO 9000 standard that defines the quality in general: ‘‘The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs’’(ISO, 2000).

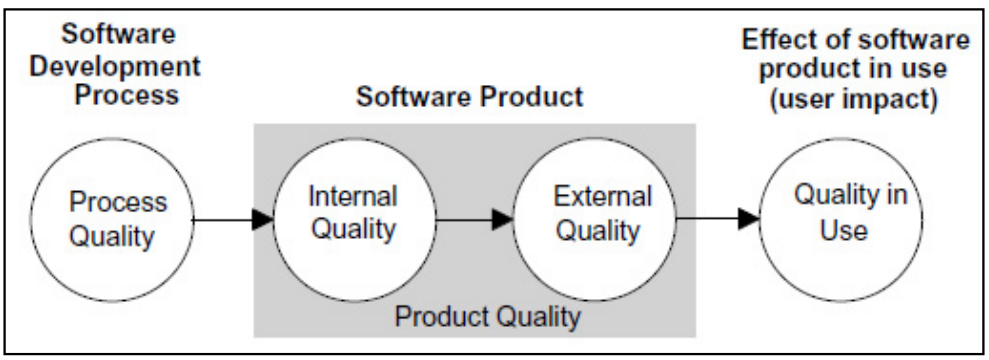
ISO/IEC 9126 classifies software quality into four categories (see Figure 1):

- Process quality: quality of software lifecycle processes.
- Internal quality: quality of intermediate products, including static and dynamic models, documentation and source code.
- External quality: quality of the final system as assessed by its external behaviour.
- Quality in use: effect of the system in use—the extent to which users can achieve their goals using the system (ISO/IEC, 2001).

The eGovernment evaluation comprises the quality among standard public sector indicators (Flynn, 2002), (Heeks, 2006). The CBG method is designed to evaluate the quality of use of electronic services (that are in fact software artefacts), which means that it is focused on the effect of services from the user’s point of view. The user requirements for the quality of use are represented as attributes in the ISO 9126 model. Each attribute belongs to at least one group of quality characteristics. Each characteristic is rendered with one or more attributes (ISO/IEC, 2001). The ISO 9126 is taken as the most comprehensive (Behkamal et al.,2008), even though some authors (Vaníček, 2008) reproach that the model is not well-arranged, that some attributes are inappropriately measured and that it is oriented towards agenda data processing. Despite above mentioned facts, the ISO 9126 model proves to be the most suitable as a foundation for the quality evaluation of electronic services. Some models and eGovernment benchmarking frameworks operate with so-called indicators (eGep, 2006). The indicator will be understood equal as the characteristics of the quality of use. The CBG method evaluates the quality of electronic services in compliance with characteristics of the quality of use that is mentioned by Vaníček (2008). The name of the fourth quality characteristics was modified:

1. Effectiveness: an ability of the system to ensure achievement of goals in precise and full manner.
2. Productivity: an ability of the system to ensure effectiveness with an adequate use of resources.
3. Safety: an ability of the system to permit only an adequate degree of risk of threat to people, environment, property or business interests under the use of system in the given context.
4. Satisfaction: of a user with the use of the system.

The model of evaluation of quality characteristics attributes by the ISO standard is applied on six services. Five of them were evaluated as most frequently used by users. There was one new service added in the list – public procurement. Because it was supposed that the service was also frequently



Source: Behkamal et al., 2008.

Figure 1 ISO 9126 software quality model.

Quality attribute/ e-service	Information system of data boxes	Electronic submission of social security and insurance [1]	Electronic submission of taxes (Tax Authority Portal)	Excerpts from public registries and submissions at Czech POINT [2]	Electronic communication with courts (Justice.cz)	Electronic public procurement (isvzus.cz)
How many data messages/submissions are sent or received via the service in your organization in a month?	< 1 message <10 messages <100 messages >100 messages					
Is sending or receiving of data messages time--saving for you?	yes no					
Is the service useful for your organization?	yes no					

[1] Three types of submissions at Public administration portal are included: Records on pension insurance, Registration and unregistration of employees for health insurance, Survey of income and expenses of the self-employed persons.

[2] Extracts from Trade Register and Commercial Register, extracts from the insolvency register, extracts from the List of Qualified Suppliers, extracts from the Land Registry, submissions according to the Trade Licensing Act (§ 72), extracts from the drivers' score, extract from the Criminal Records and submissions to the registry participants of the module of car wrecks.

Table 1 The list of attributes and characteristics quality and their measurement for selected services.

used and was of high importance for its users, especially private companies and public authorities. Finally, there were six electronic services in total to be evaluated in this survey.

To accomplish the quality evaluation of service, the key quality attributes for each service were identified. Each quality attribute belongs to one quality characteristics. Attributes were chosen by the author on the basis of previous surveys of quality evaluation by the CBG method (Ulman et al, 2011), (Ulman and Kubata, 2011), and according to recommendations of other authors (Heeks, 2006), (eGep, 2006).

Measurement

Responses to questions were gathered through online survey and stored in the database. Respondents replied to three categories of questions: classification figures about the organization, evaluation of basic eGovernment services (importance of service, expected level of implementation, actual level of implementation) and evaluation of quality attributes of selected services (effectiveness, productivity, safety and satisfaction). Each respondent assessed only those services that were actually used in the organization. Their answers were analysed in the worksheet processor.

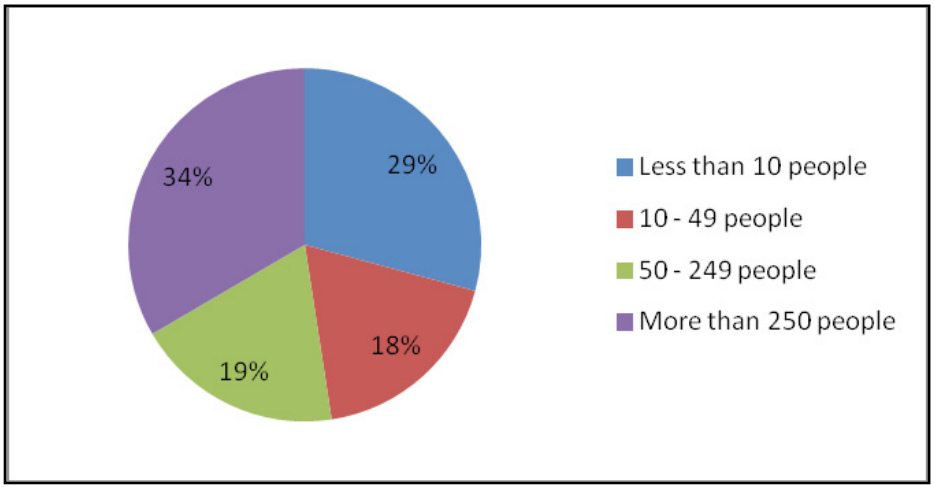
Dissemination of results

The electronic services quality evaluation regarding the user's effect could be recognized as a repeated analysis of user's requirements in the software engineering. It is worthy to observe the evolution trend of these requirements in time. The objective of the quality evaluation of eGovernment services by CBG method is to contribute to matching electronic public services demand and supply. One of technical provisions that could help to maintain collected data is to build a data base that would be periodically updated and would provide current overview of quality of the most used services. It will require to design and develop a web application capable to present results of surveys on a website. The web application would serve as an information source for other researchers, eGovernment software developers, administrators and for professionals in public services.

