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
VII, 2015, 3

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, 056
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

VII, 2015, 3
30th of September 2015
Prague

Agris on-line
Papers in Economics and Informatics

ISSN 1804-1930

VII, 2015, 3

Agris on-line Papers in Economics and Informatics

Volume VII Number 3, 2015

Content:

Agris on-line Papers in Economics and Informatics

Volume VII Number 3, 2015

Causal Effect of Off-Farm Activity and Technology Adoption on Food Security in Nigeria

A. A. Obisesan

Department of Agricultural and Resource Economics, Federal University of Technology, Akure, Ondo state, Nigeria

Abstract

This study examined off-farm activity participation, technology adoption and impact on food security status of Nigerian farming households. Data were collected using structured questionnaire through a multistage sampling technique. Propensity Score Matching, descriptive statistics and Foster-Greer-Thorbecke weighted index were employed in analysis. Participation in off-farm activity has a positive and significant ($p<0.05$) influence on level of adoption. The mean per capita household food expenditure (MPCHFE) was ₦30198.34 while the food insecurity line was ₦20132.22 per annum. The impact of improved technology adoption on food insecurity incidence of adopters with off-farm activity was higher than their counterparts without participation. This suggests that participation in off-farm activity and technology adoption have the potential to improve food security. Hence, there should be further sensitization on this technology to improve food security and policy measures should also be oriented towards the support and improvement of rural off-farm income opportunities.

Keywords:

Off-farm work, adoption, food security, rural Nigeria.

Introduction

The traditional view of rural economies as purely agricultural is obsolete. The rural areas of the sub-Saharan Africa have been thought to be synonymous with agriculture in which agricultural income activities dominate the rural economy but recently, this view has changed, there has been increasing recognition that the rural economy is not confined to agricultural sector (Csaki, Lerman, 2000). The rural households receive their income from a diverse portfolio of activities and one of the most important of these activities is that connected with the rural non-farm sector which includes different activities such as governments, commerce and services now seen as providing bulk of income to the rural households.

In Africa, about 40% of rural household incomes is generated from non-agricultural sources (Haggblade et.al., 2007), implying that off-farm activities have become a vital component of livelihood strategies among rural households. Therefore, given the importance of off-farm activity to farm households and the increasing share of off-farm income in total household income, off-farm income has recently been incorporated into the analysis of technology adoption (De Janvry, Sadoulet, 2001; Ruben, Van den Berg, 2001; Haggblade et al., 2007). According to Núñez (2005), off-farm income level of farmers has a significant impact on their decision to adopt new technologies, in that farmers with off-farm income have more financial capability to adopt new technologies.

The adoption of improved agricultural technologies is needed to improve agricultural productivity which serves as the panacea to food insecurity. In Nigeria, despite projects, programmes and policies targeted at reducing the problem of food insecurity, the country ranked 40th on the Global Hunger Index (GHI) of 81 countries with a GHI of 15.5 indicating a serious hunger situation (IFPRI, 2011). Food insecurity is predominant in the rural areas where the main occupation is farming, 48.3% of the rural households are described food poor compared to 26.7% in the urban areas (NBS, 2012). Agricultural growth remains fundamental to food security, however, agricultural growth and development is not possible without yield-enhancing technological options because merely expanding the area under cultivation (except in few places) to meet the increasing food needs of growing populations is no longer sufficient. Thus, research and adoption of technological improvement are

crucial to increasing agricultural productivity and food security (IFAD, 2011). Furthermore, it is expedient to conduct comprehensive impact assessment to elucidate the returns to investment in agricultural research (Kristjanson et al., 2002)

Therefore, this study examined off-farm income participation, its effect on technology adoption and the impact of improved production technology on food security status of cassava-farming households in southwest, Nigeria. It analyzed how participation in off-farm activity affects the adoption of agricultural technology by incorporating off-farm activity as an explanatory variable in the analysis of adoption of cassava improved production technology as well as the impact on food security. Specifically, this study: (1) examine the socio-economic characteristics of cassava farming households in the study area, (2) estimate the effect of off-farm activity participation on the adoption of improved production technology, (3) examine the impact of technology adoption on food security status of cassava -based farming households in the study area.

Materials and methods

The study was carried out in Southwest, Nigeria. South west is one of the six geopolitical zones in Nigeria. It falls on latitude 60 to the North and latitude 40 to the South while it is marked by longitude 40 to the West and 60 to the East. It is bounded in the North by Kogi and Kwara States, in the East by Edo and Delta States, in the South by Atlantic Ocean and in the West by Republic of Benin. The climate is equatorial with distinct wet (rainy) and dry seasons with relatively high humidity. The mean annual rainfall is 1480 mm with a mean monthly temperature range of 180-240°C during the rainy season and 300-350°C in the dry season. Southwest Nigeria covers approximately an area of 114,271 kilometer square that is approximately 12 percent of Nigeria's total land mass and the vegetation is typically rainforest. The total population is 27,581,992 as at 2006 (NPC, 2006). The people are predominantly farmers. The climate in the zone favours the cultivation of crops like maize, yam, cassava, millet, rice, plantain, cocoa, kola nut, coffee, palm produce, cashew etc. The zone comprises of six states namely: Ekiti, Lagos, Ogun, Ondo, Osun and Oyo states.

1. Data collection and sampling procedure

Primary data were collected for the purpose of this study using structured questionnaire. Some of the data include: socio-economic and demographic characteristics, cassava production, cassava production technology, and household food expenditure details.

Multistage sampling technique was employed in this study. The first stage was the random selection of Ondo and Ogun states from the six states in Southwest, Nigeria. The second stage involved the random selection of four LGAs from each state while in the third stage, three communities were randomly selected from each LGA. This resulted to 24 communities in the two states. The final stage involved a random selection of 540 respondents proportionate to the sizes of the communities. However, a total of 482 were retrieved and completely filled from the field. The survey was between August and November, 2011.

2. Analytical techniques

Analytical techniques employed in this study include: descriptive statistics, Tobit regression model, Propensity Score Matching (PSM) and Foster- Greer- Thorbecke (1984) model. Following (Tiamiyu et al., 2009) and adapting it to this study, technology-use ranked score was computed for each respondents based on the identified elements of the technology package (improved varieties, recommended spacing, timely maintenance, fertilizer and herbicide application) and adoption index was generated for individual farmer. Adoption index of individual farmer was calculated as follows:

$$AI_i = \frac{TS_i}{TTS} \quad (1)$$

$$AAI = \sum_{i}^{n} \frac{AI_i}{N} \quad (2)$$

Where,

AI_i = Adoption Index of the ith farmer

TS_i = Technology-use Score of the ith farmer

TTS = Total Technology-use Score obtainable

AAI = Average Adoption Index

Total technology-use score obtainable (TTS) was obtained by allotting score to each elements of the technology package and summing them up while Technology-use score of the ith farmer (TS_i) was obtained by summing up the scores allotted to the element of the technology package adopted by the farmer.

Tobit regression model was used to analyze

objective 2, Following Maddala, (1997); Johnston, Dandiro, (1997) and Negash, (2007), the Tobit model for the continuous variable adoption level, can be expressed as:

$$AL_i^* = \beta_0 + \beta_i X_i + \mu_i$$
$$AL_i = AL_i^* \text{ if } \beta_0 + \beta_i X_i + \mu_i > 0 \quad (3)$$
$$= 0 \text{ if } \beta_0 + \beta_i X_i + \mu_i \leq 0$$

Where,

AL^*_i = the latent variable and the solution to utility maximization problem of level/ extent of adoption subjected to a set of constraints per household and conditional on being above certain limit

AL_i = Adoption level for i[th] farmer

X_i = vector of factors affecting adoption and level of adoption

β_i = vector of unknown parameters

μ_i = error term

Selection of explanatory variables

The explanatory variables specified as determinants of adoption level of RTEP improved production technology were selected according to Chilot et al., (1996); Asfaw et al., (1997); Nkonya et al. (1997); Mulugeta (2000); Mesfin (2005); Omonona et al.,(2006) and Negash (2007).

The variables are defined as follows:

X_1 = Age of the household head (years)

X_2 = Age square of the household head (years)

X_3 = Gender of the household head (male = 1, 0 otherwise)

X_4 = Marital status of the household head (married=1,0 otherwise)

X_5 = Participation in off-farm activity (yes = 1, 0 otherwise)

X_6 = Level of education of household head

X_7 = Years of experience of household head in cassava production (years)

X_8 = Main occupation (farming = 1,0 otherwise)

X_9 = Household size (numbers)

X_{10} = Land area cultivated (ha)

X_{11} = Distance of farm to nearest market (km)

X_{12} = Access to credit of the household head (yes=1, 0 otherwise)

X_{13} = Cassava yield (tonnes/ ha)

X_{14} = Contact with extension agents (yes = 1, 0 otherwise)

Propensity Score Matching, one of the most commonly used quasi-experimental methods was used to address the evaluation problem (Mendola, 2007; Nkonya et al., 2007; Akinlade et al., 2011). The sample collected was matched using PSM; the aim of PSM is to find the comparison group from a sample of non-adopters that is closest to the sample of adopters so as to get the impact of the project on the beneficiaries. Though, PSM is subject to the problem of "selection on unobservables", meaning that the beneficiary and comparison groups may differ in unobservable characteristics, even though they are matched in terms of observable characteristics. However, it has been put forward that selection on unobservable is empirically less important in accounting for evaluation bias (Baker, 2000). Also in a situation where the same questionnaire is administered to both groups (so that outcomes and personal characteristics are measured in the same way for both groups) and the participants and controls are placed in a common economic environment (such as the case in this study), matching substantially reduce bias (Heckman et al., 1996).

Main steps involved in the application of statistical matching to impact evaluation are: estimating the propensity score, matching the unit using the propensity score, assessing the quality of the match and estimating the impact as well as its standard error.

Out of 482 only 387 adopters and non-adopters that had comparable propensity scores were matched. After matching, the testing of comparability of the selected groups was done and the result shows statistically insignificant difference in the explanatory variables used in the probit models between the matched groups of adopters and non-adopters.

Since the match has been deemed of good quality, this study then used the matched sample to compute the Average Treatment Effect for the Treated (ATT) to determine impact of the programme. This is defined by Rosenbaum and Rubin (1983) as follows:

$$E(Y^1 - Y^0/D = 1) = E(Y^1/D = 1) - E(Y^0/D = 1) \quad (4)$$

where, $E(Y^1/D = 1)$ is the observed outcome of the treated, that is, the expected income earned by programme beneficiaries while participating in the programme and is the counterfactual outcome - the expected income they would have received if they had not participated in the project. The counterfactual outcome represents outcome of the non-beneficiaries since they have similar

characteristics with beneficiaries. Standard errors were computed using bootstrapping method suggested by Lechner and Smith (2002) to generate robust standard errors in light of the fact that the matching procedure matches control households to treatment households with replacement.

Changes in food insecurity of the households were achieved by using Foster, Greer and Thorbecke-FGT (1984) model, households' expenditure on food per capita equivalent was used to determine households' food insecurity status (Omonona, Agoi, 2007).

This is defined as:

$$P_\alpha = \frac{1}{N}\sum_{i=1}^{q} G_i \quad (5)$$

Where,

$G_i = \left[\frac{Z-Y}{Z}\right]$ = food expenditure deficiency of household *i*

Z = food security line (2/3 mean per adult equivalent food expenditure)

q = the number of households below the food security line,

N = the total number of households in the total population,

Y_i = the per capita equivalent food expenditure of household *i*,

α = the degree of food insecurity aversion;
$\alpha = 0$ measures the incidence of insecurity.
$\alpha = 1$ measures the depth of food insecurity.
$\alpha = 2$ measure the severity of food insecurity.

STATA 10, DASP and PSM were the software package used in the analysis.

Results and discussion

1. Distribution of respondents by socio-economic characteristics

Table 1 shows the distribution of the respondents by socio-economic characteristics across the two types of respondents considered which are: adopters (participants) and non-adopters (non-participants). The average values of their socio-economic characteristics are within the same range due to propensity score matching (PSM) used in selecting the respondents with similar observable characteristics. Majority (74.63%) of the adopters are males while only 25.37% are female. The average household size was 6. The majority of the respondents have their household sizes falling within the range of 5 to 9 people, with the average age of the respondents being 44 and 45 for adopters and non-adopters respectively. Implicit in these findings is that a large proportion of the respondents were middle aged and can therefore be regarded as active, agile and with more energy to dissipate and concentrate on productive effort. The average years of experience in cassava farming was 16 years for all respondents. The average area of land cultivated was about 1 hectare for all the respondents. Accessibility to credit facility and participation in off-farm activity was higher among adopters compared to non-adopters.

Characteristics	Categories /Statistics	Adopters percentage	Non-adopters percentage
Gender	Female	25.37	22.17
	Male	74.63	77.83
	Total	100	100
Household size	0-4	16.25	26.09
	5-9	77	68.26
	>9	6.75	5.65
	Total	157	230
	Mean	6	6
	SD	1.9942	1.9576
Age	≤30	13.12	6.09
	31-40	30.25	26.09
	41-50	35.63	36.95
	>50	21	30.87
	Total	157	230
	Mean	44.2685	45.1913
	SD	10.1317	10.7219
Level of education	No formal	35.67	26.09
	Primary	51.59	36.52
	Secondary	12.74	37.39
Credit access	Yes	82.5	48.26
	No	17.5	51.74
	≤0.5	26.75	22.17
Area of land cultivated (ha)	0.6-1.0	64.33	50
	1.1-1.5	8.92	28.63
	Total	157	230
	Mean	0.98	1.01
	SD	0.35	0.56
Off-farm activity	Yes	73.13	57.78
	No	26. 87	42.22

Source: Field Survey, 2011

Table 1: Distribution of respondents by socio-economic characteristics.

2. Participation in off-farm activity and technology adoption level

The adoption level refers to the intensity of use of improved technology by the farmers measured using their adoption scores. The adoption index generated shows to what extent the farmers have adopted the whole technology package. The level of adoption (technology-use) of cassava improved production technology by off-farm activity participation, revealed that adoption level was higher among those participating than their counterparts without participation. From Table 2, the mean adoption index of the adopters with non-farm activity participation was 0.87 while that of their non-participating counterparts was 0.58 with a mean difference of 0.29 ($p<0.05$). This implies that adoption level of farmers with off-farm income source was 29% higher than those without off-farm income source, significant at 5%.

Off-farm activity	Percentage	Mean adoption index	Probability value
Participation	73.13	0.87	0.0214
Non-participation	26.87	0.58	

Source: Source: Field Survey, 2011

Table 2: The adoption index by off-farm activity participation.

3. Effect of non-farm activity participation and other socio-economic characteristics on Adoption Level of cassava Improved Production Technology

The result of the determinants of adoption level of cassava improved production technology by farming households in the study area is shown in Table 3. The result of the Tobit regression model shows that the log likelihood is -199.69 and is significant at 1% level of significance. This indicates that the model has a good fit to the data. The result shows that out of the 14 explanatory variables included in the model, participation in off-farm activity and seven other variables were found to significantly influence level of adoption. These are gender, distance to input market, land area cultivated, years of experience in cassava production, cassava yield, access to credit and level of education. Parameter with positive signs indicates that increase in the variable increases adoption level while negative signs indicate that increase in the variable decreases adoption level.

Participation in off-farm activity has a positive and significant ($p<0.05$) influence on level of adoption. During slack periods many farmers can earn additional income by engaging in various off-farm activities. This is believed to raise their financial position to acquire new inputs. Participation in off farm activity will increase adoption level by 4.68%. This concurs with Chilot et al. (1996). The gender of the farmer is significant ($p<0.01$) and has a positive sign implying that male household heads are more likely to adopt the use of improved cassava production technology than their female counterparts. From the result, being a male household head will increase the level of adoption by 13.83%. This shows that male headed households have better access to information and other resources on improved cassava production technology and are more likely to adopt new technology than female headed households. This result is in agreement with Tesfaye et al (2001); Mesfin (2005) and Omonona et al. (2006).

The coefficient of years of experience in cassava production is positive and significant ($p<0.01$). A unit increase in years of experience in cassava production will increase the adoption level by 5.06%. This is due to the fact that farmers with higher experience in cassava production appear to have full information and better knowledge hence able to evaluate the advantage of the technology. This finding is in accordance with Chilot (1994). The level of adoption of improved cassava production technology is significantly but negatively influenced by distance to the nearest input market. Market distance significantly ($p<0.01$) reduced adoption level. This indicates that farmers nearer to the markets have more access to input. The result from this study showed that a unit decrease in market distance will increase the likelihood of adopting technology by 1.80%. This concurs with Mesfin (2005) and Hailu (2008) who reported that market distance is negatively and significantly associated with adoption of crop technologies in different parts of Ethiopia.

Access to credit has positive and significant influence ($p<0.01$) on the adoption of improved cassava production technology. From the result of this study, access to credit facilities leads to 15.82% increase in the adoption level. This is attributed to the fact that credit increases the farmers' economy to purchase improved seed, fertilizer and other inputs. This is in agreement with Mulugeta (2000) and Tesfaye et al. (2001). The level of education of the household head positively and significantly ($p<0.05$) influenced adoption level of improved production technology. Educational level will increase adoption level by 17.55%. Education increases farmers' ability

to obtain, process, and use information relevant to technology adoption. This result is in line with Chilot (1994).