Results and discussion

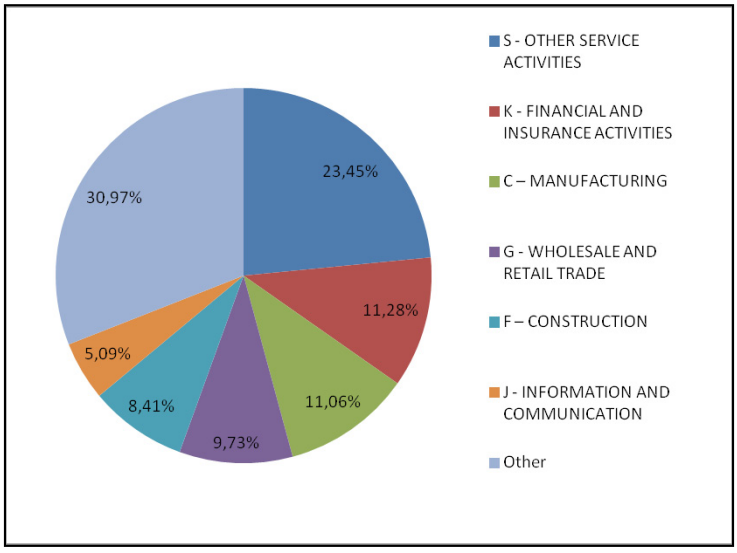
There were represented in total 452 enterprises in the survey. More than a third of the respondents (34 %) came from large enterprises with more than 250 people, but the second biggest group (29 %) were small enterprises with less than 10 people. This distribution of respondents is rather different than in the last survey by the Czech Statistical Office (CZSO, 2011), where the small enterprises possessed the overwhelming majority.

Enterprises by the classification of economic activities were represented as follows: other service activities (23,45 %), financial and insurance activities (11,28 %), manufacturing (11,06 %) and



Source: own elaboration, 2012

Figure 2 Enterprises by the number of employees.



Source: own elaboration, 2012

Figure 3 Enterprises by the type of economic activities (NACE) - shortened.

wholesale and retail trade (9,73 %). Activities represented with less than 5% were grouped into the category other (30,97 %). The cohort of respondents also covered the NACE categories 01-03 agriculture, forestry and fishing (2,88 %), and NACE 05-09 mining and quarrying (0,44 %) which in final turn did not participated much in results. But NACE 64-66 financial and insurance firms took a significant amount (11,28 %) of respondents in the survey which could be seen in Figure 3.

Quality of use of e-services among enterprises in the Czech Republic

With respect to results of survey conducted in years 2010 and 2011 and to eGovernment evaluation made for European Commission (CAPGEMINI ET AL., 2010), the list of evaluated electronic services was revised.

The European Commission inspected eight basic electronic services for businesses in its study (CAPGEMINI ET AL., 2010), while the authors' previous survey assessed seventeen services. Basic services suggested in the survey for European Commission are also included in the CBG study, excepting public eProcurement and eTaxes. EC assessed separately corporate tax and its declaration and notification, and value added tax (VAT), including its declaration and notification. Both taxes were summarized in CBG survey under the service no. 3 – Electronic submission of taxes (Tax portal by the Ministry of Finance).

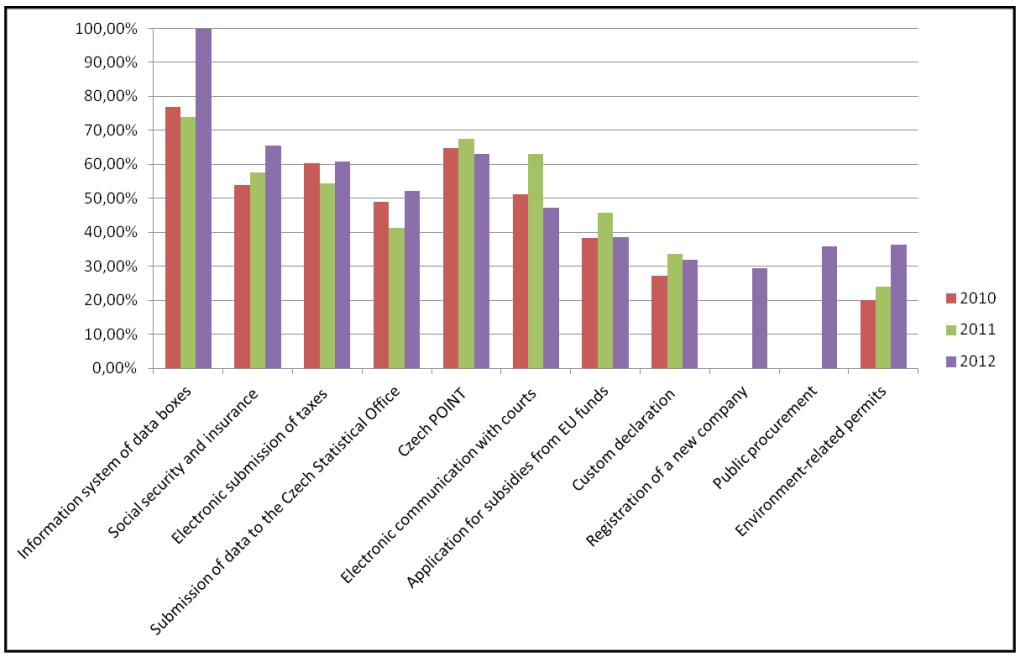
Electronic service by CBG method (2010-2011)	Electronic service by European Commission benchmarking (2010)
Information system of data boxes	-
Transactions at Public Administration Portal (electronic submission of social security and insurance)	Social contribution for employees
Tax authority portal Ministry of Finance (electronic submission of taxes)	Corporate Tax
	VAT
Submission of data to Czech Statistical Office	Submission of data to the statistical office
Excerpts from public registries and submissions at Czech POINT (Trade Register, Business Register, Real Estate Register)	-
Electronic communication with courts (www.justice.cz)	-
Electronic application for subsidies from EU funds (various ministries)	-
Electronic customs declarations (www.celnisprava.cz)	Custom declaration
Registration of a new corporate (http://www.businessinfo.cz)	Registration of a new company
Official site of public contracts (www.centralniadresa.cz or http://www.isvzus.cz/usisvz)	Public procurement
Environment-related permits (www.mzp.cz)	Environment-related permits

Source: own elaboration and Capgemini et al. (2010), modified.

Table 2 The list of electronic services in CBG method and European Commission's benchmarking.

To unify the CBG method with the EC's framework, services with the highest evaluation were selected. This criterion was met by seven services. There were three other services with the frequency of use between 24 – 45 %. These services were no. 11 - E-justice, no. 13 - The electronic submission of EU funds application, and no. 14 – Electronic customs in the previous survey (Ulman and Kubata, 2011). Other missing services on the list of EC were: registration of a new company, public procurement and environment-related permits, including reporting. The first two were added for new evaluation to the list of CBG method. The original service of reporting and environment-related permits in the Integrated Pollution Register were replaced with all environment-related permits and reporting through the website of the Ministry of Environment of the Czech Republic (www.mzp.cz). Another change was joining different kinds of outputs from registries at Czech POINT one-stop place into one single service called Czech POINT. The services that were included in Czech POINT in this survey were: Extracts from Trade Register and Commercial Register, Extracts from the insolvency register, Extracts from the List of Qualified Suppliers, Extracts from the Land Registry, Submissions according to the Trade Licensing Act (§ 72), Extracts from the drivers' score, Extract from the Criminal Records and Submissions to the registry participants of the module of car wrecks.

The newly adjusted list of electronic services for quality evaluation included eleven items. Services list matched list of eight services benchmarked by the European Commission plus three other services that are specific for the Czech eGovernment and that appeared to be frequently used in previous surveys. Figure 4 summarizes data from three different observations made between 2010 and 2012. The rate of use of e-services was measured. The substantial growth in use could be seen at electronic services such as data boxes (99,78 % in 2012), electronic submission of social security and insurance (65,49 %), submission of taxes (60,84 %), submission to the Czech Statistical Office (52,21 %), and Czech POINT (63,05 %, but in 2012 it was measured as a single item for multiple services). The very high rate of use of information system of data boxes is given by the Czech legislation requirements that force all private companies to use data boxes in communication with public administration. In past survey, there was probably less notion of respondents about it. In further survey, it will be vital to explore how many companies use data boxes for sending messages to public authorities, and not only for receiving. By CZSO (2011), 51 % of all enterprises used the data box system to send a message to public authorities in 2010. In other EU countries, there are also implementations of registered and reliable e-mail (0REM) system for delivery of documents



Source: (Ulman, et al, 2011), (Ulman and Kubata, 2011), and own figures from 2012, modified.

Figure 4 Comparison of the rate of use of e-services among enterprises in the Czech Republic between 2010 and 2012.

between companies and public authorities in Italy (Posta Elettronica Certificata — PEC), Switzerland (Incamail), Germany (De-mail) and a few others.

Two new services in the list, registration of a new company and the public procurement were evaluated for the first time in 2012, and they reached expected results. Registration of a new company with 29,42 % is rather an one-time service for most of entrepreneurs, but public procurement reached 35,84 % because there were probably higher interest of companies in attaining public contracts.

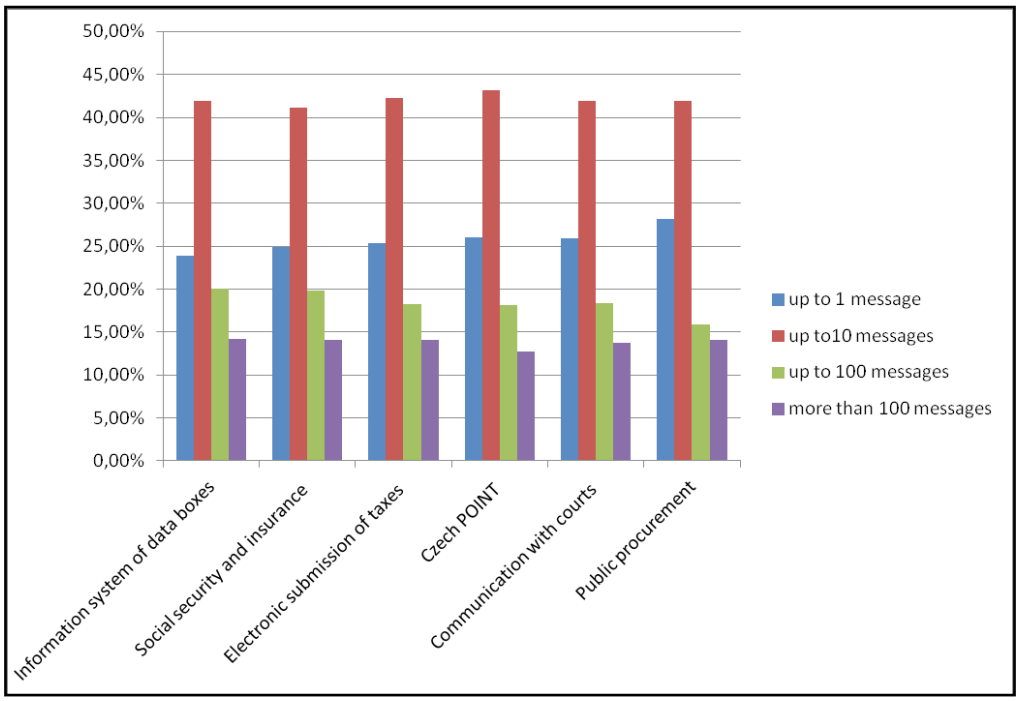
We could observe that the uptake of e-services did not exceed 40 % of enterprises at five particular e-services: Electronic application for subsidies from EU funds, Environment-related permits, Public procurement, Registration of a new company, and Electronic customs declarations. Authors consider that these services are used randomly or only once a time by most of enterprises. There was probably a smaller number of businesses that operated with foreign companies or they did not use the e-service, which pushed down the rate of use of electronic customs declarations. The lower rate of use of public procurement website (35,48 %) might have various reasons. There could be companies that did not apply for public procurements, or they might not have more information about it or any other reason.

The factors limiting electronic communication between businesses and government should be investigated more in depth, similarly to the Czech Statistical Office survey, where 53 % of all enterprises claimed that to complete transaction with a public authority still needed to use post office or to do so with personal contact. 46 % of enterprises stated that electronic transactions are too complex and time-demanding (CZSO, 2011).

Six services from the list were inspected more in details in the questionnaire and figures are presented here.

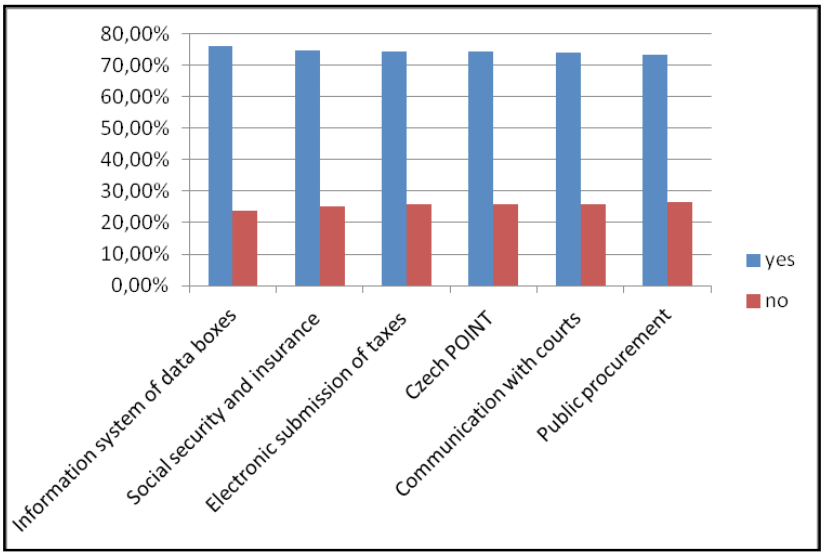
The first question was: *"How many data messages/ submissions are sent or received via the service in your organization in a month?"* In Figure 5 we can see that all services are used at least once to ten times a month which is a quite frequent use. Data were gathered for all enterprises without any difference in their size or number of employees.