The coefficient of land cultivated is positive and significant ($p<0.01$). From the result of this study, a unit increase in land cultivated will increase adoption level of improved production technology by 0.6345. Land is perhaps the single most important resource, as it is a base for any economic activity especially in rural and agricultural sector. It is frequently argued that farmers cultivating larger farm land are more likely to adopt an improved technology (especially modern varieties) compared with those with small farmland. This finding is consistent with Hailu (2008) that farm size exerts a positive influence on adoption of improved teff and wheat production technology in northern and western shewa zones of Ethiopia. Cassava yield has a positive and significant ($p<0.01$) influence on adoption level. A unit increase in last season's yield will increase the adoption level of improved production technology by 14.31%. This is in agreement with Omonona et al. (2006).

Variables	Marginal effect	Standard error	t- value
Gender	0.1383***	0.0515	2.69
Age	-0.0223	0.0239	-0.93
Marital status	0.1834	0.1759	1.04
Level of education	0.1755**	0.0834	2.1
Main occupation	0.0248	0.043	0.58
Off- farm activity	0.0468**	0.0229	2.04
Distance to market	-0.0180***	0.0058	-3.09
Land cultivated	0.6345***	0.1375	4.61
Year of experience	0.0506***	0.0086	5.88
Cassava yield	0.1431***	0.0115	12.41
Credit access	0.1582***	0.0567	2.79
Extension agent	0.0126	0.0566	0.22
Household size	0.0021	0.0048	0.08
Age square	0.0003	0.0003	1.15
Constant	-1.2732 ***	0.3942	-3.23
Sigma	0.5806	0.0319	
Prob>chi2	0		
Pseudo R2	0.4458		
Log likelihood	-199.69		

Notes: **,*** are significant levels at 5% and 1% respectively
Source: Field Survey, 2011

Table 3: Estimates of Tobit regression for the determinants of adoption.

4. Food insecurity status of respondents

From the Table 4, the estimated annual household expenditure on food consumption was ₦172726.53 while the mean per capita household food expenditure (MPCHFE) was ₦30198.34. The food insecurity line was computed for respondents using the two-thirds MPCHFE, the food insecurity line was ₦20132.22 per annum.

Item	Average annual expenditure
Food	172726.53
Mean per capital household foodexpenditure (MPCHFE)	30198.34
Food insecurity line (2/3 MPCHFE)	20132.22

Source: Field Survey, 2011

Table 4: Annual household food expenditure profile.

4.1. Food Insecurity Status and impact by participation in off-farm activity

Based on the food insecurity line, 51.25% of the adopters live below the food insecurity line (food insecure). The food insecurity incidence of adopters was lower than that of the non-adopters, this reveals that improved production technology has the potential to improve food security. The food insecurity incidence was 0.5125 for adopters compared to 0.6021 for the non-adopters. Table 5 shows the food security status of respondents by participation in off-farm activity. Based on the food insecurity line, 50.65% of adopters participating in off-farm activities were food insecure compared to 56.27% of their counterparts without participation. This reveals that food insecurity incidence among the respondents participating in off-farm activity was lower than those not participating. This might be as a result of the fact that off-farm activity increases the adoption level of improved cassava production technology in the study area.

The impact of the technology on food security status showed that the food insecurity incidence of the adopters declined by 12.42% with off-farm activity while the reduction was 5.01% with their counterparts with no participation. Furthermore, there was reduction in the food insecurity gap and severity of the adopters. The impact was significant ($p<0.05$) on the food insecurity gap of the beneficiaries participating in off-farm activity. The poverty gap of the beneficiaries declined by 38.24% for those participating in off-farm activity while the reduction was 14.68% with their counterparts without off-farm activity.

Type of Respondents/ off-farm activity	Statistics	Food Insecurity Status	ATT	Impact (%)
ADOPTERS	F0	0.5065	……	-12.42
Participation	F1	0.1224	-0.0468**	-38.24
	F2	0.0318	-0.0141	-44.34
	F0	0.5627	……..	-5.01
Non participation	F1	0.1451	-0.0213	-14.68
	F2	0.0487	-0.0097	-19.92
NON-ADOPTERS	F0	0.5598		
Participation	F1	0.1304		
	F2	0.0368		
	F0	0.5869		
Non participation	F1	0.1477		
	F2	0.0565		

Note: ** is significant level at 5%
Source: Field Survey, 2011

Table 5: Food Insecurity Status by participation in off-farm activity.

In the same vein, the impact was higher on the food insecurity severity of the beneficiaries with off-farm activity than those with no participation. The severity reduced by 44.34% with participation while it was 19.92% with their counterparts without off-farm activity.

Conclusion

This study examined causal effect of off-farm activity and technology adoption on food security status of cassava-based farming households in Southwestern Nigeria. Empirical evidence from this study revealed a higher adoption level and impact of improved cassava technology on those participating in off-farm activity. Participation in off-farm activity, gender, land area cultivated, years of experience in cassava production, cassava yield, access to credit and level of education significantly increased technology adoption while distance to input market decreased technology adoption. The mean per capita household expenditure was ₦30198.34 while the food insecurity line was ₦20132.22 per annum. The food insecurity incidence of adopters was lower than that of the non-adopters. The food security status of the adopters with off-farm activity was higher than their counterparts without participation. Though, there was reduction in food insecurity indices of both participating and non-participating beneficiaries, implying that cassava production technology is food security improving, however, the impact was higher on the food security status of those with off-farm activity participation. Hence, Policy measures should be oriented towards the support and improvement of rural off-farm income opportunities; there should be wide dissemination of this technology to improve food security in Nigeria.

Corresponding author:
Adekemi A. Obisesan
Department of Agricultural and Resource Economics, Federal University of Technology, Akure, Ondo State, Nigeria
Phone: +2348076673676, E-mail: kemi_triumph@yahoo.com

References

[1] Akinlade, R. J, Yusuf, S. A, Omonona, B. T., Oyekale A.S. Poverty Alleviation Programme and Pro-poor Growth in Rural Nigeria: Case of Fadama II Project. World Rural Observations. 2011, Vol. 3, No. 1, p. 27-33. ISSN 2042-6356.

[2] Asfaw, N., Gungal, K., Mwangi, W. and Beyene S. Factors Affecting Adoption of Maize Production Technologies in Ethiopia. Ethiopian Journal of Agricultural Economics, 1997, Vol. 2, p. 52-69. ISSN 2042-6356.

[3] Baker, J. L. Evaluating the impact of development projects on poverty. A handbook for practitioners. The International Bank for Reconstruction and Development/The World Bank, 1818 H street, N.W, Washington, D.C.20433. 2000. ISBN 0-8213-4697-0.

[4] Chilot, Y. Factors Influencing Adoption of New Wheat Technologies in the Wolmera and Addis Alem Areas of Ethiopia. An M.Sc. thesis presented to the school of graduate studies of Alemaya university of Agriculture, Ethiopia. 1994, p. 108.

[5] Chilot, Y., Shampiro, B., Demeke, M. Factors Influencing adoption of new wheat technologies in Wolmera and Addis Alem Areas of Ethiopia.Ethiopian Journal of Agricultural economics. 1996, Vol 1, p. 63-83. ISSN 2042-6356.

[6] De Janvry, A., Sadoulet, E. (2001). Income Strategies Among Rural Households in Mexico: The Role of Off-farm Activities. In: World Development, 2001, Vol. 29, No. 3, p. 467-480. ISSN 1873-5991, E-ISSN 0305-750X.

[7] Foster, J., J. Greer, and E. Thorbecke. (1984). A class of decomposable poverty measures. Econometrica. 1984, Vol. 52, p. 761–766. ISSN 0012-9682, E-ISSN 1468-0262.

[8] Haggblade, S., Hazell, P. and Reardon, T. Transforming the Rural Non-farm Economy. Baltimore:Johns Hopkins University Press.2007.

[9] Heckman, J., Icchimura, H. , Todd, P. Matching as an Econometric Evaluation Estimator. Review of Economic Studies, 1996, Vol. 65, p. 261-295. ISSN 0034-6527, E-ISSN 1467-937X.

[10] International Fund for Agricultural Development (IFAD), 2011. Rural Poverty Report: Enabling Poor Rural People to Overcome Poverty. Retrieved 10th April, 2011 [Online] Available: http://www.ifad.org/rural/index.htm [Accessed 25 Sept 2014].

[11] International Food Policy Research Institute (IFPRI). Global Hunger Index. The Challenge of Hunger: Taming Price Spikes and Excessive Food Price Volatility.Washington DC. 2011.

[12] Johnston, J. , Dandiro, J. Econometrics Methods, 4th ed., New York: McGraw Hill Companies, Inc. 1997. ISBN 0070327203.

[13] Kristjanson P., Place, F., Franzel, S., Thornton, P. K. Assessing Research Impact on Poverty: The Importance of Farmers Perspective. Agricultural systems. 2002, Vol. 72, p. 73-92. ISSN 0308-521X, E-ISSN 1873-2267.

[14] Lechner, M., Smith, J. Some Exogeneous Information Should Not Be Used in Evaluation, mimeo, 2002.

[15] Csaki C., Lerman, Z. Agrarian reform in Belarus, what has been achieved after a decade of gradualism. Quaterly Journal of International Agriculture, 2000, Vol. 39, No. 3, p. 237-260. ISSN 0049-8599.

[16] Maddala, G. S. Limited Dependent and Quantitative Variables in Econometrics. Cambridge University Press. 1997.

[17] Mendola, M. Agricultural technology adoption and poverty reduction. A propensity Score matching analysis for rural Bangladesh. Food policy, 2007, Vol. 32, p. 372-393. 0306-9192.

[18] Mesfin A. Analysis of factors Influencing Adoption of Triticale and its Impact.The Case Farta Wereda. Msc. Thesis (Unpublished) Presented to School of Graduate Studies of Alemaya University. 2005.

[19] Mulugeta E. Determinants of Adoption of soil Conservation Practices in Central Highlands of Ethiopia. The case of three districts of Selale. M. Sc. Thesis AU. 2000.

[20] National Bureau of Statistics (NBS). Nigeria Poverty Profile. Abuja. 2012.

[21] National Population Census (NPC) National Bureau of Statistics Official Gazette (FGP 71/52007/2,500(OL24) Abuja. 2006. [Online] Available: http://www.nigerianstat.gov.ng [Accessed 15 Nov. 2014].

[22] Negash R. Determinants of Adoption of Improved Haricot Bean Production in Alaba Special Woreda Southern Ethiopia. M Sc. Thesis Submitted to the Department of Rural Development and Agricultural Extension, School of Graduate Studies Haramaya University. 2007.

[23] Nkonya, E., Schroeder, T., Norman, D. (1997). Factors affecting adoption of improved maize seed and fertilizer in North Tanzania. 1997, Indian j. Agri.econ. Vol. 48, No. 1, p.1-1, ISSN 00195014.

[24] Núñez, J. T. The Adoption of Manure Management Practices. Unpublished M.Sc. Thesis University of Missouri-Columbia. 2005.

[25] Omonona, B. T, Oni, O. A., Uwagboe, O.A. Adoption of improved Cassava varieties and its Impact on Rural Farming Households in Edo State, Nigeria. Journal of Agriculture and Food Information, 2005, Vol 7, No. 1, p. 40-45. DOI:10.1300/J108v07n01_05

[26] Omonona, B.T and Agoi, C.A. An Analysis of Food Security Among Nigerian Urban Households: Evidence from Lagos State, Nigeria. Journal of Central European Agriculture. 2007, Vol. 8, No. 3, p. 399-406. ISSN 1332-9049.

[27] Ruben, R., M. van den Berg, M. Nonfarm Employment and Poverty Alleviation of Rural Farm Households in Honduras. World Development. 2001, Vol. 29, Vol. 3, p. 549-60. ISSN 1873-5991, E-ISSN 0305-750X.

[28] Rosenbaum, P. R, Rubin, D. R. The Central Role of the Propensity Score in Observational Studies for Causal Effects. 1983, Biometrika. Vol. 70, p. 41-55.ISSN 0006-3444, E-ISSN 1464-3510.

[29] Tesfaye Z., Girma, T., Tanner,D, Verkuijl, H. Aklilu, I., Mwangi, W. Adoption of Improved Bread Wheat Varieties and Inorganic Fertilizer by Small Scale Farmers in Yelma Dansa and Farta Districts of Northern Ethiopia. Mexico, D.F. Ethiopian Agricultural Research Organization (EARO) and International Maize and Wheat Improvement Center (CIMMYT). 2001.

[30] Tiamiyu, S. A., Akintola, J. O., Rahji, M. A. Y . Technology Adoption and Production Difference among Growers of New Rice for Africa in Savanna Zone of Nigeria. 2009. Tropicultura, Vol. 27, No. 4, p. 193-197. ISSN ISSN 0771-3312, E-ISSN 2295-8010.

Agris on-line Papers in Economics and Informatics

Volume VII Number 3, 2015

Crops Rotation – the Solution of Environmental Problems (a Case Study of Prince Edward Island in Canada)

P. Procházka, H. Řezbová, L. Smutka

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

Anotace

Ostrov prince Edwarda je ve světě známí zejména pro svoji produkci brambor. Zatímco brambory představují velmi zajímavý zdroj příjmů, jejich produkce je spojena s výraznými dopady na životní prostředí. Hlavní roli v tomto ohledu hrají chemie a hnojiva použité v procesu pěstování brambor. Jejich užití se projevuje výrazným znečištěním vodních zdrojů. Jako odpověď na rostoucí znečistění místní vláda navrhla strategii/politiku vedoucí k redukci negativního vlivu spojeného s produkcí brambor na kvalitu vodních zdrojů. Jedna z nových politik (povinné střádání plodin) je analyzována v tomto článku. Analýza vlivu této politiky je provedena prostřednictvím aplikace „optimal control theory“ a dynamického programování. Poznatky plynoucí z kointegračního modelu poukazují na vliv zemědělství jakožto jednoho z významnější zdrojů znečištění vodních zdrojů. Je poskytnut statistický důkaz, že politika týkající se ochrany vodních zdrojů, musí být zaměřená právě na proces produkce brambor. Nicméně je nutno zdůraznit, že implementace environmentálně orientovaných opatření (povinná rotace plodin) se negativně promítá do ekonomiky farem.

Klíčová slova

Teorie optimální kontroly, povinná rotace plodin, politika životního prostředí, zemědělství, producenti brambor, ekonomické dopady.

Abstract

Prince Edward Island (PEI) is well known around the world for its potato industry. While economically beneficial for PEI, potato production contributes to its environmental deterioration. This can be attributed to the high use of chemicals and fertilizers in the production, which leads to the pollution of PEI's watercourses. In response to the environmental crisis, the PEI provincial government proposed several land use policies to mitigate the negative influence of potato production on water quality. One of the policies that is analyzed in this paper is a mandated crop rotation. The analysis of the mandatory crop rotation policy is achieved through the application of optimal control theory and dynamic programming. Findings from the co-integration model show that agriculture is most likely responsible for watercourse pollution in PEI. This provides statistical evidence that a policy aimed at water protection, specifically targeting potato land use is necessary. However the application of environmentally friendly approach (mandatory crops rotation) is positive, its negative impact on individual farms economy is evident.

Key words

Optimal control theory, mandatory crop rotation, environmental policy, agriculture, potato producers, economy impact.

Introduction

In nowadays agricultural sector performance and its relationship with environmental issues are discussed very often. Increasing interference of agriculture with the environment (Clark et al. 2012) has led to a greater concern associated with the external effects associated with agricultural production (Svatoš, 2008). The conducted paper is focused on problems of agricultural activities' impact on living environment. Discussion related to improvement of mutual relationship between agricultural and environmental activities are very dynamic in many countries around the world including the European Union. The paper is based on research conducted by one of the authors during his long-term study stay

in Canada. The main ambition of the paper is to encourage discussion about the importance of crop rotation both in relation to farming activities and living environment. The conflict between agriculture and living environment is typical for many countries including Canada – as an example of this conflict we can take in consideration the problems existing between farmers producing potatoes and living environment development in the case of Prince Edward Island (PEI), the smallest province of Canada which is known for its clean environment and progressive environmental legislation. For local economy two activities are the most important – agriculture and tourism. Tourism expenditures in 2013 totaled $295.7 million (Prince Edward Island Provincial Treasury, 2014). Besides tourism that is driven by the natural beauty of PEI, Prince Edward Island is also known for growing potatoes. Agriculture contributed about $497 million to PEI's economy, with approximately 50% of total farm cash receipts being generated by potatoes in 2013 (Statistics Canada, 2014). For many years agriculture and tourism have co-existed with no major disputes. According to e.g. Canadian Broadcasting Corporation (2007a, 2007b, 2007c) agriculture has begun to interfere with tourism and other economy activities, sport fishing etc. in the moment when farmers significantly increased the level of potato production. In surface water, excessive nitrogen and phosphorus levels from agricultural production are assumed to cause three major pollution problems: 1) enrichment of an ecosystem with chemical nutrients; 2) a change in the composition and distribution of flora and fauna in the streams (Government of Prince Edward Island, 1996); and 3) health hazards due to the contamination of wells and other sources of drinking water (PEI Government, 2002). Agriculture in PEI has been blamed in the past two decades for deterioration of an environment that is considered to be one of the best in Canada (Jatoe et al., 2007). This conflict, however, is quite common in Canada, as well as around the world. Famous examples of agricultural interference with the environment include the pollution of Lake Winnipeg (Lake Winnipeg Stewardship Board, 2008) or the Baltic Sea pollution (BAAP, 2003), both caused by agricultural run-off. Increased concerns over the environmental impacts of agriculture have encouraged entreaties throughout the world for agricultural production methods which are more environmentally sustainable. One of the controls that policy makers have implemented to assuage the long-run environmental impacts of agricultural production is the mandated crop rotation. While mandated crop rotations have been used as a common tool for environmental sustainability in the European Union, they were implemented only recently in North America in the province of Prince Edward Island. The aim of the mandatory crop rotation legislation is to reduce environmental pollution associated with potato production by limiting the maximum number of years that potatoes can be grown. Surprisingly, however, as opposed to the European Union, mandated crop rotations met with resistance from PEI farmers. Mandatory crops rotation is affecting farmers' decision making process related to their economy activities. The application of mandatory crops rotation is affecting farmers' production costs and also it has a significant impact on their profitability. The proposed crops rotation models have reduced farmers' crops (potato) production volume by about 20% (in same cases even more). However mandatory crops rotation has a negative economy impact on farmers and farmers' willingness to apply that model is limited or even negative. It must be emphasized that mandatory crops rotation represents the solution of several problems (environmental pollution management, land quality management etc.). The main motivation of this paper is encouraging discussion related to crops rotation problem.

The papers main goal is to specify the impact of mandatory crops rotation of farming activities in PEI. Main goal is divided into three following sub-goals.

1. The identification of impact of intensive farming on living environment (the impact of intensive potato production on watercourse pollution).
2. The specification of watercourse pollution elimination through the optimal crops rotation.
3. The specification of mandatory crops rotation (different scenarios) impact on farmers' production structure decision making process and their profitability.

Materials and methods

No statistical evidence was hitherto provided whether agriculture is the only polluter of PEI watercourses. This paper aims to gain insight into the environmental pollution concern in PEI, as well as to analyze why the implementation

of the mandatory environmental legislation was not supported by PEI potato producers. Environmental pollution in PEI watercourses is analyzed using time series analysis tools. In order to analyze what is causing water pollution in PEI, individual time series are examined for the presence of a unit root. This is done by the Dickey-Fuller test, originally proposed by Dickey and Fuller (1979). The question that arises is why the crop rotation legislation was resisted by potato producers. To answer this question, an optimal control model of PEI potato rotations was developed. Unique to the modeling effort of potato rotations is the fact that the rotations are not fixed; each year, the choice of crop is based on present and future value. Also, a distinction is made between organic nitrogen (modeled as stock) and inorganic nitrogen (modeled as flow). The optimal control model has as its state variable nitrogen stock (that is related to soil organic matter) and nitrogen fertilizer as its control variable.

A continuous optimal control model is presented below:

$$Max\ U\ \int_{t=0}^{T}\left[\left(piyit(Nt,Fit)\right)-cFit\right)x+\left(piyit(Nt,Fit)\right)-cFit)(1-x)]dte^{-rt} \quad (1)$$

$$N1=\frac{\delta N1}{\delta t}=g1[N(t),F1(t)]x+g2[N(t),F2(t)](1-x)-\varphi N1(t) \quad (2)$$

$$N1(0)=N1, Fi\geq 0, 0\leq x\leq 1, and\ i=1,2 \quad (3)$$

and

$$N1(T)=free \quad (4)$$

where U is a discounted cumulative performance measure, i.e. profits over the planning horizon. T, pi are the prices of the respective crop i, $i=1,2$ $r > 0$ is the private rate of discount, c is the input price of fertilizer, and N0 is the initial value of nitrogen stock. Nt is the value of nitrogen in time t, Fit is the value of fertilizer applied to the field at time t for crop i, yit represents a yield function of crop $_i$ at time t, x represents a proportion of field devoted to potatoes and φ is the rate at which the stock releases nitrogen that is used by the crop. The model hence consists of three control variables x, Fi for $i=1.2$, and one state variable $N1$. The model represents a process in which each year producers are presumed to choose, based on current profit and future conservation value, the most profitable of two crops: potatoes (high valued, high depletion crop); and barley (intermediate valued, intermediate depletion), ryegrass (low valued as it is used as manure, high conservation). The nitrogen cycle is developed to understand peculiarities of PEI potato production, whereas in the optimal control model, it is introduced as the equation of motion (equation 3). Various crops have different biophysical properties that are reflected in the equation of motion and represent residues and their quality. For example, in the case of potatoes where most of the plant is harvested, potatoes return less nitrogen to the soil than they extract. Forage, on the other hand, leaves abundant soil residues and hence contributes to soil organic nitrogen conservation. In order to solve the problem, an empirical discrete time simulation model is provided below (equations 5, 6). A discrete time approach has advantages as it allows the introduction of stochasticity by random price generation and to use computer algorithms to obtain quantitative results.

$$Max\frac{1}{(1+r)^t}\sum_{t=0}^{T}(p1y1(N,F)-cF1+p2y2(N,F)-cF2+p3y3(N,F)-cF3 \quad (5)$$

$$\Delta N1t=\beta i(Fit-1+Nt-1)-\varphi Nt-1, N1=Nx \quad (6)$$

where N denotes the nitrogen released from the stock $N1$ that is made available to the plant, φ is the rate at which the stock releases nitrogen that is used by the crop, β is the rate at which fertilizer and nitrogen flow from the previous time period, transferred through crop residues into nitrogen stock $N1$, $N10$ is the initial nitrogen stock, and Nx is the value of initial nitrogen stock. The remaining elements of the equation (equations 5, 6) are described in the theoretical optimal control model in the previous section of this paper.

Results and discussion

An impact of agricultural production on environment and government's reaction

In order to examine the impact of agricultural production upon the environment, nitrogen is analyzed based on the following factors: **1)** nitrogen is believed to be a good indicator of the overall impact of agricultural activity on the environment (PEI government, 2002); **2)** potato production is characterized by high usage of nitrogen fertilizer while at the same time is of a highly erosive nature; **3)** nitrogen is the main fertilizer used in agricultural production to boost crop yields (Fertilizer Institute, 2007); **4)** nitrogen pollution can also be linked

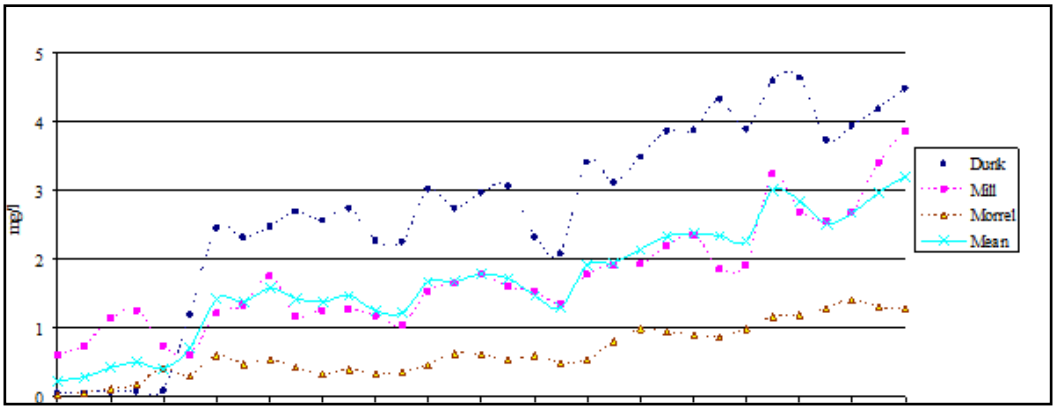
to non-agricultural influences (Crist, Monroe, Poats, 1999); **5)** nitrogen in the soil can be related to soil organic matter, an indicator of overall soil quality; and most importantly **6)** during the last thirty years, there has been an alarming increase in nitrogen pollution in PEI watercourses. This is demonstrated in Graph 1. The figure plots the average amount of nitrogen in three PEI streams during the last almost four decades (from the beginning of 70ties) together with three observations from three watersheds in PEI. The figure shows a definitive rise over time. This has led to increasing concern that the pollutants in the streams may be causing environmental damage.

In response to the increased pollutants in PEI watercourses, the Provincial government of PEI set up a commission to study the problem and make recommendations to the Provincial government. This commission produced a report known as the Round Table on Resource Land Use and Stewardship (PEI Government, 1997), hereafter simply called the Round Table. Several recommendations were made in the report; however, in dealing with agriculture, the two that are directly of concern to this research include:

1. The establishment of buffer zones between cultivated agriculture and watercourses; these buffer zones are intended to mitigate pollutant runoff from intensive agriculture into PEI watercourses. Potato producers are offered compensation in the form of subsidies for instituting buffer zones;
2. A mandatory three year crop rotation for potato producers. This rotation mandated that potatoes could only be grown one year in three. The other two years are at the discretion of the producer, but are hoped to include a grain crop (mostly wheat or barley) followed by a forage crop. The Agricultural Crop Rotation Act (ACRA) is the first legislation in North America to directly target pollution from agriculture so that agricultural producers themselves have to bear the costs associated with that decision. Potato producers are not offered any compensation for the implementation of crop rotations. The recommendations of the Round Table were legislated in PEI in the late early millennium. While the general consensus seems to be that the buffer zones have generally been enacted, the same cannot be said for the mandatory crop rotations. The rotations legislation was not supported by potato producers, who argued that the legislation, especially the crop rotation legislation, was unduly restrictive to producer choice, costly to implement, and possibly redundant since farmers were already practicing a three year crop rotation (Canadian Broadcasting Corporation, (2001)).

Time series analysis of watercourses pollution in PEI

In order to examine what is causing the rise in nitrogen levels in PEI watercourses and to analyze the conflict of the agricultural vs. non-agricultural sector, some of the tools of the time series analysis are used. Two candidates selected on the base of available literature sources (increasing potato production and waste management) from both agricultural and nonagricultural sectors are chosen as possible polluters of PEI watercourses. The major cause of increased nitrogen levels is assumed to be



Source: Environment Canada (2015)

Graph 1. Average total nitrogen level in PEI watercourses (30 years development).

the agricultural industry, especially the intensive cultivation of potatoes. The assumption that primary potato production is the cause of increased pollution on the Island is due to the fact that there has been a large expansion of the potato industry during the last two decades. This expansion has been facilitated by the expansion of processing capacity, since a new processing plant was built by McCains foods and an existing plant was expanded by Cavendish farms during the same time. This led to large areas of land converted into potato production, especially in Eastern PEI. The rise of farmed areas in PEI is certainly consistent with the rise of nitrogen levels presented in Graph 1., but the relationship could be spurious. With respect to nonagricultural influence, for example, Crist, Monroe and Poats (1999) argue that in the rural areas, there are almost no sanitary sewers. The lack of sanitary sewers requires an on-site sewage disposal system. These septic systems may have negative influences upon the environment under certain circumstances. Crist, Monroe and Poats (1999) further argue that there is a major problem associated with septic tanks and water pollution since as many as one-half of all septic tanks in operation are not functioning correctly. Since no data is available on the number of septic tanks in PEI or the quality of septic tanks, another variable has to be chosen to approximate influence of septic tanks upon the environment of PEI. Rural population in PEI is chosen as a proxy variable for the number of septic tanks.

Model and results of watercourses pollution analysis

In order to analyze what is causing water pollution in PEI, individual time series are examined for the presence of a unit root. This is done by the Dickey-Fuller test. Case 1 of Dickey-Fuller implies that the original time series has a zero mean. Since this does not seem to be plausible for rising nitrogen levels in watercourses of PEI, only Case 2 (intercept, no trend) and Case 4 (intercept, trend) are examined. In Table 1, results of Dickey-Fuller test are presented.

The table indicates that for all variables, existence of a unit root in the series cannot be rejected t the 5% level of significance. In the non-stationary framework it is true that in order for one time series to explain another time series, they have to be integrated with each other, i.e. there has to be a long-run relationship between two or more series (Granger, 2002). There are several methods on how to test for integration. Park's (1992) canonical integrating regression (CCR) used in this paper extends to more general integrated models, such as the models with structural breaks and the system of regressions given in structural form. Hence, CCR can be used for models with variables which include deterministic as well as stochastic trends. This is important for the case of PEI since there were no reported fish mortalities (as an evidence of living environment improvement) since the end of 2004 due to the change in legislation of buffer zones (Canadian Broadcasting Corporation, 2007c). In order to represent the effects of legislation upon the level of nitrogen, a dummy variable is created so that it takes the value of zero within the analyzed time period before the legislation was changed, and one within the period after the new legislation was introduced. Table 2 presents the findings of an analysis of a possible relationship between the expansion of the PEI potato industry, rural population, and nitrogen pollutants in PEI watercourses using CCR.

The table indicates that the null hypothesis of no integration between nitrogen levels, areas seeded to potatoes, and the dummy variable can be rejected, while it cannot be rejected for population, dummy, and constant variables. Hence, it is concluded from the results of CCR that there is evidence that the rise in nitrogen levels in PEI is related to the expansion of the PEI potato industry, while it is not related to the rural population of PEI. These results further motivate the need to analyze the environmental legislation that was not supported by farmers' groups in PEI.

	PEI nitrogen levels	PEI rural population	PEI potato acreage
Case 1 (no intercept, no trend)	-1.37	0.07	1.77
Case 2 (intercept, no trend)	-3.00	-2.33	-1.33
Case 4 (intercept, trend)	-3.00	-2.38	-2.10

* Level variable from the regression $\Delta y_t = \beta_1 T + \beta_2 y_{t-1} + \beta_3 \Delta y_{t-1} + v_t$, where $T=0$ for Case 1 (no intercept, no trend); $t=1$ for Case (intercept, no trend); and $T=[1,t]$ for Case 4 (intercept, trend) included in the Dickey-Fuller regression.

Source: own processing, 2015

Table 1: Dickey-Fuller test*.

Scenarios	# of added polynomials	H(p,g) test	
		Chi²	p-value
Scenario 1 (acreage, constant, dummy)	T^2	0.58	0.45
	T^3	0.59	0.75
	T^4	4.49	0.21
Scenario 2 (population, constant, dummy)	T^2	5.09	0.02
	T^3	7.68	0.02
	T^4	7.92	0.05
Scenario 3 (acreage, population, constant, dummy)	T^2	0.36	0.55
	T^3	2.66	0.26
	T^4	4.69	0.19

* Level variable from the regression $\Lambda y_t=\beta_1 T+ \beta_2 y_{t-1}+ \beta_3' y_{t-1}+v_t$, where $T=0$ for Case 1 (no intercept, no trend); $t=1$ for Case (intercept, no trend); and $T=[1,t]$ for Case 4 (intercept, trend) included in the Dickey-Fuller regression.

Source: own processing, 2015

Table 2: Variable addition Chi2 test from canonical co-integrating regression.

Empirical optimal control model – results

The optimal control model was solved and simulated for the following four scenarios using deterministic numerical computational algorithms. Results of the model can be summarized as follows:

1. Continuous potatoes. This rotation is not sustainable over the long run. The model treats nitrogen naturally occurring in the soil differently than nitrogen fertilizer and natural nitrogen is a necessary factor of production. Since the only way to enhance this source of nitrogen is through the growth of grain or forage, eventually the increase in the future value of entering another crop into the rotation outweighs the current profit of growing potatoes. While continuous potatoes does not lead to a steady-state rotation, it can be sustained over the short term, particularly if natural nitrogen levels in the soil are high. This may be true of land that has recently been brought into production, like land in the eastern part of PEI.
2. Two crop rotation: potato and grain. This crop rotation dominates the simulation results. It also leads to a steady state level of nitrogen and a steady state rotation. Therefore, it is sustainable. However, this rotation also leads to a significant amount of pollution from nitrogen runoff. This crop rotation is likely to result in continued interference of agriculture on other industries in PEI and therefore agriculture or other industry conflicts may remain. There is evidence of an anecdotal nature that this rotation is highly prevalent in PEI. Profitability of this crop rotation is highest.
3. Two crop rotation: potato and forage. The results show that this crop rotation is rarely optimal. Much of the reason that forage never enters the rotation is due to the fact that forage is treated as a green manure. Therefore, forage enters the rotation when it is given some value other than simply its conservative effects on soil quality. The steady state level of nitrogen is highest with this rotation, while discounted present value of profits is lowest.
4. Three crop rotation: potato, grain, and forage. The results show that this crop rotation is never optimal. When forage enters the rotation, grain leaves, implying that a three crop rotation is never optimal. There is anecdotal evidence that three crop rotations are not the dominant in PEI, which suggests that grain/forage interactions may not be economically important to the explanation of observed PEI crop rotations.

Results from analyzed scenarios suggest that in order to bring in the most soil conserving crop rotation (potato-grain-forage), certain compensations are needed.

The economy aspects of mandatory crops rotation – farmers' decision making process

In order to evaluate crop rotation policy options and implications, it is necessary to determine the crop rotation given the model assumptions. Clearly, the crop rotation depends on the settings of the model. It is apparent that there is an indefinite

combination of settings; for example, conditional on different initial nitrogen level, different input/ output prices, or interest rate. Six different scenarios were created to simulate various exemplary situations; settings and simulation results under these scenarios are presented in Table 3.