Next question was: *"Is sending or receiving of data messages time-saving for you?"* All of evaluated services were perceived as useful by their enterprise users with more than 72 % of respondents (see Figure 6). It is supposed that if one stated that he or she used the service than it is perceived as useful by that person.



Source: own elaboration, 2012

Figure 5 The volume of messages sent or received monthly via e-services by enterprises in the Czech Republic (2012)



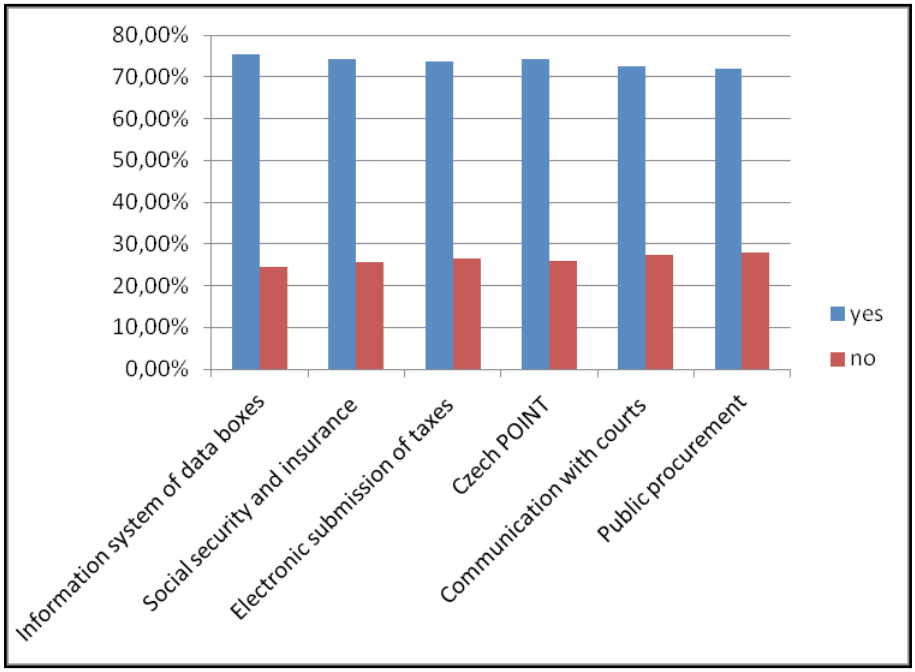
Source: own elaboration, 2012

Figure 6 Time savings through public services perceived by enterprises in the Czech Republic (2012)

Final question was: *"Is the service useful for your organization?"* General assumption that if one uses electronic service then it is perceived as a time-saving was verified by responses to the question (see the Figure 7).

In general, we can confirm that Czech enterprises currently have perceived electronic services provided by Czech government as useful and time-saving, they also have used them between one to ten times a month and six out of eleven services have been used by more than 40 % of asked enterprises.

The enterprises in agriculture in the Czech Republic have been growing significantly, as to their access to the Internet and the usage of public administration e-services. The survey conducted among Czech agricultural enterprises with more than one hundred of hectares of land in 2009 (Vaněk et al., 2010) was intended to bring the information about ICT use



Source: own elaboration, 2012

Figure 7 The usefulness of public services perceived by enterprises in the Czech Republic (2012)

among Czech agricultural enterprises. There were 93 % of enterprises in agriculture with access to the Internet in 2009, while 12% used to have mobile access. The access to the internet among agriculture enterprises used to be fair then and farmers have been currently big consumers of eGovernment services due to their strong connections to the system of state and EU funds, donations and control mechanisms. Since farmers and agriculture enterprises were poorly represented in our survey (2,88 %), it is needed to conduct another survey among them.

Conclusions

EGovernment benchmarking and evaluation has undergone long effort in European countries. Many dispute the lack of focus on user impact of e-services supplied by governments (Heeks, 2006), (Yildiz, 2007), and (Arduini et al., 2011). Authors at the Department of information technologies in FEM CULS in Prague have developed the simple method of quality evaluation of e-services provided by the government to businesses (CBG). The research was already conducted in three periods between 2010 and 2012. The method was reviewed regarding the benchmarking method of European Commission, as to the range of evaluated e-services – three new services were added while nine were omitted or joined with others. New quality evaluation model was introduced in the CBG method – a set of quality indicators that were identified from the previous research and the literature review.

The authors believe that main effort of quality evaluation should be to meet the public demand for government and public administration services with their supply respecting public values (Grönlund, 2010). We also found a large group of users of electronic public services in agriculture and forestry that still have not been surveyed about the use of public e-services yet despite they generate large volume of electronic communication with public administration.

Acknowledgement

Pieces of knowledge introduced in this paper resulted from solution of an institutional research intention MSMT 6046070906 *„Economics of resources of Czech agriculture and their efficient use in frame of multifunctional agri-food systems“*.

Corresponding author:
Ing. Milos Ulman, Ph.D.
Department of Information Technologies,Faculty of Economics and Management,
Czech University of Life Sciences in Prague
Kamycka 129, 165 21 Prague 6 Suchdol
Phone: +420 22438 2050
E-mail: ulman@pef.czu.cz

References

[1] Arduini, D. , Zanfei, A., Denni, M., Giungato, G. (2011) The eGovernment Services Delivery of the Italian Municipalities. 10th IFIP WG 8.5 International Conference on Electronic Government, 2011. Delft. 28 August 2011 - 2 September 2011. pp 144-158.

[2] Behkamal, B., Kahani, M., Akbari, M. K. (2008) Customizing ISO 9126 quality model for evaluation of B2B applications. Information and Software Technology, vol. 51, 2009, pp. 599 – 609. Elsevier B.V., 2008.

[3] Capgemini, Idc, Rand Europe, Sogeti, Dti. (2010) Digitising Public Services in Europe: Putting ambition into action - 9th Benchmark Measurement. Prepared for Directorate General for Information Society and Media. [on-line]. December 2010. [Accessed on 2012-04-20]. Available from: http://ec.europa.eu/information_society/newsroom/cf/document.cfm?action=display&doc_id=747

[4] Czech Statistical Office (2011) (CZSO). Využívání informačních a komunikačních technologií v podnikatelském sektoru za rok 2011. [on-line]. Praha: CZSO, 2011. [Accessed on 2012-05-20]. Available from: http://www.czso.cz/csu/2011edicniplan.nsf/p/9702-11.

[5] EGEP. (2006) EGovernment Economics Project (eGEP). Compendium to the Measurement Framework. 1 March 2006. [on-line]. [Accessed on 2012-05-23]. Available from: http://82.187.13.175/eGEP/Static/Contents/final/Measurement_Framework%20_Compendium.pdf.

[6] EUROSTAT.(2011) EGovernment statistics. [on-line]. [Accessed on 2012-05-20]. Available from: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/EGovernment_statistics.

[7] Flynn, N. (2002) Public Sector Management, 4th ed., Harlow: Pearson Education. 2002.

[8] Floropoulos, J., Spathis, C., Halvatzis, D., Tsipouridou, M. (2010) Measuring the success of the Greek Taxation Information System. International Journal of Information Management, 30(1), pp. 47-56.