The first two scenarios are created to represent differences in the behavior of farmers, depending on different initial levels of soil nitrogen. This may illustrate the situation in the Eastern part of the province, where land was recently brought into production. The third and fourth scenarios represent the effects of interest rate change. The fifth scenario represents an increase in the output price of potatoes. The last scenario demonstrates an increase in the input price of nitrogen fertilizer. While the results provide an explanation as to what is the optimal crop rotation, it also shows that ceteris paribus initial soil conditions matter. Hence, when a mandated crop rotation land use policy is introduced, those farmers who previously rotated the crops and maintained high soil quality may be disqualified. The simulation is further expanded to include the changes in output prices, as in the market environment agricultural producers have to face oscillating prices. In the presence of a market-based environment, mandatory fixed crop rotations have important economic impacts. For the purpose of demonstrating how the mandatory fixed rotation affects farmers when prices are not assumed to be fixed, random number generated data is used. Specifically, potato and barley prices were randomly generated based on a historical mean price, and its standard deviation. The process of random number generation also implements stochastic behavior into an otherwise deterministic model. The simulation yields approximately 83% potatoes as the optimal long-run average rotation (potatoes are grown on average once every three years over the entire optimization horizon). The same pattern of approximately 83% is also used for the fixed rotation simulation (potatoes are grown only once every three years consecutively). As expected, the profits associated with simulation based on the fixed rotation pattern are smaller. The difference in the profits between them is approximately 15%. Environmental approach is determining the farmers' economy activities stricture and their profit. The reduction of potato producing areas is reducing profitability. If farmers would produce potatoes on 100% of available plots their profits per acre would be significantly higher in comparison to mandatory crops rotation system (e.g. compare scenario 1 and scenario 3).

Discussion on Flexible vs. Mandatory Environmental Legislation in relation to economy aspects

Furthermore, the results can explain why there is resistance by producers to the mandated three year fixed crop rotations instituted by the PEI government. In order to explain the resistance,

		Scenarios					
		1	2	3	4	5	6
Model inputs							
Interest rate	(% p.a.)	5	5	10	2	5	5
Time horizon	(years)	300	300	300	300	300	300
Initial nitrogen level	(lb/acre)	500	6000	500	500	500	500
Output price potatoes	($/lb)	0.1	0.1	0.1	0.1	0.15	0.1
Output price barley	($/lb)	0.05	0.05	0.05	0.05	0.05	0.05
Output price forage	($/lb)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Input price fertilizer	($/lb)	0.5	0.5	0.5	0.5	0.5	1
Model outputs							
Optimal crop rotation							
% potatoes		72	81	100	79	79	73
% barley		28	19	0	21	21	27
% forage		0	0	0	0	0	0
Steady state nitrogen stock	(lb/acre)	1600	700	t=>inf	1300	1300	1600
Discounted present value of profits	($/acre)	44790	117728	197930	129404	129404	43780

Source: own processing, 2015

Table 3: Simulation results.

it is necessary to introduce a stochastic element into the model in the form of randomly generated prices. Several rotation scenarios were modeled using this approach. One crop rotation scenario involves a flexible crop rotation where farmers are allowed to react to short-run price fluctuation. The other crop rotation simulates a fixed mandatory crop rotation as proposed by PEI legislation. Comparison of these rotations highlights two different views of crop rotations. Finally, scenarios were generated with different initial soil conditions. Under fixed crop rotation systems, crop rotations are viewed as non-stochastic in nature and adhered to because of their biophysical impacts on soil and other environmental factors. Farmers are assumed to strictly adhere to a particular regimen that is independent of stochastic fluctuations in prices and other variables that may affect the short-run competitiveness of a crop in a rotation, but not its long-run average competitiveness in the rotation. Under flexible crop rotation systems, a rotation is defined as an average amount of time a crop enters a rotation and therefore is not deterministic, but is stochastic in nature. Hence, although in the short-run a particular crop may deviate from its long-run mean in the rotation due to short-run fluctuations, over the long-run mean reversion will result. Ceterus paribus, flexible crop rotations, and fixed crop rotations generate similar long-run results and so the long-run environmental impacts of both of these systems is, for the most part, environmentally neutral. However, since flexible crop rotation systems allow producers to make short-run adjustments in crop decisions given relative prices that are excluded in fixed crop systems, in stochastic environments, flexible crop rotation systems will maximize returns to producers and fixed crop systems will not. In simulated results for PEI where potatoes entered the rotation once in three years on average, fixed crop rotation systems yielded a 20% loss in wealth as compared to flexible crop rotation systems. In the case of different initial soil quality, the results indicate that farmers who are not allowed to use expendable surpluses from their soil, i.e. part of soil that is not economic to regenerate, may suffer economic loss up to 50%, as opposed to cases when abundant soil quality is used until equilibrium is attained. The results of the optimal control model indicate that there are important costs associated with mandated crop rotations that may explain why there is resistance by producers to this legislation in PEI. The results indicate that the choice of crop in rotation is very much an entrepreneurial decision. If this aspect of the production decision making is taken out of the hands of producers through mandated crop rotations, significant losses may result. Furthermore, flexible crop rotation and fixed crop rotation systems generate similar long term environmental impacts. The losses to producers are not transferred into environmental gains. They are therefore a deadweight loss associated with the implementation of a fixed crop rotation rather than flexible crop rotation systems. Given that rotations mandated by the PEI government represent fixed crop rotation systems, this policy may be inefficient when compared to one where flex cropping is allowed.

Crops rotation as positive factor/as positive externality

The application of crops rotation is not only the problem of Canada. Crops rotation in nowadays is also very important topic discussed at the level of FAO, WTO and also the EU. However farmers attitude to mandatory crops rotation is not really positive, crops rotation is able to generate the significant externalities. The value of those externalities is estimated to be much higher than the farmers' loses. There are several positives related to crops rotation.

- Crop rotation improves soil structure, soil fertility and biodiversity over time, preventing the build - up of pathogens and pests and decreasing pesticide use and water pollution (Ulmer, 2013).
- Where leguminous plants are part of crop rotation schemes, significant amounts of energy - intensive and increasingly expensive mineral fertilizer can be replaced by natural nitrogen fixation. This decreases the risk of nitrogen leaking into water bodies and prevents emissions of N2O and other NOx gases into the atmosphere, these being among the most potent greenhouse gases (Ulmer, 2013).
- While there is almost universal agreement among experts that crop rotation provides a variety of environmental and agronomic benefits, the crop diversification plan currently proposed by global authorities, now being discussed by the stakeholders, not only offers inferior agro-environmental results, but also creates a diversity of additional agronomic management problems, especially for small holdings (Ulmer, 2013).
- Crop rotation fully complies with WTO

green box requirements when the focus of any proposed greening measure remains on the environmental function and intended agro-ecological results of crops rotation, which is the most tangible and locally measurable benefit of crop rotation (Ulmer, 2013).

- Mandatory crop rotation, which includes plants that have demonstrated positive environmental and agro-ecological functions, may thus put government subsidies/payments on an even safer and more legitimate footing (Ulmer, 2013).

Conclusion

The results coming from the analysis suggest that potato production in PEI can be a source of watercourse pollution. These results support the actions of the Round Table of PEI's government to introduce legislation to protect the environment and maintain its high quality. If no actions are taken, the environment in PEI can be degraded and non agricultural sectors depending on high living environment quality (e.g. tourism industry) may sustain significant losses associated with agricultural interference. PEI was supposed to serve as a template for other Canadian provinces with regards to the Agricultural Crop Rotation Act, the first legislation of its kind in North America that was supposed to limit the negative environmental impacts of agricultural production, where producers carry its costs. Based on the conducted analysis, mandatory crop rotations legislation, as introduced by PEI government in the Agricultural Crop Rotation Act, is likely to meet with farmers' resistance. Each year, producers face a decision as to what crop to grow. At that time, decisions are made as to the tradeoff of present profit based on current market conditions compared to expected future profit. Mandated rotations take this decision out of the hands of producers, without compensation. Furthermore, mandated rotations are based on an assumption of a steady state outcome that may not be relevant to producers who have recently brought land into production. Continuous potatoes may be optimal for these producers in the short run until liquidation values of natural stocks of nitrogen are exhausted. For this reason alone, mandated rotations are likely to meet with resistance from producers. Mandated rotations largely take quantity decisions out of the hands of producers and place them in the hands of government. However, producers are left to bear the costs of not being able to take advantage of price fluctuations. In this sense, mandated rotations may be perceived as unfair by producers. Cases where quantity decisions are mandated by the government with the support of producers are the supply managed industries. Under supply management, the government takes on the responsibility of controlling price through the control of quantity. If the Provincial government were willing to finance a guaranteed price support along with mandating rotations, crop rotation legislation may have more support from producers. Guaranteed prices for producers may be a reason why mandated crop rotations are not opposed in the European Union. In the absence of price supports, together with mandated rotations, the more flexible approach would be the use of taxes and subsidies without mandated rotations. Market based approaches influence producer behavior and enhances the goals of environmental preservation over the long term without taking from producers the potential gains resulting from short term market fluctuations. Therefore, flexibility is left with producers to adjust rotations as market conditions arise and can therefore result in increases in producer welfare without destroying long-run environmental targets of society. As the European Union shifts away from agricultural subsidies schemes towards market based approaches, legislators may find agricultural producers to be reluctant to follow fixed environmental policies. In this sense, analysis of mandatory crop rotations in Prince Edward Island may serve as an example for policy makers on how to adjust environmental policies in the presence of market based environment.

Acknowledgements

This paper was prepared within the project 20151016 - Establishing food security for Bangladesh's rural poor through sustainable collective farming practices. The project is supported by FEM, CULS in Prague, Internal Grant Agency.

Corresponding author:
Ing. Petr Procházka, Ph.D.
Department of Economics, Faculty of Economics and Management,
Czech University of Life Sciences Prague, Kamýcká 129, 165 21, Prague, Czech Republic
E-mail: pprochazka@pef.czu.cz

Ing. Helena Řezbova, Ph.D.
Department of Economics, Faculty of Economics and Management,
Czech University of Life Sciences Prague, Kamýcká 129, 165 21, Prague, Czech Republic
E-mail: rezbova@pef.czu.cz

Doc. Ing. Luboš Smutka, Ph.D.
Department of Economics, Faculty of Economics and Management,
Czech University of Life Sciences Prague, Kamýcká 129, 165 21, Prague, Czech Republic
E-mail: smutka@pef.czu.cz.

References

[1] BAAP (Baltic Agricultural run-off Action Programme). About BAAP, 2003. [Online]. Available: http://www.baap.lt [Accessed: 12 December 2014].

[2] Canadian Broadcasting Corporation. PEI Introducing Crop Rotation Legislation, 2001. [Online]. Available: http://www.cbc.ca/news/story [Accessed: 30 December 2014].

[3] Canadian Broadcasting Corporation. Second P.E.I. fish kill uncovered, 2007a. [Online]. Available: http://www.cbc.ca [Accessed: 10 November 2014].

[4] Canadian Broadcasting Corporation. Buffers not enough to stop fish kills. 2007b. [Online]. Available: http://www.cbc.ca/canada [Accessed: 10 November 2014].

[5] Canadian Broadcasting Corporation. Fish kill unfortunate, says minister, 2007c. [Online]. Available: http://www.cbc.ca [Accessed: 10 November 2014].

[6] Clark, J. S., Cechura, L., Thompson, S. J. Induced Innovation in Canadian Agriculture. Book Group Author(s): Czech Univ Life Sci Prague, Fac Econ & Management Conference: Joint Conference on 21st International Scientific Conference on Agrarian Perspectives / 131st EAAE Seminar Location: Prague, Czech Republic Date: Sep. 18-19, 2012. ISBN 978-80-213-2370-4

[7] Crist, S., Monroe, R., Poats, J., Environmental impacts of septic systems, 1999. [Online]. Available: http://www.cee.vt.edu/ewr [Accessed: 10 September 2014].

[8] Dickey, D. A., Fuller, W. A., Distribution of the estimators of auto-regressive time series with a unit root. Journal of American Statistical Associaton. 1979, No. 74, p. 427-431, ISSN 0162-1459.

[9] Environment Canada. Prince Edward Island Water Quality Program, 2007. [Online]. Available: online: http://www.gov.pe.ca [Accessed: 10 January 2015].

[10] Fertilizer Institute. About Fertilizer, 2007. [Online]. Available: http://www.tfi.org. [Accessed: 3 December 2014].

[11] Government of PEI. Potato industry fact book, 2002. [Online]. Available: http://www.gov.pe.ca/af [Accessed: 10 August 2011].

[12] Granger, C. W. J. Time Series Analysis - Cointegration and Application, 2002 (The Nobel Lecture). Stockholm, Sweden. [Online]. Available: http://www.eco.uc3m.es/~jgonzalo/teaching/EconometriaII/GrangerNobelTalk.pdf [Accessed: 10 November 2014].

[13] Jatoe, J., Yiridoe, E., Weersink, A., Clark, J. S. Economic and Environmental Impacts of Introducing Land Use Policies and Rotations on Prince Edward Island Potato Farms. Land Use Policy, 2008, No. 25, p. 309-319. ISSN 0264-8377.

[14] Lake Winnipeg Stewardship Board. Lake Science, 2008. [Online]. Available: http://www.lakewinnipeg.org/web/downloads [Accessed: 10 January 2011].

[15] Park, J. Y. Canonical Cointegrating Regressions. Econometrica, 1992, Vol. 60, No. 1, p. 119-143, ISSN 1468-0262.

[16] PEI Government. Round Table on Resource Land Use and Stewardship, 2007. [Online]. Available: http://www.gov.pe.ca [Accessed: 30 December 2011].

[17] PEI Government. Land Use Policy, 2002. [Online]. Available: http://gov.pe.ca/af/agweb.html [Accessed: 10 December 2011].

[18] Prince Edward Island Provincial Treasury. Annual Statistical Review 2013-2014, 2014. [Online]. Available: http://www.gov.pe.ca [Accessed: 10 January 2014].

[19] Svatoš, M. Selected trends forming European agriculture. Agric. Econ. – Czech, 2008, Vol. 54, No. 3, p. 93-101. ISSN 0139-570X.

[20] Statistics Canada. E-STAT, Canadian Socio-economic Information Management System, 2007. [Online]. Available: http://estat.statcan.ca/ [Accessed: 10 August 2011].

[21] Ulmer, K. Global Food Security – Crop Rotation in the CAP reform: Relevance of WTO Constraints, Benefits and Control, 2013. [Online]. Available: http://aprodev.eu/files/Trade/aprodev%20croprotationinthecapreform_wtoconstraintsandcontrol_finalfeb2013.pdf [Accessed: 22 June 2015].

Agris on-line Papers in Economics and Informatics

Volume VII Number 3, 2015

Accessibility of Rice Farmers to the Ghana School Feeding Programme and its Effect on Output

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

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

Abstract

The Ghana School Feeding Programme (GSFP) is the Ghanaian version of a Home-Grown School Feeding Programme (HGSP) that has a mandate to give one hot meal a day to school children in public schools from kindergarten through to primary six. The programme was launched in 2005 with the goal of contributing to poverty reduction and increased food security in Ghana. One of the key objectives of the programme is to boost domestic food production by sourcing GSFP raw materials locally, and providing a sustainable market for local food producers in the community. To analyse accessibility of rice farmers to the Ghana School Feeding Programme and its effect on production in three districts of the Northern Region of Ghana, a formal cross section survey of 100 small holder rice farmers was conducted. The transcendental logarithmic production function was applied to analyse the programme's effect on rice output in the three districts using access to the GSFP and other input variables. Our results show that farm labour, farm size, and fertilizer application were significant in increasing farmers' output while access to the GSFP market was not. Again there is no significant difference between the output of those who had access to the school feeding programme and those who do not.

Keywords:

Accessibility, effect, production, Ghana School Feeding Programme and rice farmers.

Introduction

Halving hunger by the year 2015 is one of the fundamental objectives of the Millennium Development Goals (MDGs). According to the 2009 Global Hunger Index, Ghana was making relatively good progress in addressing food insecurity. It was the only country in sub-Saharan Africa to cut its score by half in from 23.5 in 1990 to 11.5 in 2009. The Ghanaian economy grew at an average rate of 6.7% over the period, 2007 to 2010. In 2011, the agricultural sector contributed 25. 6% to GDP and the economy continues to revolve around subsistence agriculture which employs nearly 60% of the workforce (GSS, 2011)

Although a largely agrarian economy, Ghana is 51% self-sufficient in cereal production. Rice self-sufficiency was estimated at 30% in 2009 (Asare, 2010). From the national perspective, Ghana is a food secure nation (WFP, 2007b). However, lack of physical and economic access to food is perhaps the largest contributor to household food insecurity in many rural and urban poor households. Despite progress towards achieving food security, hunger is still prevalent in Ghana. The government's poverty reduction strategy paper identifies low productivity and poorly functioning markets as the major causes of rural poverty (IFAD, 2009).

Home-Grown School Feeding (HGSF) is an intervention by many developing countries including Ghana to reduce poverty, hunger and malnutrition, and food insecurity overall, especially among children. The HGSF programme provides food produced and purchased within a country to school children. In the view of Tomlinson (2007), HGSF aims to reach 50 million children of school age worldwide by 2015 and according to NEPAD (2005b), if 50 million children were fed for 220 days a year, 5 million tons of food per year would be consumed, which would require the produce of at least 2 million poor farmers.

Ghana has a long history of school feeding programmes implemented by different development agencies, particularly in the north of the country. Fisher, (2007) reported that the Catholic Relief Services and the World Food Programme have been active in school feeding programmes in Ghana since 1958 and late 1960s respectively. The Ghana School Feeding Programme which was launched in 2005 was basically intended to stimulate the local

economy through creation of additional demand for local farm produce, and to improve food security. This objective aligns closely with the United Nations' Millennium Development Goals (MDGs) on hunger and poverty

The programme is independently implemented by the Government of Ghana except in the three northern regions (Northern, Upper East and Upper West), where some primary school children receive food through joint programming with the World Food Programme.