[9] Grönlund, Å. (2010) Ten Years of EGovernment: The 'End of History' and New Beginning. Lecture Notes in Computer Science, vol. 6228, pp. 24 ISSN 978-3-642-14798-2.

[10] Gupta, M. P., Jana, D. E. (2003) Government Evaluation: A Framework and Case Study. Government Information Quarterly, 2003, vol. 20, no. 4, pp. 365-387 SCOPUS. ISSN 0740624X.

[11] Heeks, R. (2006) Benchmarking eGovernment: Improving the National and International Measurement, Evaluation and Comparison of eGovernment. IDPM Working papers. [on-line]. 2006, no. 18. [Accessed on 2012-04-20]. Available from: http://www.sed.manchester.ac.uk/idpm/research/publications/wp/igovernment/documents/iGWkPpr18.pdf

[12] ISO. (2000) ISO Standard 9000-2000: Quality Management Systems: Fundamentals and Vocabulary. International Standards Organisation (ISO), 2000.

[13] ISO/IEC.(2001) ISO/IEC Standard 9126: Software Product Quality. International Standards Organisation (ISO),International Electrotechnical Commission (IEC), 2001.

[14] Ruggieri, F. (2010) Registered e-mail (REM) — Reliable e-mail for everybody. Datenschutz und Datensicherheit - DuD Volume 34, Number 5 (2010), 314-317, DOI: 10.1007/s11623-010-0094-3.

[15] Ulman, M., Havlíček, Z., Pokorná, I. (2011) Hodnocení kvality elektronických agend státní správy. Systémová integrace, 2011, roč. 18, č. 2,s. 26 - 38. ISSN: 1210-9479.

[16] Ulman, M., Kubata, K. (2011) Quality Evaluation of eGovernment services in the Czech Republic. In 17th European Conference of Information Systems in Agriculture and Forestry 2011 11.07.2011, Prague. Prague: Czech University of Life Sciences Prague, Information and Consultancy Centre FEM, 2011. pp. 62-74.

[17] Vaněk, J., Červenková, E., Jarolímek, J., Šimek, P. (2010) State and evaluation of information and communication technologies development in agricultural enterprises in the Czech Republic. Plant, Soil and Environment, 56(3), pp. 144-147.

[18] Vaníček, J. (2008) Mezinárodní normy řady ISO/IEC 250xx pro jakost softwarového produktu. LInux +. 2008, vol. 2.

[19] Wang, Y., Liao, Y. (2008) Assessing eGovernment Systems Success: A Validation of the DeLone and McLean Model of Information Systems Success. Government Information Quarterly, vol. 25, no. 4, pp. 717-733. ISSN 0740624X.

[20] Yildiz, M. (2007) EGovernment research: Reviewing the literature, limitations, and ways forward. Government Information Quarterly, 24(3), pp. 646-665.

Agris on-line Papers in Economics and Informatics

Volume IV Number 2, 2012

Resource-use Efficiency in Cashew Production in Wenchi Municipality, Ghana

C. A. Wongnaa, D. Ofori

Institute of Entrepreneurship and Enterprise Development, Kumasi Polytechnic, Ghana

Abstract

The study considered the determinants of cashew production with special reference to cashew production in Wenchi Municipality of Brong-Ahafo Region of Ghana. Data collection was through well structured questionnaire administered on 140 respondents selected through random sampling technique. The methods of analysis used were descriptive statistics and production function analysis using the Ordinary Least Square (OLS) criterion. Results showed that majority of the farmers were ageing and there was high level of illiteracy as about 61.4% of total respondents had no formal education. Results further showed that farm size, capital, fertilizer and pesticides are positively related to cashew output while labour is inversely related. Also, the farmers were inefficient in the use of resources. Land, fertilizer and pesticide were underutilized while labour and capital were over utilized. Farmers should be encouraged to increase the use of land, fertilizers and pesticides so as to increase productivity.

Key words

Production function, Cobb-Douglas, resource-use, Cashew.

Introduction

Agriculture is the predominant sector in Ghana's economy. In 2008, agricultural activities contributed to 33.6% of Gross Domestic Product (GDP), employed about 60% of the labour force, and accounted for 54% of foreign exchange earnings. The sector itself is composed of five subsectors, namely crops other than cocoa, livestock, fisheries and forestry. However, non-traditional crops, such as pineapple, mango and cashew nuts, are increasingly of importance to the Ghanaian economy (MOFA, 2007).

Cashew is one of the non-traditional export crops being given the necessary boost by the government of Ghana. Cashew has a long history as a useful plant but only in the present century has it become an important tropical tree crop. The earliest reports of cashew are from Brazil (Mitchell and Mori, 1987). Cashew (Anacardium occidentale linn) is one of the important tree-nut crops, ranking third in international trade after hard nuts and almonds (MOFA, 2007).

The first ever recorded exports of cashew nuts from Ghana was in 1991, amounting to 15 metric tonnes. In 1997, export volumes rose to 3,571 metric tonnes. According to the Ghana Export Promotion Council, in 2002, the country exported 3,893 metric tonnes of cashew valued at $1,450,306. This export figure increased by 79.15% in 2003 to 6,338 metric tonnes, which was valued at $1,598,636. Annual export of raw nuts reached 47,000 metric tonnes in 2006, contributing approximately US$ 23 million in foreign exchange earnings. This figure is considered very small when compared with world excess demand of 430,000 metric tonnes of raw nuts, valued at US$270 Million, and growing at a rate of 5-8% per annum. It is therefore obvious that demand continuous to exceed supply; meanwhile there are many cashew farmers in Ghana and their productivity is on the lower side (MOFA, 2007).

Cashew production in Ghana is mainly a smallholder activity and provides income to farmers and all other agents involved in its production and marketing. Resources used in any production activity are regarded as the inputs that drive the production process. In cashew farming, the resources required include the seeds, land, labour, capital, fertilizer

and pesticides. The main technology applied is the traditional cutlass and hoe technology which has been blamed for the low output levels of farmers. A resource or input is said to be efficiently utilized when it is put to the best use possible and at minimum cost allowable. In a bid to help farmers increase productivity, the focus is usually on whether farmers are using better and improved technologies. It is however necessary to investigate whether these farmers are even making maximum use of what is available to them in terms of inputs so that the stakeholders involved in agriculture will be convinced that the new technologies they intend to introduce to farmers will be used efficiently and cost effectively to boost output. Farmers might use resources rationally but not at the economic optimal level. As the aim of every agribusiness firm is to maximize profit whiles minimizing cost, it is pertinent to determine the efficiency of resource-use (Tambo and Gbemu, 2010).

Materials and methods

Study area and Data Collection

The study was carried out in Wenchi Municipality in Brong-Ahafo Region of Ghana as it is the major cashew production zone in Ghana. The study area lies between latitudes 7°27N and 8°30N and longitudes 1°30N and 2°36W. Wenchi Municipality occupies an area of 7,619.7 square kilometres and a population density of 5-20 persons per square kilometre. The study used both primary and secondary data. Primary data was mainly cross-sectional. It was collected from 140 cashew farmers randomly selected from lists of cashew farmers in the following farming communities: Akrobi, Awisa, Nkonsia and Abotareye, for the 2009-2010 production season. The communities were purposively selected based on the level of cashew production. In each community 35 cashew farmers were randomly selected. Variables included in the questionnaire were: initial capital outlay or establishment cost, area of land under cashew cultivation, labour input in land preparation, planting, weeding, fertilizer, pesticide application and harvesting, the quantities of pesticides and fertilizer used in cashew cultivation. Others include farmer's age, farmers' educational level, gender, household size, farmers contact with extension workers, economic part of cashew sold, farming experience and sources of finance. Also the study made use of secondary data obtained from the internet, academic journals, Libraries and the Ministry of Food and Agriculture (MOFA).