Rice constitutes a major staple on GSFP menu. It is normally cooked 3 times a week for the pupils. Based on the objectives of Programme of reducing malnutrition and boosting domestic food production among others, the study focused on how procurement of rice domestically could impact on local output. The rice grown in the country especially in the north (more of it being brown rice) provides more nutrition than foreign white rice. Local rice (especially brown rice) has been reported to be nutritionally better than foreign (white rice). Brown rice provides more fiber and naturally occurring vitamins and minerals than white rice. Brown rice contains antioxidants. It also contains important vitamins such as vitamin B, folic acid, niacin and riboflavin. These vitamins help the body use the energy provided by the foods we eat, as well as helping it use dietary protein to build and maintain cells and tissue[1]. People who consume five or more servings of white rice every week had a greater risk of developing type 2 diabetes[2].

Malnutrition is both a cause and consequence of poverty. Malnutrition remains a pervasive problem spreading through urban communities in Ghana. The most important form of malnutrition is Protein-Energy Malnutrition (PEM) which specifies the lack of enough protein from meat and other sources (World Bank, 2011).

According to a UN Development Assistance Framework (UNDAF) for Ghana 2006-2010, there has also been an increase in child malnutrition in all regions of Ghana between 2006 and 2010. In the three northern regions the report showed that, the proportion of underweight children under five years is much higher, ranging from 34% to 38%. In general rural children are twice as stunted (30%) as urban children.

From these reports it is not surprising that the government has in recent years been making frantic efforts to address malnutrition among children in Ghana. One of the major policy interventions is the Ghana School Feeding Programme. This intervention perhaps is most laudable as beneficiary children are mostly from rural communities where the malnutrition prevalence rates are high. Though not an exact agricultural policy, its potential impact on both malnutrition and food security and has been clearly highlighted in the programme document. Thus the government of Ghana has over the years pursued significant policies intended to tackle the problem of malnutrition and food insecurity in the country. Despite the moderate progress made in recent years, these problems still persist in the country especially in the north.

Generally, School Feeding Programmes in Ghana had seen considerable investment in the local economy since 2005. In 2006 for example, the World Food Programme (WFP) paid about US$549,376 to local contractors for supplying food for school feeding. It was also expected to source 100% of its food procurement needs locally which was estimated to be US$1.9 million for 2007, US$1.9 million for 2008, US$2.3 million for 2009 and US$1.6 million for 2010. It is further estimated that 90% of this value will be bought from small-scale farmers. With these kinds of investment, the expectation that domestic food production will increase is therefore not out of place. However, the GSFP has little impact in boosting domestic food production. This is mainly due to challenges regarding procurement processes.

Following these investment, however, the educational portfolio of the GSFP has made relatively great strides as compared to the agricultural portfolio of the programme. Seven years after the inception of the programme, enrolment, attendance and retention have improved remarkably in most beneficiary schools.

PCD (2010) developed a sustainable model to link farmers and caterers in GSFP. In the model, the challenges faced by farmers and caterers were presented and analysed through value chain frameworks and the participation of stakeholders. They identified the mismatch of incentives[3] of farmers and caterers which prevent their integration in the GSFP value chain.

[1] See Ohio State University online nutrition column

[2] See: www.livistrong.com on nutrition from beans and rice

[3] Cash flow, lack of trust between farmers and caterers and difficulty of farmers accessibility

Objective of paper

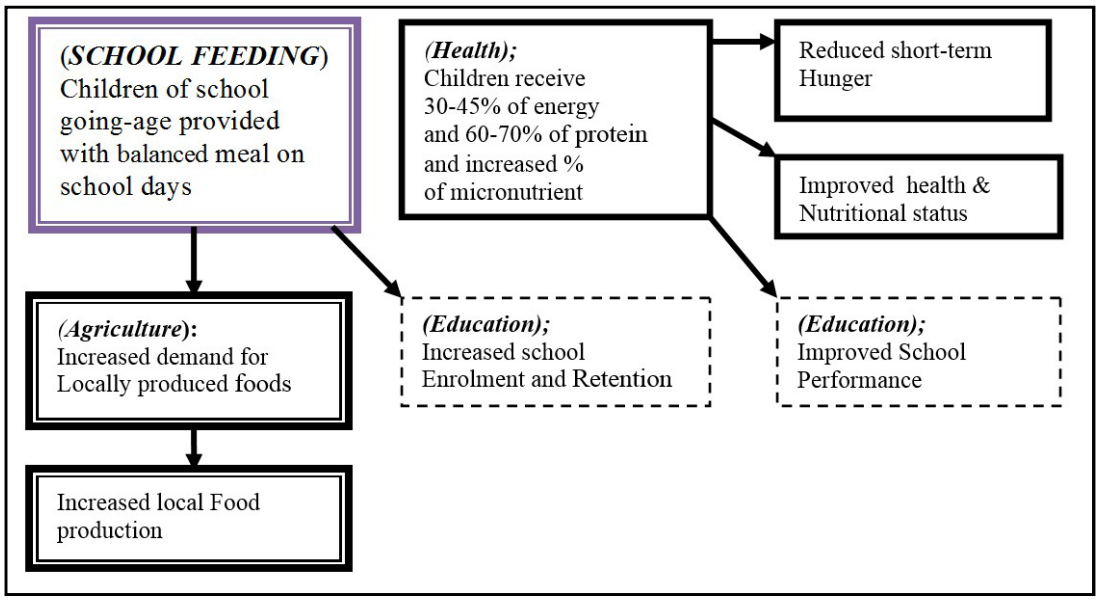
The main objective of this paper is therefore to determine rice farmers' accessibility to the Ghana School Feeding Programme and its effect on production in the Tamale metropolis, Tolon-Kumbungu and Karaga districts of the northern region of Ghana and the specific objectives are; (i) to determine rice farmers accessibility to the programme. (ii) to analyse the effect of access to the programme on rice output and yield and (iii) to determine how the rice value chain facilitates procurement by the School Feeding Programme

The Ghana School Feeding Programme (GSFP) concept

The Ghana School Feeding Programme's objective to reduce poverty and food insecurity is anchored on the following conceptual framework:

1. Long term community food security among poor rural households is the ultimate objective. The strategy to feed school children with locally prepared food that is nutritionally adequate will focus on spending on local foodstuffs. This is expected to provide ready market for farm output, leading to wealth creation at the rural household and community level. This will help rural communities to generate wealth through improved incomes from the ready market for their farm output (as provided by the school feeding programme).
2. With improved incomes, poor rural households can afford the additional food intake needed to ensure the full complement of nutritional needs that will address the rampant short-term hunger, and the problems of malnutrition.
3. Importantly, it is expected that this strategy will be supported by the spending of about 80% of the feeding cost in the local economy, particularly in the community of the school, or in the district as a whole for the direct sourcing of the programme's inputs.

Figure 1 illustrates the possible impacts of the Ghana School Feeding Programme as an intervention to reduce hunger and malnutrition using locally produced foods. As illustrated, there are 3 main outcomes of the GSFP, namely; increased demand for locally produced foods, increased school enrolment and increased nutrient intake of school children. The first box on the top left corner of the diagram represents the basic idea of the Ghana School Feeding programme. Boxes with broken lines specifically illustrate the programme's impact on education, the boxes with single line represents its impact on the nutrition and health of school children, while the boxes with double lines illustrate the impact on agriculture.



Source: Adapted from NEPAD, (2005b)

Figure 1: Conceptual framework of school feeding interventions.

Materials and methods

A combination of analytical tools was used in the study. These include descriptive statistics, t-test, and econometric regression model. A total of 100 small holder rice farmers and 90 individual players[4] in the rice supply chain of the school feeding model were sampled across the three districts using a combination of purposive and simple random sampling techniques. That is targeting the population living in communities where the GSFP was being implemented. Both the farmers and the actors in the rice supply chain were interviewed using structured questionnaires.

In analyzing farmers' accessibility to the GSFP market, descriptive statistics were used and farmers were categorized into those who have had access to GSFP market either directly or indirectly through local millers and those who have not. The number of farmers in respect of each group was identified. Frequency tables cross tabulation were used to analyse the data. Farmers accessibility were measured using variables such as, farmers' awareness of GSFP programme, farmers living in GSFP Community, farmers' direct sales of paddy rice to caterers, the number offers made and the proportion of local rice purchased by the school caterers.

In determining the effect of the Programme on output of rice farmers in the study area, we used the Independent t-test to compare the mean output and yield across three different groups of 100 sampled farmers in 2011. The three categories include farmers who have direct access to GSFP, those who have indirect access and those who have no access. The transcendental logarithmic production function was used to further investigate whether access to GSFP (direct or indirect) had any significant effect on output.

The transcendental logarithmic production function commonly referred to as the translog function, is an attractive and flexible function. This function has both linear and quadratic terms with the ability of using more than two factor inputs. Its flexibility circumvents the problem of over restrictions and allows a more general specification of the model since it can represent any underlying arbitrary structure of production at any point. Moreover, the translog function relates output to inputs and can be augmented with socioeconomic[5] and demographic variables. It allows the introduction of a dummy variable to capture the difference in production or productivity between two groups of farmers.

The translog has therefore been widely applied in empirical analysis. For instance it has been used to examine input substitution, technical change and productivity growth, and production efficiency. Tzouvelekas, (2000) Cites Berndt and Christensen (1973); May and Denny (1979); Greene (1980) and Kalirajan (1990) as having applied this model. In their study on 'A Stochastic Production Investigation of Fish Farms in Ghana Onumah and Acquah (2011) used the stochastic production frontier approach to analyse the technical efficiency and its determinants of fish farms in Ghana using a cross-section data. The study considered the explicit effects of family and hired labour on production by setting the log-value of the zero-observation of these two sources of labour to zero with dummy variables. Thus this approach though focused on technical efficiency can also be useful in assessing the effect of School Feeding Programmes on the output of farmers using farmers' access to the market created by the programme as a dummy variable as opposed to Cobb Douglas Production model.

The Cobb Douglas model is strongly criticized on the following; its accuracy in different industries and time periods (Stewart 2008), for analysis of policies affecting factor returns such as taxes on capital and labor income, the Cobb-Douglas specification may be too restrictive (Antras 2004). More so it was developed because it had attractive mathematical characteristics, and concentrated so much on diminishing marginal returns to capital and labour as key factors of production. Empirical study by Krishnapillai and Thompson (2012) indicate that the translog production function is preferred when analysis are made using cross sectional data[6].

Model specification

In a simplified analysis, the function can be approximated by second order Taylor series as originally specified by Christensen et al. (1973). In this case a three-input translog production function can be written in terms of logarithms as:

[4] Local millers, wholesalers, and retailers

[5] Eg Access to GSFP Market which is a key interest variable in the study

[6] Cross sectional data was used in this study

$$\ln Q = \alpha 0 + \beta K \ln K + \beta L \ln L + \beta M \ln M + \tfrac{1}{2} \beta KK \ln K2 + \beta KL \ln K \ln L + \beta KM \ln K \ln M \tfrac{1}{2} \beta LL \ln L2 + \beta LM \ln L \ln M + \tfrac{1}{2} \beta MM \ln M2 + \mu \quad (1)$$

Where Q = output variable, α = constant term, β = coefficients of variables to be measured, K, L, M = input variables, μ = error term.

The use of this model in analysing the effect of the Ghana School Feeding Programme on output of rice following this review is therefore justified. The empirical tranlog model for the study is given as:

$$\text{Ln } (Y) = a_0 + a_1 \text{Ln}(X_1) + \ldots\ldots + a_6 + \text{Ln}(X_6) + 0.5[\text{Ln}(X_1)^2 + \ldots\ldots\ldots + a_6 \text{Ln}(X_6)^2] + a_{12} \text{Ln}(X_1) \text{Ln}(X_2) + \ldots\ldots + a_{16} \text{Ln}(X_1) \text{Ln}(X_6) + a_7 X_7 + \mathcal{E} \quad (2)$$

Where Y = rice output (explained variable). The explanatory variables are X_1 = insecticide usage, X_2 = farm labour, X_3 = total farm size, X_4 = age of farmer, X_5 = fertilizer application, X_6 = extension visits, X_7 = access to GSFP, and $\mathcal{E}$ = error term.

Estimation procedures

Quantity of rice output (Y): The volume of production of rice which is an explained variable is measured in kg. Rice farmers output was estimated using total rice harvest in 2011 season. Farmers could not provide standard unit of measurement. Data indicated quantity of rice in bags (cocoa sacks) which was converted in kg using standard scale measure.

Independent variables

The translog is a production function which relates output to inputs. In addition the model can be augmented with socioeconomic and demographic variables. The following are hypothesized to influence farmers' output.

Insecticide usage (X_1): This is a continuous variable measured in litres. Farmers were asked to provide data on litres of insecticides applied to their rice farms. The a priori expectation of the effect of insecticide on production is mixed. Tremendous benefits have been derived from the use of pesticides in forestry, public health and the domestic sphere and, of course, in agriculture (Wasim et al. 2009). However, pesticides may cause damage to the soil and non-target plants if not properly applied. In the view of Glotfelty and Schomburg (1989), some pesticide drift occurs during every application, even from ground equipment. This perhaps is the negative side of insecticides usage which may also affect output.

Farm Labour (X_2): It is a continuous variable, measured in man-days. Farm labour in this study comprises both family and hired labour. The study used the total number of labour man-days used by sampled rice farmers. This variable could have a positive or negative influence on farmers' output. As farmers have access to more labour, the interest to expand farm size would increase. Increases in labour productivity were achieved without a substantial increase in output per unit of land from the mid 5th through the 18th centuries in the English agriculture thus showing a positive effect of farm labour on output (Apostolides et al., 2008). This suggests that the more man-days of farm labour a farmer uses, the more output he could get from the farm cetris paribus. However in analysing production in the short run, the law of diminishing returns could have a negative farm labour effect on output as land is a fixed input.

Total farm size (X_3): The total size of rice farm land owned by a farmer is among the variables that could influence both output and supply. It is a continuous variable, measured in hectares and is expected to influence output positively. Data on farm size was recorded in acres but later converted to hectares.

Age of farmer (X_4): Age is a continuous variable and measured in years. The expected influence of age is assumed positive or negative taking the presumption that as farmers get older they could acquire skills and hence produce more. It is also a proxy measure of farming experience. Tshiunza et al. (2001) found in Nigeria that younger farmers tended to produce and sell more bananas for market than older farmers thus an indication of a negative relationship between age of farmer and output.

Fertilizer application (X_5): This is also a continuous variable measured in kilograms and the apriori expectation is positive. This represents the total quantity of fertilizer applied by farmers to their rice farms during the year under consideration. As the farmer applies more fertiliser to his rice field, it is expected that farm yield will increase. Crop yields have increased substantially in many parts of the world which have been attributed to a combination of factors including increased used of mineral fertilizers.

Extension visits (X_6): This is a continuous variable measured as the number of extension visits farmers

got from extension officers in a season. This variable is expected to influence output and supply of rice positively. Obviously, as farmers learned more they would produce more and supply or participate more in a market provided the knowledge acquired is effectively utilised.

Access to a GSFP market (X_7): This is a dummy variable with a value of 1 for farmers who had access to the GSFP market and 0 for those who did not. Access here has been defined at two levels; farmers who sold their paddy rice directly to GSFP and those who sold through local millers. This variable is therefore estimated using the combined effect of direct and indirect access to the GSFP market. This was necessitated by the fact that paddy rice is a raw material which requires processing before consumption and this emphasizes the role of other players in the value chain. The survey data on the rice value chain analysis indicate that the local miller is an import intermediary between the rice farmer and the GSFP caterer. The a priori expectation for this variable is positive. As farmers have access to the market created by the GSFP, their output will increase.

The summary of variables definitions and a priori expectation is presented in Table 1 below.

The rice supply chain and GSFP procurement

A supply chain is a network of facilities that procure raw materials, transform them into intermediate goods and then final products, and deliver the products to customers through a distribution system. This system may include a physical person such as a farmer, a trader or a consumer, as well as legal entities such as a business.

In this section descriptive statistics was employed to analyse the rice commodity chain. The analysis was based on quantitative and qualitative flow among key actors such as rice farmers, GSFP caterers, local millers, retailers and wholesalers. Using a cross section data, the output of rice farmers was computed. At farm gate level, quantity of rice used for personal consumption by the farmer was estimated. The quantity of paddy rice purchased at farm gate by the local millers, GSFP caterers, retailers and wholesalers were also computed alongside the price levels. The quantity flow of milled rice between local millers, GSFP caterers, wholesalers and retailers was also analysed. In this regard pictorial description of the players, their roles and relationships and how each facilitates procurement by the GSFP is presented. Using a cross section data in 2011, the relationship between GSFP rice consumption and the cost of procurement from the various sources of supply have been also been analysed

The study area

The Northern Region is the largest land area of Ghana. It has a land size of 70,383sq km representing 29.51% of total land area in the country. As of 2011, the region was made up of 20 districts. The total labour force in the region is also estimated as 727,553 with 71.2% of this number engaged in agriculture (GSS 2011). The figures of the 2010 Ghana Population and Housing Census puts the population of the region at about 2,479,461 representing about 10.1% of the national total (GSS 2012).

The study was conducted in the Tamale metropolis, Tolon-Kumbungu[7] and Karaga districts of the Northern region of Ghana. The study considered two main factors; first, the number of pupils fed by the programme and second, the areas that rice is mostly grown. Additionally Tolon-Kumbungu in particular has been a pilot district for the GSFP. According to the World Food Programme monthly bulletin for November 2010,

[7] Now two districts – Tolon and Kumbungu districts

Explanatory variables		Definition	A priori expectation
Insecticides	(X_1)	Litres of insecticides used	+
Farm labour	(X_2)	Man days of total labour services	+
Farm size	(X_3)	Farm size in hectors (ha)	+
Age of farmer	(X_4)	Age of farmer in years	+/-
Fertilizer usage	(X_5)	Kilograms of fertilizer used	+
Extension visits	(X_6)	Extension visits in numbers	+
Access to GSFP	(X_7)	Access to GSFP (Yes = 1, No = 0)	+
Farm output (Y) = explained variable measured in kilograms			

Source: own processing

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

it was the only district that recorded a 45% increase in rice production over the year 2009 output (WFP, 2010). Tamale metropolis also had the highest number of pupils enrolled in schools under the programme with an estimated 13.5% of the 50,597 pupils benefitting in the entire region[8] as at the year 2011.

In Tamale metropolis it is estimated that about 60% of the people are engaged in agriculture. The major crops cultivated are maize, rice, sorghum, millet, cowpea, groundnuts, soya bean, yam and cassava. Farmers in the Metropolis and rural Tamale in particular are small holder subsistence food producers with few income earning opportunities largely due to low productivity, lack of off-farm employment and vulnerability to natural calamities such as unreliable rainfall and bush fires (MoFA, 2011). Total land holders in the metropolis in 2006 were 33,614 of which 23,018 holders representing 68% were producing rice (Seidu 2008). Low productivity and marketing of farm produce are the most prominent challenges in the agricultural sector in the metropolis.

Tolon/Kumbungu District is one of the districts created by the erstwhile Provisional National Defence Council (PNDC) Law 207 in 1988 with Tolon as its Capital. The district was carved out of the then West Dagomba District Council (WDDC). It covers an area of about 2,741 square kilometres and forms about 3.9% of the total land size of the northern region. The district shares borders with the West Mamprusi District to the north, West and Central Gonja districts to the west and south respectively and with the Savelugu-Nanton District and Tamale metropolis to the east.

Results and discussion

Farmers' accessibility to the Ghana School Feeding Programme

From the literature there seem to be no clear guidelines regarding how caterers should buy foodstuffs from the farmers. Caterers are asked to buy local foodstuffs from farmers living in the communities where the GSFP is being run. To facilitate farmers accessibility to the GSFP market more easily a GSFP procurement manual could have been designed detailing the procedure and information of farmers including their farm activities in the communities. Farmers who sell paddy rice to the GSFP caterers were identified by asking them if they were aware of the school feeding programme and whether caterers have been buying rice from them directly or through middlemen such as local millers, retailers/market women or wholesalers.

Feeding of the children is happening on a daily basis in the schools visited. However, most of foodstuffs especially rice are not purchased from local farmers but from local millers and from the market. From the table for example only 17% of rice farmers sell their paddy rice to caterers while 34% sell through local millers. From the study, farmers are within the reach of the GSFP and it would not be difficult if the programme really intends to source foodstuff from the communities where the GSFP schools are located. This is because 83% of the rice farmers are in the communities where the programme is being implemented while about 87% of them are aware of the existence of the programme. Accessibility is therefore not a serious challenge. With only 17% of farmers supplying directly to the programme it means that GSFP caterers are not making offers to the rice farmers.

From table 2, caterers buy more directly from farmers in Karaga and Tolon/Kumbungu districts than they do in Tamale metropolis. The table shows that about 94% of the rice farmers who sell directly to the GSFP caterers said the caterers do not have any selection criteria for buying from them and only 6% said they buy from them because they live in the communities where the GSFP is being run. This clearly indicates that selection of farmers is arbitrary. There are no clear guidelines regarding the purchase of foodstuffs from the farmers. This could be attributed to the nature of the supply chain in the various districts. It is easier for caterers to locate farmers in these two districts than it is in the Tamale metropolis. Most of the caterers are residents of the communities where GSFP is being implemented in the two districts than they do in Tamale metropolis. For example about 100% of the sampled farmers interviewed from both Tolon-Kumbungu and Karaga districts are residents of GSFP Communities. The caterers did not have any selection criteria for purchasing rice from 64.5% of the farmers who sold directly to the GSFP (11 respondents out of 17) while 34.2% (6 respondents out of 17) from whom they bought the rice lived in the communities where the GSFP is being implemented. This clearly indicates that selection of farmers is arbitrary. There are no clear guidelines regarding the purchase of foodstuffs

[8] GSFP statistics 2011

Level of Accessibility		Tamale metropolis	Tolon/ Kumbungu	Karaga	Total
Resident in GSFP community	Yes	47	20	20	87
	No	13	0	0	13
	Total	**60**	**20**	**20**	**100**
Awareness of GSFP	Yes	48	19	20	87
	No	12	1	0	13
	Total	**60**	**20**	**20**	**100**
Direct access	No	52	16	15	83
	Yes	8	4	5	17
	Total	**60**	**20**	**20**	**100**
Selection criteria	Prox. to Sch	0	3	3	6
	No Criteria	3	5	3	11
	Total	**3**	**8**	**7**	**17**
Access via local miller	No	15	6	2	23
	Yes	17	7	10	34
	I don't Know	28	7	8	43
	Total	**60**	**20**	**20**	**100**

Source: from survey data December 2011. N = 100

Table 2: Farmer accessibility to the GSFP by district (% of farmers).

from the farmers. For analytical purposes however, farmers' accessibility in general including those who sold their rice produce to the GSFP caterers through local millers is significant[9].

Effect of GSFP procurement on output of rice farmers

To analyse the effect of the Ghana School Feeding Programme on output and yield of rice farmers, the t-test statistics was initially used to see if there was any significant difference between participants and non-participants in the GSFP market followed by a regression using the translog model to find out whether access to GSFP had a significant effect on rice output. The results are presented in tables 3, 4 and 5 below.

The rice farmers were initially categorized into two groups; those who have been selling rice to GSFP either directly or indirectly (51%) and those who do not sell to them (49%). Firstly, we conducted t-test to see if there were any significant differences in rice output and yield among the two categories of farmers. Secondly a comparison was made between those selling directly and indirectly to the GSFP. The results of the t-test are presented in tables 3 and 4 while that of the translog model is presented in table 5. From the tables, the average output of farmers who sold rice to the caterers (directly or indirectly) was marginally higher than those who did not sell. However in terms of yield, those who did not have access to the programme had a slightly higher rice yield relative to farmers who had access (see table 3). Also the average output and yield of farmers who had direct access to the programme were relatively higher than those who had indirect access (see table 4). The differences in each of the above cases were however not statistically significant.

Table 5 presents the regression results for the transcendental logarithmic production function. The R-squared value of 0.9235 implies that, about 92.4% of the variations in the dependent variable are explained by the variations in the independent variables. The F-statistic value of 388.5 shows the fitness of the model which explains the explanatory power of all the independent variables put together on the dependent variable. This is significant at 1%.

From the table all the variables are statistically significant with the exception of insecticides, age, extension visits and access to Ghana School Feeding Programme. The variables that met the a priori expectations are farm labour (significant at 10%), farm size and fertilizer application (both significant at 1%). Farmer access to GSFP has positive effect on rice output. Farmers who had access to the Programme had 3 percent more output than those who do not but this margin of a difference is not statistically significant.

[9] Direct access = 17%, access via local miller = 34% a cumulative of 51%

Test variable	Access	N	Mean (000)	Std. deviation	Std. error	Mean difference	Sig (2-tailed)
Output	Yes	51	5.370	4682.895	668.985	1170.580	0.337
(tons)	No	49	4.199	7134.392	999.015	-	0.333
Yield	Yes	51	1.482	832.291	118.899	-122.086	0.632
Kg/ha	No	49	1.604	1578.337	221.011		0.628

Source: survey data 2012

Table 3: Output and yield differences for access and no access to GSFP market (N=100).

Test variable		N	Mean (000)	Std. deviation	Std. error mean	Mean difference	Sig (2-tailed)
Output (kg)	Direct	17	7.012	11648.963	2825.289	1219.824	0.345
	Indirect	34	5.793	2283.59	391.632	-	0.158
Yield (kg/ha)	Direct	17	2.704	2355.74	571.351	649.629	0.894
	Indirect	34	2.055	387.748	66.498	-	0.311

Source: survey data 2012

Table 4: Output and yield differences for direct and indirect access to GSFP market (N=51).

Variable	**Coefficients**	**Std err**	**t-value**	**P-value**
Constant	-	0.042	0.29	0.772
lnInsecticides	0.202	0.228	1.11	0.273
lnlabour	0.059**	0.071	2.29	0.025
lnFarm size	0.585***	0.254	2.84	0.006
lnAge	0.048	0.218	1.59	0.117
lnFertilizer	0.012***	0.118	0.12	0.007
lnExt visits	-0.115	0.118	-2.8	0.903
Access to GSFP	0.029	0.037	2.49	0.215
***significant at 1 % level			Sample size = 100	
** significant at 5% level R-square = 0.72				
F-statistic (28, 71) = 388.50			Prob F = 0.000	
Dependable Variable: Rice output measured in kg				

Source: own processing

Table 5: Regression results explaining rice output.

Rice supply chain assessment and GSFP procurement

Descriptive statistics were used to analyse the rice supply chain and GSFP procurement. Actors in the School Feeding model supply chain were identified. Table 6 illustrates the frequencies of the various sources of rice supply to the caterers. The local miller is the GSFP caterers' major source of rice supply followed by a combination of farm gate and local miller, the retailer/market queen. The farmer/farm gate and the wholesaler being the least sources of supply.

Supplier	Frequency	Percent
Local Miller	20	40
Retailers	10	20
Farm gate and local miller	11	22
Farm gate only	6	12
Wholesaler	3	6
Total	50	100

Source: author's computation from survey data December 2012

Table 6: GSFP caterers' sources of rice supply.

Actors in the rice supply chain (the school feeding model)

The key actors in the rice supply chain in the model of school feeding in Ghana include rice farmers, GSFP caterers, local millers and market women who are mostly retailers. Analysis of the supply chain is presented in figure 1. Structured questionnaires were used to interview 190 respondents, made up of 100 rice farmers, 50 GSFP caterers, 22 local millers, 11 retailers and 7 wholesalers.

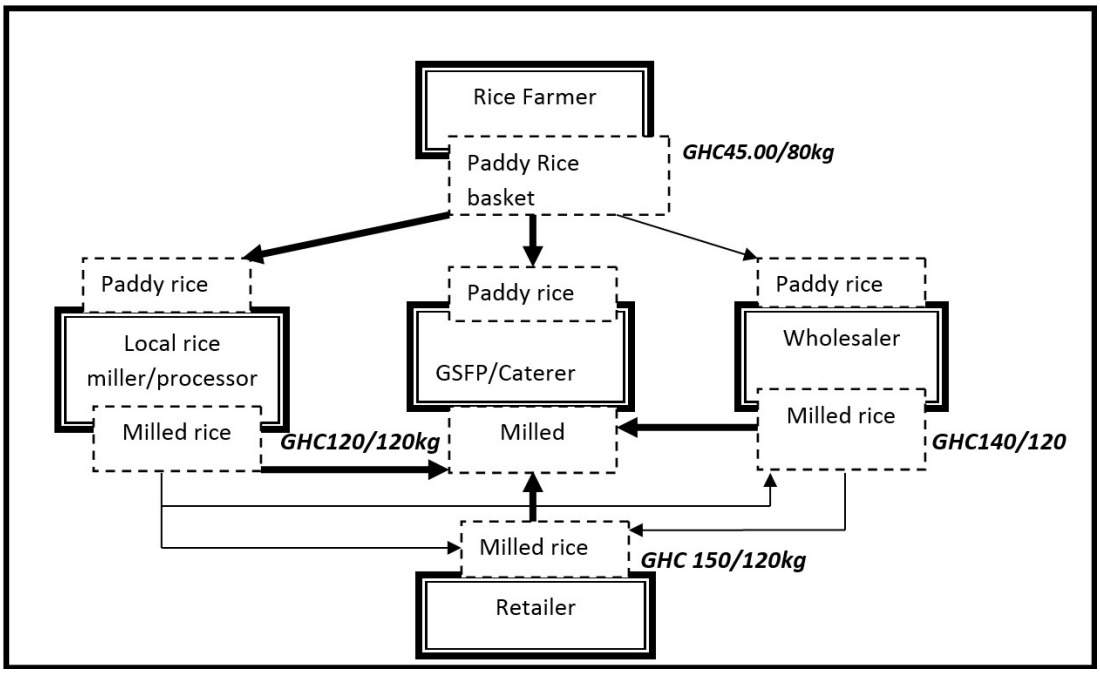
Figure 2 illustrates the pattern of rice flow from farmers to local millers, through to GSFP caterers, wholesalers and retailers or market queens. The boxes with broken lines represent quantities of milled and paddy rice based on 2011 estimates. The GSFP caterer is at the centre of the chain buying both paddy and milled rice from the farmer and the rest of the actors respectively. From the survey data all the actors in the chain with the exception of the retailers who sold only milled rice got their supplies from the farmer. The deep arrows show the principal sources of supply of paddy and milled rice for the GSFP caterer and the local miller. The survey data illustrated in table 5 suggest that about 40 percent of caterers buy from local millers. The light arrows show an interaction between the local miller, the retailer and the wholesaler. Milled rice is supplied from the local miller to the retailer and the wholesaler. The retailer also gets his/her supplies from the wholesaler and there is also a flow of paddy rice from the farmer to the wholesaler. As can be seen, majority of the local millers draw their paddy rice supplies from the farmer.

The average prices of paddy and milled rice have also been appropriately shown in the chain. The farm gate price of paddy is GHC 45.00 per bag (80kg) and the wholesale price is GHC50.00. After processing, a bag of milled rice (120 kg) is sold by the local miller at GHC130.00 while the same quantity is being sold by the wholesaler and the retailer at GHC 140.00 and GHC 150.00 respectively

Conclusion

Rice farmers across the study districts do not have direct access to the Ghana School Feeding Programme as more GSFP caterers buy milled rice from local millers than paddy rice. This is largely due to the fact that majority of the caterers have other jobs aside the catering services and therefore do not have enough time to process paddy rice which they can easily purchased from the farmers. Another factor that hinders farmers' accessibility to the GSFP market is delays in the release of feeding bursaries to caterers.

Selling to the Ghana School Feeding Programme



Source: from survey data December 2012

Figure 2: Actors in the rice supply chain – (the school feeding model).

does not enhance farmer's yield or output because farmers are not directly linked to programme. The rice value chain does not facilitate GSFP procurement from local farmers because farmers do not process paddy into milled rice, a product used by caterers. Caterers have other jobs and prefer not to add rice milling to their income generation portfolios.

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

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

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

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

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

References

[1] Antras, P. Is the U. S. Aggregate Production Function Cobb-Douglas? New Estimates of the Elasticity of Substitution. The Berkeley Electronic Press (bepress). 2004. [Online] Available: http://www.bepress.com/bejm [Accessed: 25 Sept 2014].

[2] Apostolides, A. Stephen B., Bruce, C, Mark, O., and van Leeuwen, B. English Gross Domestic Product, 1300-1700: Some Preliminary Estimates. 2008. [Online] Available: www2.warwick.ac.uk/fac/soc/economics [Accessed: 22 Febr 2012].

[3] Asare, O., Yaw, B. Mapping of Poverty Reductions Strategy Papers. Sector Strategies and Policies related to rice development in Ghana. Coalition for Africa Rice Development (CARD), C/o AGRA-Nairobi, Kenya 15th October 2010.

[4] Christensen, L., Jorgenson, D., and Lau, L. Transcendental Logarithmic Production Frontiers, The Review of Economics and Statistics, February 1973, p. 28-45.

[5] Fisher, E. A Desk Review of the Ghana School Feeding Programme. Centre for Development Studies University of Swansea, United Kingdom. 2007.

[6] Ghana Statistical Service. Gross Domestic Product 2011. Ghana Statistical Service National Accounts and Economic Indicators Division. Accra Ghana. 2011.

[7] Ghana Statistical Service. 2010 Population and Housing Census. Ghana Statistical Service National Data Archive. Accra Ghana. 2012.

[8] Glotfelty, D. E., and Schomburg, C. J. Volatilization of pesticide data reported in this paper, PELMO can be used for from soil. SSSA, Madison, WI. 1989. p. 181–206.

[9] IFAD. Annual Report. 2009. [Online] Available: http://www.ifad.org/pub/ar/2009/e/print.pdf [Accessed: 10 August 2014].

[10] Krishnapillai, S. and Thompson, H. Cross Section Translog Production and Elasticity of Substitution in U.S. Manufacturing Industry. International Journal of Energy Economics and Policy. 2012, Vol. 2, No. 2, p. 50-54. ISSN: 2146-4553

[11] NEPAD School Feeding Programme. (2005b). NEPAD School Feeding Programme; Annual Operating Plan.

[12] Onumah, E. E. and De-Graft, A. H. A Stochastic Production Investigation of Fish Farms in Ghana. Agris on-line Papers in Economics and Informatics. 2011, Vol. III, No. 2. ISSN 1804-1930.

[13] Partnership for Child Development. Osun State Home Grown School Feeding and Health Programme. Case study. 2010. [Online] Available: hgsf-global.org/.../94-osun-state-hgsf-and-health-programme-case-st... [Accessed: 9 March 2012].

[14] Stewart, J. Calculus. Early Transcendentals. Thomson Brooks/Cole, 6th Edition, 2008, p. 857 and 887. ISBN-10: 0495011665.