Conceptual framework

Determinants of Cashew output

The economic model commonly used to determine the relationship between the various factors and the output in agriculture is production function model. The production function of any farmer is determined by resource availability of the farmer. In agriculture, the production inputs consist of land, labour and capital as the basic factors of production. The expected relationship between output and land is that as more land is brought under production, output is increased (Malassis 1975). The simplified form of production function is given by:

$$Q=f(L_d,K,L) \quad (1)$$

Where Q is the production output, which is a function of land (L_d), the capital (K) and the labour force (L) used for the production of the same output. A production function may be defined as a mathematical equation showing the maximum amount of output that can be realized from a given set of inputs. The mathematical form of the Cobb-Douglas production function is given by:

$$Q=AL^{\alpha} K^{\beta} \quad (2)$$

Where Q is the output, A is the technology used in the production of output, L is labour input, K is capital input and α and β are elasticity. Alternatively, a production function can show the minimum amount of inputs that can be utilized to achieve a given level of output (Malassis 1975). To find out the impact of these factors on farm level production of cashew on small-scale farmers in Wenchi Municipality, the functional relationship is specified.

$$OUTPUT=f\,(FAMS, LAB, CAP, FERT, PEST, u) \quad (3)$$

Where,

OUTPUT = Cashew nut output (in kilogrammes of cashew nut)

FAMS = Farm size (in acres)

LAB = Labour quantity (in man-days)

CAP = Physical capital (in Ghana cedis (Gh¢) spent on equipments)

FERT = Liquid Fertilizer used (in litres)

PEST = Pesticides used (in litres)

u = stochastic error term.

Among the various functional forms for analyzing production functions, double-log gives the best fit and is the best (Eze et al, 2010 and Goni et al, 2007). The econometric model is specified using the double-log Cobb-Douglas production function as follows:

$$\ln OUTPUT = \ln\beta_0 + \ln\beta_1 FAMS + \ln\beta_2 LAB + \ln\beta_3 CAP + \ln\beta_4 FERT + \ln\beta_5 PEST + u \quad (4)$$

Using Ordinary Least Squares (OLS) technique, the coefficients of the above variables were estimated. For the study to estimate with OLS, the Cobb-Douglas production function had to be a transformed model, to satisfy the Classical Linear Regression Model (CLRM), so as to come up with the usual assumption of Best Linear Unbiased Estimator (BLUE).

Efficiency of resources use in cashew production

To ensure maximum profit and efficiency of resources, a cashew farmer must utilize resources at the level where their marginal value product (MVP) is equal to their marginal factor cost (MFC) under perfect competition (Kabir Miah et al, 2006; Tambo and Gbemu, 2010). The efficiency of a resource would be determined by the ratio of MVP of inputs (based on the estimated regression coefficients) and the MFC. Following Goni et al. (2007), Fasasi (2006) and Stephen et al (2004), the efficiency of resource use is given as;

$$r = \frac{MVP}{MFC} \quad (5)$$

r = Efficiency coefficient

MVP = Marginal Value Product

MFC = Marginal Factor Cost of inputs

$$MFC = P_x \quad (6)$$

Where

P_{xi} = Unit price of input, say X.

$$MVP = MPP_x . P_y \quad (7)$$

Where

MPP = Marginal Physical Product

P_y = Unit Price of cashew output

From equation 4,

$$\beta_i = \frac{\partial Y}{\partial X} \cdot \frac{X}{Y} \quad (8)$$

$$MPP_x = \frac{\partial Y}{\partial X} = \beta_x \frac{Y}{X} \quad (9)$$

MPP_x = Marginal Physical Product of input X and is a measure of technical efficiency of input X.

β_x = Elasticity of production with respect to Input X = Regression coefficient of input X

Therefore

$$MPP_x = \frac{\partial Y}{\partial X} = \beta_x \frac{Y}{X} \quad (10)$$

Y = mean value of output,

X = mean value of input X

MVP for each input is therefore obtained by multiplying the regression coefficient of that input with the ratio of the mean value of output and that of input and with the unit price of output. MFC of each input will however be obtained from the data collected on the unit market prices of the various inputs. The decision rule for the efficiency analysis is if:

r = 1; resource is been used efficiently

r >1; resource is underutilized and increased utilization will increase output.

r <1; resource is over utilized and reduction in its usage would lead to maximization of profit.

(Eze, 2003; Mbanasor, 2002; Olayide and Heady, 1982; Okon, 2005).

Returns to scale is estimate by the sum of the elasticity of the various inputs. The decision rule for the return to scale is that if:

$\sum\beta_i$ = 1, implies constant returns to scale

$\sum\beta_i$ <1, implies decreasing returns to scale

$\sum\beta_i$ >1, implies increasing returns to scale

Results and discussions

Descriptive Analysis

Evidence from the descriptive analysis of socioeconomic characteristics of respondents in the study area in Table 1 shows that 61.4% of the sampled cashew farmers were males and 38.6% were females. The results show that more men are involved in cashew production in the Wenchi Municipality than women. This is consistent with the results of CASCA (2002) which revealed that most cashew trees or farms are owned by men (60%) while the other 40% are divided amongst women (10%), the family as a whole (15%) and grandparents (15%). It also shows that both men and women can take cashew production as a business and a source of employment.

The results of the study show that most cashew farmers in Wenchi Municipality are ageing since a greater percentage of the cashew farmers interviewed (74.3%) were above forty (40) years and none of the respondents was below twenty (20) years. Very few cashew farmers in the municipality (25.7%) were between the ages of twenty-one (21) and forty (40) years. Farmers in this age group constitute the very energetic youth and are likely to work effectively to increase their yields. The few number of youth involved in cashew production (25.7%) could indicate that the future of the cashew industry, especially in the Wenchi Municipality is bleak. The youth are the future growers of the cashew crop and if cashew nut supply is to be sustained, there is the need for the youth to be encouraged to go into cashew production.

From the study, it was realised that a higher percentage of cashew farmers in Wenchi Municipality (61.4%) are illiterates. Such farmers did not receive formal education. About 17.1% of cashew farmers in the Wenchi Municipality ended in the primary school while 10.7% of them were educated up to the Middle or Junior Secondary School level. Some cashew farmers

Characteristic	Frequency	Percentage (%)	Characteristic	Frequency	Percentage (%)
Gender			*Household Size*		
Male	86	61.4	1 - 5	81	57.9
Female	54	38.6	6 - 10	40	28.6
Total	140	100.0	>10	19	13.5
Age			Total	140	100.0
≤20	0	0.0	*Farming Experience (Years)*		
21 - 40	36	25.7	≤5	78	55.7
41 - 60	68	48.6	6 - 10	34	24.3
61 - 80	36	25.7	11 - 15	20	14.3
Total	140 characteristic	100.0	>15	8	5.7
Education			Total	140	100.0
Illiterate	86	61.4	*Source of finaces*		
Primary	24	17.1	Personal Saving	91	65.0
Middle School/JSS	15	10.7	Friends	10	7.1
SSS/Vocational/Technical	10	7.1	Relatives	9	6.4
Post Secondary/Tertiary	5	3.7	Cooperatives	12	8.6
Total	140	100.0	Bank Loans	18	12.9
Pruning			Total	140	100.0
Do pruning	74	52.9	*Contact with Extension Officers*		
Do not do pruning	66	47.1	Contact	42	30.0
Total	140	100.0	No Contact	98	70.0
Cashew Varieties			*Economic part of cashew sold*		
Improved	44	31.4	Apple	0	0.0
Local	96	68.6	Nut	140	100.0
Total	140	100.0	Total	140	100.0

Source: Field Survey data 2010

Table 1. Socioeconomic Characteristics of Cashew Farmers.

in the municipality (7.1%) had Senior Secondary School education while very few of them (3.7%) got to the Post Secondary and Tertiary level. The higher percentage of illiterate farmers could have negative impact on the adoption of new production technologies.

The results of the study revealed that a greater percentage of cashew farmers in the Wenchi Municipality (52.9%) pruned their cashew trees while 47.1% did not do pruning. The results show that most cashew farmers in Wenchi Municipality probably saw pruning as a very important cultural practice in cashew production. There is however the need for increased awareness of the importance of pruning in cashew production since 47.1% of the respondents did not do pruning at all.

The results showed that only 31.4% of cashew farmers in the Wenchi Municipality used improved varieties of cashew while the rest (68.6%) used local varieties. The results of the study showed that cashew nut is the main product of the cashew crop of economic importance in Wenchi Municipality. Also, a greater proportion of cashew farmers in the Municipality (65%) financed their production through personal savings. The distribution of the household size indicated that most cashew farmers in the Municipality (57.9%) had a household size that ranged from 1 to 5 while the average farm size was found to be 3.33 acres. The study also revealed poor extension visits to cashew farmers since 70% of farmers sampled had no extension contact. Finally, most cashew farmers sampled had less than five (5) years of experience in cashew production. This could have a negative impact on output.

Cashew production function analysis

From the regression results in Table 2, farm size, labour, capital, fertilizer and pesticide were observed to affect cashew output significantly and hence are the determinants of cashew production in the study area. Farm size, labour and pesticides were significant at 1% whereas capital and fertilizer were significant at 5%. The R2 value for the regression is 0.840912 and this means that 84.1% of the variations in cashew output are explained by the factor inputs. Also from the F-statistic it can be concluded that the overall regression is significant at 1% significance level which means that at least one of the explanatory variables significantly affects the output of cashew. The values of the coefficients indicate the elasticity of the various inputs to the output. Considering farm size, the elasticity value indicates that if land under cultivation is increased by 1%, the yield of cashew would increase by 92.4%. If quantity of capital, fertilizer and pesticides increase by 1%, yield of cashew would increase by 4.3%, 8.7% and 4.3% respectively because they are positively related to cashew output. This is in line with the results of Goni et al (2007) who conducted a study into the analysis of resource-use efficiency in rice production in the lake Chad area of Borno state, Nigeria and found out that a unit increase in the level of seed, farm size, and fertilizer will lead to 12.6, 127.2, and 20.5 percent changes in rice output respectively. Imoudu (1992) also showed that farm size is a significant determinant of maize output and profitability in Ondo-State. The results of the study are also in consonance with those of Ohajianya (2006) in Imo State, Nigeria, and Onyenweaku et al (1996). Labour however had a negative coefficient

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.106303	0.739814	6.902142	0.0000
lnFAMS	0.923613	0.188644***	4.896063	0.0000
lnLAB	-0.022457	0.185277***	0.121206	0.0007
lnCAP	0.043158	0.189123**	2.456227	0.0289
lnFERT	0.087111	0.024699**	3.526886	0.0226
lnPEST	0.042582	0.018065***	2.357151	0.0099
R-squared	0.840912	Mean dependent var	6.442207	
		F-statistic	98.92029	
		Prob (F-statistic)	0.000000	

Note: (***) Indicates significance at the 1% level. (**) indicates significance at the 5% level.
Source: Field Survey data 2010

Table 2. Estimates of the Production function analysis.
Dependent Variable: lnOUTPUT

indicating that an increase in labour will lead to a decrease in yield and this corroborates Stephen et al (2004), who studied on resource-use efficiency in cowpea production in North East Zone of Adamawa State, Nigeria and reported an inverse relationship between labour and output.

Return to scale was calculated as the sum of individual production inputs elasticities. The sum of elasticities resulted to a value of 1.074, which shows increasing returns to scale. This suggests that cashew farmers in the study area can increase their cashew output by employing more of these five resources (i.e land, labour, capital, fertilizer and pesticide). This is in line with the results of Goni et al (2007) who found out that rice farmers in the study area could increase their rice output by employing more of seed, farm size, fertilizer and labour. The result of increasing return to scale is also in line with the findings of Ajibefun (2002) and Uchegbu (2001) but contrary to the finding of Obasi (2007).

The values of the Marginal Physical Product (MPP) show that the farmers were more efficient in the use of land than the other resources. This suggests that if additional acres were available, it would lead to an increase in cashew production/yield by 299.72 kg among the farmers. This implies that the farmers are more technically efficient in the use of land. Of all the resources used, labour had the least MPP (0.017 kg). This shows inefficiency in the use of available labour. These results also corroborate those of Goni et al (2007).

Given the level of technology and prices of both inputs and outputs, efficiency of resource use was further ascertained by equating the Marginal Value Product (MVP) to the productive Marginal Factor Costs (MFC) of resources. A resource is said to be optimally allocated if there is no significant difference between the MVP and MFC i.e. if the ratio of MVP to MFC =1 (unit). Table 3 further reveals that the ratios of the MVP to the MFC were greater than unity (1) for all the inputs except labour and capital which implies that within the limits of statistical error, none of the inputs was efficiently allocated by the cashew farmers. This implies that farm size, fertilizer and pesticide were under-utilized, while labour and capital were over utilized (less than one). This means that cashew output was likely to increase and hence revenue if more of such inputs (land, fertilizer and pesticide) had been utilized. The efficiency results of land, labour and capital agree with those of Eze et al (2010) who studied the Resource Use Efficiency in Arable Crop Production among Smallholder Farmers in Owerri Agricultural Zone of Imo State, Nigeria but that of fertilizer disagrees. The adjustment in the MVPs for optimal resource use (% divergence) in Table 4 indicates that for optimum allocation of resources more than 92% increase in farm size was required, while approximately 28% increase in fertilizer was

Resource	Mean	Elasticity	MPP	MVP	MFC	r
Farm Size	3.34	0.923613	299.72	125.88	8.91	14.13
Labour	1469.54	-0.022457	-0.017	-0.0071	3.00	-0.0024
Capital	18.34	0.043158	2.55	1.071	18.34	0.058
Fertilizer	2.20	0.087111	42.92	18.03	13.05	1.38
Pesticide	0.65	0.042582	71.00	29.82	12.71	2.35

Mean of Cashew output = 1083.86 Price of cashew nut = 0.42 $\sum\beta_i$=1.074

Source: Field Survey data 2010

Table 3. Values of estimates of efficiency parametersDependent Variable: lnOUTPUT.