[15] Tomlinson, M. School feeding in east and southern Africa: Improving food sovereignty or photo opportunity? Equinet Discussion Paper Number 46. March 2007, Regional Network for Equity in Health in Southern Africa. South Africa. 207.

[16] Tshiunza, M., Lemchi, J. and Tenkouano, A. Determinants of Market Production of Cooking Banana in Nigeria. African Crop Science Journal. 2001, Vol. 9. No. 3, p. 537-547. ISSN 1021-9730.

[17] Tzouvelekas, E. Approximation Properties and Estimation of Translog Production Function with Panel Data. 2000. [Online] Available: http://ideas.repec.org/a/ags/jlaare/30959.html [Accessed: 19 Oct 2011].

[18] Wasim, M. A., Dwaipayan, S., Samsul, A., and Ashim, C. Degradation Dynamics Of A Di-Nitro Aniline Herbicide (Trifluralin) In/On Black Gram (Vigna Mungo) Under East-Indian Climatic Condition. Electronic Journal of Enviromental, Agricultural and Food Chemistry. 2009, Vol. 8, No. 11, p.1172. ISSN 1579-4377

[19] World Bank (2011). World Bank Annual Report 2011. [Online] Available: http://web.worldbank.org/ [Accessed: 5 November 2013].

[20] World Food Programme (2007b). Home-Grown School Feeding A Framework To Link School Feeding with Local Agricultural Production 77.

Agris on-line Papers in Economics and Informatics

Volume VII Number 3, 2015

Evaluation of Capital Structure of Agricultural Cooperatives

J. Steklá, M. Gryčová, J. Homolka

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

Anotace

Jedním z významných faktorů ovlivňujících ekonomickou efektivnost je vhodná kapitálová vybavenost podniků. V případě správného nastavení kapitálové struktury, přesněji řečeno poměru vlastního kapitálu a cizího kapitálu, je třeba vzít v úvahu několik faktorů, které působí na strukturu kapitálu, například různé zdroje financování. Hlavním cílem této práce je analyzovat vývoj struktury kapitálu a kapitálové disparity v zemědělských družstvech v rámci čtrnácti krajů České republiky pro časovou řadu 2009 – 2013. Pro tuto analýzu jsou použity ukazatele zadluženosti a metody komparativní statiky. Data jsou získána a zpracována z databáze podniků Albertina. Finanční a ekonomická krize snížila dluhové finanční indikátory, stejně tak i indikátory zisku. Kapitálová disparita mezi regiony na konci sledovaného období se zdá nezměněna. Obvykle Praha jako region s nejvyšším HDP na obyvatele během sledovaného období vykazuje extrémní hodnoty většiny indikátorů a vyšší odchylky v dluhových finančních indikátorech a nižší v indikátorech ziskovosti. Vliv indikátorů kapitálové struktury na ziskovost družstev se zdá nevýznamný během sledovaného období.

Klíčová slova

Kapitálová struktura, disparita, zemědělská družstva, kraje.

Abstract

One of the major factors, which affect the economic effectiveness, is suitable capital facilities of enterprises. In case of correct adjustment of capital structure, more precisely the ratio of equity capital and foreign capital, it is necessary take into account a number of factors which operate on the structure of capital, for example a variety of funding sources. The main aim of this paper is to analyze the development of the capital structure and capital disparity across the farmers' cooperatives from fourteen regions of the Czech Republic for time series 2009 – 2013. For this analysis is used the debt leverage indicators and method of comparative statics. Data are obtained and processed from the database of enterprises of Albertina. The financial and economic crisis lowered the debt to equity ratio and debt to assets ratio and the profitability ratios as well and the indicators reports V-shaped trend. The disparity of the ratio values among regions at the end of the monitored period seems not to be changed. Usually Prague as the region with the highest GDP per capita during the monitored period reports usually the extreme values in most ratios and higher deviations in debt ratios and lower deviations in profitability ratios. Also the impact of capital structure indicators on the profitability of cooperatives seems to be not significant during the monitored period.

Key words

Capital structure, disparity, farmers′ cooperatives, regions.

Introduction

The agricultural sector is an important part of an economy and has its own specifics. Its specificities are primarily of seasonal nature of production and dependence on natural conditions. These specifics are reflected in the economic results of farm enterprises, which affecting their capital structure, thereby arise capital disparity.

It is important to find out an optimal capital structure. The enterprises that are situated too far from the optimum faced greater risk of failure. The businesses make efforts to increase leverage when they face growth opportunities or when poor performances reduce equity value. The enterprises could gain advantage when rapid growth reduces financial slack.

Financial indicators, which influence capital structure, are mentioned in many studies. For example Rosochatecká (2002) mentions this problem, or Gurčík (2002), Chrastinová (2004) etc.

Capital structure has two main theories. It is the optimal trade-off theory and the pecking order theory. The first one was mentioned by Kraus and Litzenberger (1973), Jensen and Meckling (1976) and Morellec (2004). The second one is mentioned by, for example, Donaldson (1961) and Myers and Majluf (1984).

Kraus and Litzenberger (1973) emphasized that there exists balance between the tax debt and the bankruptcy. But Choi (2015) mentioned that debt is not one-sided. Jensen and Meckling (1976) found out that managers with mixed financial structure of an enterprise include debt, choose such activities for enterprises that decrease the value of the enterprise. Their theory is called the theory of agency costs and is a part of trade-off theory. Morellec (2004) said that optimal capital structure reflects the tax debt bankruptcy costs and the agency costs of managerial discretion. On the other side, within pecking order theory, Donaldson (1961) found out that management needs internal financing as a source of a new fund and does not need external financing. Myers and Majluf (1984) in their study said that external financing by debt is quite better than financing by equity.

According to the optimal trade-off theory, taxes and costs combine to yield, thereby is acquired an optimal capital structure. And the enterprises are punished for deviating from that optimum in form of lower risk-adjusted returns, and potentially failure. On the basis the pecking order theory, capital structure is a result of investment opportunities in the presence of asymmetric information. The enterprises are faced to the new investment opportunities and they strive to moderate unfavorable selection costs and so they seek use the least risky forms of financing. The leverage is increased when there are a lot of investment opportunities and the demand for investment capital is high. The other way around the leverage is decreased when there are not much investment opportunities and cash flow is considerable. The enterprises are punished that they have not enough financial slack on investments or they do not keep more slack than is optimal.

The leverage was mentioned and the difference of this ration was used by Welch (2011), Fama and French (2005), Lemon, Roberts and Zender (2008), DeAngelo and DeAngelo (2007). Welch (2005) gave a definition of leverage as total liabilities to total assets. He mentioned that a lot of authors define leverage as debt divided by assets, but it is incorrect according by his study. He proved that the best definition for leverage is the liabilities to assets, or if the managers want to focus on financial leverage, they can use definition as debt to capital. Fama and French (2005) used the same definition for leverage as Welch (2005) but Welch (2005) added that financial debt and non-financial liabilities as the same as equity. Baker and Wurgler (2002) defined leverage as debt divided by total assets. This definition follows the study from Fama and French (2005) and they suppose convertible debt. Lemon, Roberts and Zender (2008) define leverage as debt to total assets, i.e. sum of total debt and market equity. The same definition use DeAngelo and DeAngelo (2007). And they mentioned that the important is tax advantage of debt.

Minton and Wruck (2001) mentioned that the enterprises which have quite low leverage have quite high, or rather normal, book-to-market ratio. This effect is not specific to particular industries. In addition the enterprises do not have low tax rates, high non-debt tax shelters or information asymmetries. Shivdasani and Stefanescu (2010) mentioned that the enterprises are less conservative in their choices of leverage and they informed that the enterprises incorporate the magnitudes of pension liabilities in their capital structure decisions. Lemmon, Roberts and Zender (2008) found out that regression of leverage ratios do not explain, and is inadequate, for heterogeneity in capital structure. Graham and Leary (2011) found out that standard variables used to explain capital structures have little ability to explain variation.

The main aim of this paper is to analyze the development of the capital structure and capital disparity across the farmers' cooperatives from fourteen regions in the Czech Republic for time series 2009 – 2013 using the statistical analysis and correlation analysis.

The main objective of this study is to find out the impact of capital structure on the profitability of the farmers' cooperatives. Some other specific objectives are:

i) To identify the profitability of farmers' companies over the period of study.

ii) To identify and to analyze the relationship between profitability and capital structure.

Materials and methods

Data were obtained from the database Albertina for time series 2009 – 2013. There were analyzed 493 farmers' cooperatives which belong to the section Agriculture, according to CZ-NACE, with focusing on crop and agriculture production. The farmers' cooperatives were divided into regions, i.e. 68 farmers' cooperatives in Central Bohemia region, 64 in Highland region, 14 in Karlovy Vary region, 20 in Hradec Králové region, 18 in Liberec region, 20 in Moravia-Silesia region, 43 in Olomouc region, 32 in Pardubice region, 30 in Pilsen region, 9 in Prague region, 81 in South Bohemia region, 49 in South Moravia region, 15 in Ústí region and 30 in Zlín region.

The most farmers' cooperatives farmed in South Bohemia region (15.0 %, i.e. 356 382 ha), followed by the Central Bohemia region (13.4 %, i.e. 294 284 ha), South Moravia region (284 859 ha) and Vysočina region (271 078 ha). The agricultural holdings with the agricultural land area from 10 to 50 ha (and also to 5 ha) are the most in the Central Bohemia region, followed by Central Bohemia region. The largest part of the farmed agricultural land belongs to the Central Bohemian region (15.8 %) and South Bohemia region (12.0 %). The smallest part of the farmed agricultural land belongs to the region of Prague (10 771 ha), Karlovy Vary region (59 771 ha) and Liberec region (62 434 ha). The vast majority of the farmed agricultural land (71.3 %) consists of the arable land, except for the Liberec region (34.1 %), where the permanent grassland predominate (65.8 %). The largest percentage of arable land is in the South Moravian region (88.8 %), in the Central Bohemia region including Prague (87.4 %), where the acreage of grassland is the smallest (6.1 % and 11.6 %). The cereals accounted for the largest share on the arable land in all the regions. It is the most in the South Moravian region (64.7 %) and Ústí region (64.0 %), the least in Pardubice region (51.1 %) and Vysočina region (51.7 %). The wheat fields account for half of the cereal areas (Olomouc region, 51.8 %) and two thirds (Ústí region, 68.5 %). The maize accounts for a significant share in the South Moravia region (44.8% of the area). The potato growing is concentrated in the Vysočina region (37.8 %) and in the Central Bohemia region (24.0 %). The largest share areas of sugar beets (27.7 %), colza (21.5 %), other oil plants (soybeans 20.1 %) and vegetables (40.1 %) are in the Central Bohemia region. The biggest area of sunflowers (50.3 %) and flax (97.7 %) are in the South Moravia region (Regionální vyhodnocení výsledků FSS, 2013; Využití obhospodařované zemědělské půdy, 2013; Statistické ročenky, 2014).

In this paper are used the following formulas, i.e. relative indicators:

a) Debt to equity ratio (D/E). This ratio (Leavy, 2004) is a financial ratio that indicates the relative proportion of shareholders' equity and debt which is used to finance a company's assets. Because of closely relating to leverage, this ratio is also known as Risk, Gearing or Leverage. It can be calculated as total liabilities divided by total equity.

b) Debt to assets ratio (D/A). This ratio (Welch, 2011) is the debt, i.e. liabilities, plus equity equals assets. Ratio shows the proportion of a company's assets which are financed through debt. The enterprises with high debt could be in danger if creditors start to demand repayment of debt. It can be calculated as total liabilities divided by total assets.

c) Interest coverage ratio (ICr). The formula for the interest coverage ratio (Faulkender, Wang, 2006) used to measure a company's earnings relative to the amount of interest that they pay. It can be calculated as earnings before interest and taxes divided interest expense.

d) Gross profit ratio (GPr). This ratio (Peterson, Fabozzi, 1999) is important for business. It should be sufficient to cover all expenses and moreover provide for profit. Ratio is also known as gross profit margin or gross profit percentage. It can be calculated as gross profit divided by net sales.

e) Net profit ratio (NPr). According to this ratio (Guthmann, Dougall, 1955), net profit is equal to gross profit minus operating expenses and income tax. Net profit ratio is a useful tool to measure the overall profitability of the enterprises. It can be calculated as net profit after tax divided by net sales.

f) Return on capital employed (ROCE). This ratio (Gill et al., 2011) measures a company's profitability and the efficiency with which its capital is employed. The capital employed is the sum of shareholders' equity and debt liabilities or total assets minus current liabilities. It can be calculated as earnings before interest and taxes divided by total assets minus current liabilities.

In this paper is used the Pearson's Correlation coefficient (King, Rosopa, Minium, 2011) which is a statistical measure of the strength of a linear correlation between two variables X and Y. Where 1 is total positive correlation, 0 is no correlation, and -1 is total negative correlation. This coefficient is defined as the covariance of the two variables divided by the product of their standard deviations. Formula for Pearson's Correlation coefficient is:

$$r = \frac{\sum_{i=1}^{n}\left(X_i - \overline{X}\right)\cdot\left(Y_i - \overline{Y}\right)}{\sqrt{\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^2}\sqrt{\sum_{i=1}^{n}\left(Y_i - \overline{Y}\right)^2}} \quad (1)$$

There is also used the coefficient of determination. Coefficient of determination (Hirschey, 2008) is used in multiple regression models where more than one independent X variable is considered. The coefficient shows how well a multiple regression model explains changes in the value of the dependent Y variable. This coefficient can be calculated as (Lang, Secic, 2006):

$$R^2 = \frac{variation\ explained\ by\ regression}{total\ variation\ in\ Y} \quad (2)$$

The minor hypothesis used in this paper based on the theoretical background about the regional development used in this paper states that the region with higher GDP per capita (i.e. Prague) performs the values for debt ratios in average lower and the deviation higher during and after the crisis than the region with a low GDP per capita (e.g. Karlovy Vary or Liberec) according to the average of the period 2009-2013. The opposite might be true for the profitability ratios.

Results and discussion

Firstly, the calculated values for each ratio are listed in the following tables with their mean and standard deviation with respect to the regions.

The table no. 1 summarizes the results for the debt to equity ratio in every Czech region. The region with the highest average value during the monitored period is Liberec and the lowest value is in the region of Ústí (Prague is just the second). The region with the highest standard deviation is Liberec (Prague is just second one) that means that the crisis hit this region the most and so that the ratio changes the most during the period of 2009-2013. On the contrary, the region whose ratio varies the least is Karlovy Vary which is accordingly with the hypothesis. The calculated values are just around or below the general optimum level of 1. There is a decreasing trend during the recovery, but in 2013 there is an upward move in most regions. The highest variation range was in the year 2009 and in the regional point of view it was the region of Prague that means that in this region the value of the debt to equity ratio varied the most during the monitored period, that it could be said that the crisis and the recovery period affected the region of Prague the most. The regional

CR regions	2009	2010	2011	2012	2013	Mean	St. Dev.	C. V.
Central Bohemia	0.723	0.663	0.599	0.629	0.631	0.649	0.042	0.124
Highland	0.978	0.974	0.915	0.903	0.944	0.943	0.030	0.075
Karlovy Vary	0.702	0.709	0.716	0.655	0.689	0.694	**0.022**	0.061
Hradec Králové	0.952	0.850	0.599	0.594	0.613	0.722	0.150	0.359
Liberec	1.581	1.563	1.155	1.077	1.001	**1.275**	**0.247**	0.580
Moravian-Silesian	0.952	0.850	0.599	0.594	0.657	0.730	0.145	0.358
Olomouc	0.665	0.606	0.517	0.537	0.565	0.578	0.053	0.148
Pardubice	0.910	0.843	0.766	0.754	0.702	0.795	0.073	0.208
Pilsen	0.956	0.844	0.763	0.844	0.893	0.860	0.064	0.193
Prague	0.302	0.425	0.467	0.662	0.759	0.523	0.165	**0.457**
South Bohemia	0.905	0.926	0.890	0.809	0.838	0.874	0.043	0.117
South Moravia	0.923	0.929	0.799	0.797	0.825	0.855	0.059	0.132
Ústí	0.553	0.541	0.526	0.473	0.512	**0.521**	0.028	0.080
Zlín	0.751	0.705	0.659	0.581	0.634	0.666	0.058	0.170
C. V.	**1.279**	1.138	0.688	0.604	0.489	-	-	-

Source: Albertina database, Czech Republic; own calculations

Table 1: Debt to equity ratio [Figures in times], 2009-2013.

differences lowered during the crisis in this ratio and during the recovery as well.

The table no. 2 lists the results for the debt to assets ratio in every region. The region with the highest average value during the monitored period is Liberec again and the lowest value is in Prague. The region with the highest standard deviation is Prague that means that the crisis hit this region the most and so that the ratio changes the most during the period. The regions whose ratios vary the least are Karlovy Vary and Highland. The results are quite in accordance with the paper main hypothesis. Also the calculated values in regions are in the range of the general optimum level of 0.5. There could be also find a V-shaped trend during the monitored period, but rather decreasing with the top values in the year of 2009. The highest variation range was also in the year 2009, the year of the crisis, and in the regional point of view it was the region of Prague that means that in this region the value of the debt to assets ratio changed the most during the monitored period, that it could be said that the crisis and the recovery period affected the region of Prague the most. Also the regional differences lowered during the crisis in this ratio and during the recovery as well but a slow little upward trend in 2013.