Resource	Efficiency Gap	% Divergence
Farm Size	117.00	92.92
Labour	3.01	41,766.67
Capital	17.28	1,624.14
Fertilizer	4.96	27.54
Pesticide	17.16	57.45

Source: Field Survey data 2010

Table 4. Adjustments in MVPs for optimal resource use (% divergence).

needed. Similarly, over 57% increase in pesticide was needed. Labour and capital were over utilized and required approximately 41,766.67% and 1,624.14% respectively reduction for optimal use in cashew production. Eze et al (2010) obtained similar results for land, labour and capital but that of fertilizer disagreed.

Conclusion

Findings from the study indicate that cashew farming in the municipality is a male dominant activity with the men making up 61.4% of the respondents sampled. Most of the cashew farmers in the study area (70%) have no contact on a regular basis with extension agents. Also, a greater proportion of cashew farmers in the Municipality (65%) financed their production through personal savings. That is most farmers do not receive financial assistance in the form of credit from formal sources. The results also showed that majority of the farmers were ageing and quite inexperienced in cashew production. Also, the level of illiteracy was very high among the respondents as about 61.4% of total respondents had no formal education while 17.1%, 10.7%, 7.1 and 3.7% had primary, Middle School/ JSS, secondary/Vocational and tertiary education respectively. Respondents are majorly small-scale farmers with a mean farm size of 3.33 acres. Results further showed that variables such as farm size, capital, fertilizer and pesticides are positively related to cashew output while labour is inversely related. Also, the farmers were inefficient in the use of resources. Land, fertilizer and pesticide were underutilized while labour and capital were over utilized. Farmers should be encouraged to increase the use of land, fertilizers and pesticides so as to increase productivity. Enough potential therefore exist for increased production of cashew in the study area. Among other things, farmers should have more access to extension services in order to improve their knowledge of farm management. Also, the government should introduce the farmers to formal education through adult literacy education, evening classes and establishment of demonstration farms.

Acknowledgement

The authors are especially indebted to the staff of the Ministry of Food and Agriculture (Wenchi) for the information they provided about the cashew crop. They are also grateful to the respondent farmers without whose co-operation the study could not have taken place.

Corresponding author:
Wongnaa Camillus Abawiera
Institute of Entrepreneurship and Enterprise Development, Kumasi Polytechnic, Ghana
P.O. Box 854, Kumasi, Ghana-West Africa
Phone: +233(0)243389509. Fax: +233(322)(0)22387, Email: wongnaaa@yahoo.com

References

[1] Ajibefun, I. A. (2002). "Analysis of Policy Issues in Technical Efficiency of Small Scale Farmers using the Stochastic Frontier Production Function". With Application to Nigerian Farmers". Paper prepared for presentation at the international farm Management association congress, Wageningen, Netherland.

[2] CASCA. (2002). "Programme Proposal. Support to the cashew sector in Nampula Province, Mozambique". ADPP, AMODER and SNV.

[3] Eze, C. C. (2003). "Resource Use Efficiency in Cocoyam Production in Ihitte/Uboma Area of Imo State, Nigeria". Journal of Applied Sciences, 6 (3): 3865- 3871

[4] Eze, C.C., Amanze, B and Nwankwo, O. (2010). "Resource Use Efficiency in Arable Crop Production among Smallholder Farmers in Owerri Agricultural Zone of Imo State, Nigeria". Researcher, 2 (5).

[5] Fasasi, A.R. (2006). "Resource Use Efficiency in Yam Production in Ondo State, Nigeria". Agricultural Journal, 1 (2): 36-40

[6] Goni, M., Mohammed, S. and Baba, B. A. (2007). "Analysis of Resource-Use Efficiency in Rice Production in the Lake Chad Area of Borno State, Nigeria". Journal of Sustainable Development in Agriculture & Environment. Paraclete Publishers, 3 (2): 31-37.

[7] Imoudu, P.B. (1992). "Economics of Maize Production and Marketing in Ondo State of Nigeria", Unpublished PhD Thesis. Department of Agricultural Economics and Extension, FUTA, Akure, Ondo-State, Nigeria.

[8] Kabir Miah MA, Ashraful Alam A.K.M and Rahman A.H.M.A (2006). "Impact of Agricultural Credit on MV Boro Rice Cultivation in Bangladesh". Journal of Agriculture & Rural Development, 4 (1): 161-168.

[9] Malassis, L. (1975). "Agriculture and the Development Process". The UNESCO Press. Paris.

[10] Mbanasor, J. A. (2002). "Resource Use Pattern among Poultry Enterprises in Abia State, Nigeria". Nigerian Journal of Animal Production, 29 (1): 64-70.

[11] Mitchell, J.D and Mori. S.A. (1987). "The cashew and its relatives". Memoirs of the New York Botanical Garden English, pp42, 76.

[12] Ministry of Food and Agriculture [MoFA] (2007). "Status of Ghana Cashew Industry". www.ghanacashewproducts.com.

[13] Obasi, P.C. (2007). "Farm Size Productivity Relationship among Arable Crops Farmers in Imo State, Nigeria". International Journal of Agriculture and Rural Development, 9 (91): 91-99

[14] Ohajianya D.O. (2006). "Resource use Efficiency of land Owners and Tenants in Food Crop Production in Imo State Nigeria". Journal of Sustainable Tropical Agricultural Research, 17: 26-30.

[15] Olayide, S. O. and Heady E. O. (1982). "Introduction to Agricultural Production Economics". University Press, Ibadan.

[16] Okon, E. T. (2005). "Comparative Analysis of Large and Small Scale Farmers Resource Use Efficiency in Food Crop Production in Akwa-Ibom State, Nigeria". Journal of Agriculture and Food Science, 3 (1): 75-84.

[17] Onyenweaku, C.E, Obasi, P.C and Anyanwu, S.O. (1996). "Production Relationships among Compound and Non-Compound Farmers in Imo State Nigeria". Journal of Applied Science in Southern Africa, 2 (1): 31-36.

[18] Stephen, J, Mshelia, S.I, Kwaga, B.T. (2004). "Resource-use Efficiency in Cowpea Production in the North-Eastern zone of Adamawa state, Nigeria". Department of Forestry and Wildlife Management, Federal University of Technology. Yola, Nigeria.

[19] Tambo, J.A and Gbemu, T. (2010). "Resource-use Efficiency in Tomato Production in the Dangme West District, Ghana". Conference on International Research on Food Security, Natural Resource Management and Rural Development. Tropentag ETH Zurich.

[20] Uchegbu, B. A. (2001). "A Comparative Analysis of Small and Large Scale food Crops Farmers in Imo State. Unpublished M.sc Thesis, Imo State University, Owerri.

Agris on-line Papers in Economics and Informatics

Volume IV Number 2, 2012

Agris on-line Papers in Economics and Informatics

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

http://online.agris.cz

ISSN 1804-193