The table no. 3 contains the calculated values of the interest coverage ratio for each region. The region with the highest average value during the monitored period is Zlín and the lowest value is in Prague. The region with the highest standard deviation is Ústí that means that the interest coverage varies the most in this region during the period. The region whose ratio varies the least is Prague that is in accordance with the idea that more developed region has a more stable interest rate. The region with the highest variation range was Ústí that means that the Interest coverage ratio changed the most during this period and so that the interest were the least stable for that region as expected by the theory and the highest variation range was in the crisis year of 2009 when counting all regions. Thus the regional differences lowered during the crisis in this ratio but then during the recovery started to rise again.

The table no. 4 shows the results for the gross profit ratio in every region. The region with the highest average value during the monitored period is Zlín and the one with the lowest value is Prague. The regions with the highest standard deviation are South Bohemia and South Moravia that means that the ratios there change the most during the period. The region with the lowest variance is Karlovy Vary. The region with the smallest ratio in 2009 is Prague. However, it is hard to find out any common trend because of the dependence of agricultural sector on weather and other agro-environmental conditions and the harvest values, even though there can be seen some increasing trend during the recovery and usually the value in 2013 is higher than in 2009. As expected, the values are lower than in other sectors. The region with the highest variation range was South Bohemia that means

CR regions	2009	2010	2011	2012	2013	Mean	St. Dev.	C. V.
Central Bohemia	0.420	0.399	0.375	0.386	0.399	0.396	0.015	0.045
Highland	0.492	0.491	0.475	0.475	0.477	0.482	**0.008**	0.017
Karlovy Vary	0.413	0.415	0.417	0.396	0.404	0.409	**0.008**	0.021
Hradec Králové	0.488	0.457	0.374	0.373	0.389	0.416	0.047	0.115
Liberec	0.613	0.610	0.536	0.519	0.511	**0.558**	0.045	0.102
Moravian-Silesian	0.488	0.457	0.374	0.373	0.391	0.417	0.047	0.116
Olomouc	0.399	0.377	0.341	0.349	0.352	0.364	0.021	0.058
Pardubice	0.477	0.457	0.434	0.430	0.428	0.445	0.019	0.049
Pilsen	0.489	0.458	0.433	0.444	0.467	0.458	0.019	0.056
Prague	0.232	0.298	0.318	0.398	0.425	**0.334**	**0.070**	**0.193**
South Bohemia	0.475	0.481	0.471	0.447	0.463	0.467	0.012	0.034
South Moravia	0.480	0.482	0.444	0.443	0.441	0.458	0.019	0.041
Ústí	0.356	0.351	0.345	0.321	0.302	0.335	0.020	0.054
Zlín	0.429	0.414	0.397	0.368	0.336	0.389	0.033	0.093
C. V.	**0.381**	0.312	0.218	0.198	0.209	-	-	-

Source: Albertina database, Czech Republic; own calculations

Table 2: Debt to assets ratio [Figures in times], 2009-2013.

CR regions	2009	2010	2011	2012	2013	Mean	St. Dev.	C. V.
Central Bohemia	5.302	2.108	5.601	9.650	7.541	6.040	2.509	7.542
Highland	3.321	-0.844	3.790	6.885	8.987	4.428	3.354	9.831
Karlovy Vary	0.998	-0.318	0.101	2.265	2.843	1.178	1.215	3.161
Hradec Králové	7.734	0.331	3.777	9.523	7.199	5.713	3.272	9.192
Liberec	2.642	-0.396	3.937	4.166	5.672	3.204	2.041	6.068
Moravian-Silesian	7.734	0.331	3.777	9.523	9.920	6.258	3.675	9.589
Olomouc	8.530	-0.003	3.656	13.439	6.318	6.388	4.530	13.442
Pardubice	5.648	1.096	5.212	8.583	9.825	6.073	3.035	8.729
Pilsen	0.772	0.532	5.309	9.568	6.033	4.443	3.415	9.036
Prague	-0.003	0.007	0.009	0.008	0.006	**0.004**	**0.006**	0.016
South Bohemia	3.481	-1.540	3.789	7.698	8.502	4.386	3.583	10.042
South Moravia	5.603	-1.150	5.862	11.311	8.226	5.970	4.110	12.461
Ústí	16.625	0.838	-1.832	9.320	4.251	5.840	**6.555**	**18.457**
Zlín	10.109	1.734	4.691	12.407	10.367	**7.862**	3.990	10.673
C. V.	**16.628**	3.648	7.694	13.447	10.373	-	-	-

Source: Albertina database, Czech Republic; own calculations

Table 3: Interest coverage ratio [Figures in times], 2009-2013.

CR regions	2009	2010	2011	2012	2013	Mean	St. Dev.	C. V.
Central Bohemia	0.033	0.006	0.036	0.058	0.047	0.036	0.017	0.052
Highland	0.016	-0.022	0.020	0.043	0.062	0.024	0.028	0.084
Karlovy Vary	-0.002	-0.024	-0.010	0.009	0.019	-0.002	0.015	0.043
Hradec Králové	0.037	-0.006	0.019	0.056	0.086	0.038	0.031	0.092
Liberec	0.012	-0.022	0.025	0.022	0.011	0.010	0.017	0.047
Moravian-Silesian	0.036	-0.005	0.018	0.057	0.073	0.036	0.028	0.078
Olomouc	0.046	-0.014	0.012	0.053	0.084	0.036	0.034	0.098
Pardubice	0.043	-0.004	0.031	0.053	0.075	0.040	0.026	0.079
Pilsen	-0.003	-0.009	0.035	0.058	0.063	0.029	0.030	0.072
Prague	-0.006	0.014	0.021	0.014	0.002	**0.006**	0.012	0.035
South Bohemia	0.021	-0.035	0.025	0.061	0.091	0.033	**0.042**	**0.126**
South Moravia	0.038	-0.023	0.034	0.065	0.087	0.040	0.037	0.11
Ústí	0.078	-0.021	-0.023	0.044	0.059	0.027	**0.042**	0.101
Zlín	0.061	0.006	0.029	0.069	0.095	**0.052**	0.031	0.089
C. V.	0.084	0.049	0.059	0.083	**0.097**	-	-	-

Source: Albertina database, Czech Republic; own calculations

Table 4: Gross profit ratio [Figures in times], 2009-2013.

that the Gross profit ratio changed the most during this period and so that the gross profits were the least stable in that region and the highest variation range was in 2013 when counting all regions. Thus the regional differences decreased during the crisis in this ratio but then during the recovery increased again.

The table no. 5 lists the calculated values of the net profit ratio with regional aspect. The region with the highest average value during the monitored period is Zlín and the one with the lowest value is Prague. The region with the highest standard deviation is Ústí that means that the ratio there changes the most during the period. The region with the lowest variance is Karlovy Vary and Prague. The region with the smallest (even negative) ratio in 2009 is Prague again. The trend for this monitored period is more or less V-shaped for most of the regions with minimum usually in 2010

CR regions	2009	2010	2011	2012	2013	Mean	St. Dev.	C. V.
Central Bohemia	0.030	0.007	0.033	0.050	0.070	0.038	0.021	0.063
Highland	0.015	-0.017	0.021	0.039	0.056	0.023	0.025	0.073
Karlovy Vary	-0.005	-0.011	-0.010	0.009	0.013	-0.001	**0.010**	0.024
Hradec Králové	0.029	-0.005	0.016	0.045	0.087	0.034	0.031	**0.092**
Liberec	0.010	-0.016	0.023	0.015	0.002	0.007	0.013	0.039
Moravian-Silesian	0.030	-0.006	0.015	0.046	0.078	0.033	0.028	0.084
Olomouc	0.043	-0.008	0.013	0.045	0.059	0.030	0.024	0.067
Pardubice	0.036	0.001	0.028	0.044	0.068	0.035	0.022	0.067
Pilsen	-0.004	-0.006	0.029	0.049	0.071	0.028	0.030	0.077
Prague	-0.010	0.009	0.021	0.016	0.003	**0.008**	**0.010**	0.03
South Bohemia	0.020	-0.030	0.026	0.053	0.045	0.023	0.029	0.083
South Moravia	0.035	-0.023	0.031	0.054	0.060	0.031	0.029	0.083
Ústí	0.071	-0.004	-0.019	0.043	0.058	0.030	**0.035**	0.09
Zlín	0.051	0.005	0.023	0.057	0.067	**0.041**	0.023	0.062
C. V.	0.081	0.039	0.054	0.073	**0.09**	-	-	-

Source: Albertina database, Czech Republic; own calculations

Table 5: Net profit ratio [Figures in times], 2009-2013.

and with the value of 2013 higher than in 2009. The values are much lower than in other sector because of the specific characteristics of the agricultural business. Also the regions with the highest variation range were Hradec Králové and Ústí region that means that the Net profit ratio changed the most during this period and so that the net profit was the least stable for those regions as expected by the theory and the highest variation range was in 2013 when counting all regions. Thus the regional differences lowered during the crisis in this ratio but then during the recovery increased again.

The table no. 6 shows the calculated values of the return on capital employed in each region. The region with the highest average value during the monitored period is South Moravia and the one with the lowest value is Prague. The region with the highest standard deviation is South Moravia that means that the ratio there changes the most during the period. The region with the lowest variance is Liberec. The region with the smallest (even negative) ratio in 2009 is Prague again. The trend for this monitored period is again V-shaped for most of the regions with minimum usually in 2010 and with the value of 2013 higher than in 2009. Also the region with the highest variation range was South Moravia that means that the Return on capital employed ratio changed the most during this period and so that the returns on capital were the least stable for those regions and the highest variation range was in the year 2013 when counting all regions that could mean that the crisis and recovery period affected the region by increasing their return on capital employed disparity. So the regional differences lowered during the crisis in this ratio, but during the recovery the differences increased much more over the starting level.

Lastly, the table no. 7 sums up results of correlation analysis between all mentioned ratios using data for all regions in order to uncover the relationship between the capital structure and the profitability ratios.

The very high positive correlation between the debt to equity ratio and the debt to assets ratio is clearly deduced from the definition of those ratios. Also the gross profit ratio, the net profit ratio and the interest coverage ratio are very highly positively correlated among each other by the definition.

As assumed the relationships between the debt to equity ratio and the following ratios respectively, i.e. the interest coverage ratio, the gross profit ratio and the net profit ratio, are negative, but very close to zero. The correlation coefficients are equal to -0.088, -0.064 and -0.125 respectively. As assumed the correlation coefficients between the debt to assets ratio and the interest coverage ratio, the net profit ratio are negative, but again close to zero (-0.035, -0.046 respectively). The positive correlation coefficients between the debt to assets ratio and the gross profit ratio, the return on capital employed ratio are very low and close to zero, i.e. no relationship

CR regions	2009	2010	2011	2012	2013	Mean	St. Dev.	C. V.
Central Bohemia	0.054	0.021	0.051	0.081	0.079	0.057	0.022	0.06
Highland	0.030	-0.008	0.034	0.062	0.088	0.041	0.032	0.096
Karlovy Vary	0.010	-0.003	0.002	0.024	0.056	0.018	0.021	0.059
Hradec Králové	0.057	0.003	0.026	0.075	0.084	0.049	0.030	0.081
Liberec	0.026	-0.004	0.040	0.037	0.012	0.022	**0.016**	0.044
Moravian-Silesian	0.058	0.002	0.027	0.078	0.099	0.053	0.035	0.097
Olomouc	0.066	0.054	0.021	0.067	0.083	0.058	0.021	0.062
Pardubice	0.068	0.012	0.046	0.075	0.092	0.059	0.028	0.08
Pilsen	0.009	0.004	0.048	0.078	0.093	0.046	0.036	0.089
Prague	-0.010	0.042	0.067	0.040	0.023	**0.020**	0.036	0.109
South Bohemia	0.033	-0.015	0.035	0.074	0.075	0.040	0.033	0.09
South Moravia	0.063	-0.013	0.054	0.101	0.136	**0.068**	**0.050**	**0.149**
Ústí	0.104	0.005	-0.012	0.057	0.064	0.044	0.042	0.116
Zlín	0.081	0.013	0.034	0.080	0.100	0.062	0.033	0.087
C. V.	0.114	0.069	0.121	0.141	**0.159**	-	-	-

Source: Albertina database, Czech Republic; own calculations

Table 6: Return on capital employed [Figures in times], 2009-2013.

Variables	D/E	D/A	ICr	GPr	NPr	ROCE
D/E	1.000					
D/A	0.985	1.000				
ICr	-0.088	-0.035	1.000			
GPr	-0.064	0.014	0.963	1.000		
NPr	-0.125	-0.046	0.969	0.968	1.000	
ROCE	0.025	0.116	0.935	0.926	0.934	1.000

Source: Albertina database, Czech Republic; own calculations

Table 7: Correlation matrices for capital structure and profitability ratios, all economic subjects together (Pearson Correlation), 2009-2013, 5% critical value (two-tailed) = 0.5324.

(the correlation coefficients equal 0.014 and 0.116 respectively). The same is true for the correlation between the debt to equity ratio and the return on capital employed ratio (the correlation coefficient is equal to 0.0285).

To conclude, during the crisis year and the recovery period the relationship between the capital structure ratios and profitability ratios is negligible and it is not statistical significant. This result acts for non-refusing the null hypothesis of this paper. Therefore, it can be said that during this monitored period the factors that influence the profitability are different from the capital structure changes for the cooperatives when adding the regional perspective.

The table no. 8 includes the main results of the regression analysis. All the models are statistical significant in consideration of the p-values of the F-tests.

An analysis of variance is used to measure effectiveness of the multiple regression models. The results of this analysis show that R-square for Debt to equity ratio is in size of 0.7764. It indicates a relatively high portion (77.64 percent) of the total variation which is associated with the three explanatory variables of the multiple regression models. And the result for R-square for Debt to assets ratio is in size of 0.8847 (88.47 percent). It can be concluded that the debt to equity ratio and debt to assets ratio is determined by the variables included in the model. The variables which are tested in this study are Interest coverage ratio, Gross profit ratio, Net profit ratio and Return on capital employed.

The model explains the three of eight explanatory variables in the model are statistically significant

Debt to equity ratio		Debt to assets ratio	
Variables	**Parameter estimates**	**Variables**	**Parameter estimates**
ICr	0.1598	ICr	0.1675
GPr	0.1601	GPr	0.1722
NPr	0.1498	NPr	0.1564
ROCE	-0.0389	ROCE	-0.0453

Source: Albertina database, Czech Republic; own calculations

Table 8: Test results of parameter estimates for ratios of capital structure, all economic subjects together, 2009-2013.

at the 10 percent level or better. The result presents that the interest coverage ratio, gross profit ratio and net profit ratio are significantly positively related to the debt to equity ratio and to the debt to assets ratio, while return on capital employed is significantly negatively related to the debt to equity ratio and to the debt to assets ratio.

Conclusion

The financial and economic crisis lowered the debt to equity ratio and debt to assets ratio and the profitability ratios as well. There is a decreasing V-shaped trend in the mentioned financial indicators during the recovery. However, in 2013 there is an upward move in most regions, but still the value is below the level of 2009. Also the interest coverage ratio has a V-shaped trend with a minimum in 2010 for most of the regions. The trend of the gross profit ratio, net profit ratio and the return on capital employed ratio is also V-shaped with minimum in 2010 as well, and with the value of 2013 much higher than in 2009 in most of the regions. The disparity of the ratio values among regions at the end of the monitored period seems to be very similar to the one at the beginning of the monitored period.

The regional part of the hypothesis was only partly proved.

Usually Prague as the region with the highest GDP per capita and big investment possibilities during the monitored period reports usually the extreme values in most ratios, mainly in the debt to equity ratio (just the second lowest value), the debt to assets ratio and the interest coverage ratio, but in opposite direction than assumed by the paper hypothesis in the gross profit ratio, the net profit ratio and the return on capital employed ratio as well as mostly the regions with small GDP per capita during this period reports the opposite values. This can be explained by the other factors playing more important role in affecting the debt ratios and the profitability ratios than the regional development level as the agricultural sector has very specific characteristics.

The region that reports the opposite extreme values is Liberec in debt ratios and Zlín for most of the profitability ratios. The reasons behind the highest debt ratios in hilly region of Liberec might be the whole very high indebtedness of the Liberec region that levels off recent years. The region of Zlín and the region of South Moravia for the return on capital employed ratio might be the most profitable ones because of the residence of the one of the biggest agricultural holdings and because of the rich harvests thanks to favorable agro-environmental conditions.

The same is partly true for the standard deviations. The region of Prague reports higher deviations in debt ratios and lower deviations in profitability ratios. Also the variation range was the highest in the crisis year of 2009 for the debt ratios and for the interest coverage ratio and profitability ratios the leveling year is 2013. The lowest deviations in debt ratios are reported in the region of Karlovy Vary maybe because of the low investment possibilities so during the recovery period there is no room for booming and thus no high deviations from the levels of the ratio during the crisis. The reason might be also that in the region of Karlovy Vary there is a high concentration of highly indebted self-employed persons in agricultural sector that influences the capital structure and their profitability. Also the highest deviations in profitability ratios can be found in Ústí and South Moravia regions. The reason behind this result might be the high concentration of big holdings that are more affected by the crisis or by a bad harvest in those regions with very good agro-environmental conditions. So the profits change more than in other regions.

The crisis and the recovery period increase the variation range among the regions in the case of profitability ratios, i.e. the gross profit ratio

and the net profit ratio and the return on capital employed ratio the most. This could be explained by the loosing of the negative effect of the crisis and by the recovery in the profitable regions and thus an increase in the differences across the regions. Conversely, the crisis and the recovery period decrease the variation range among the regions in the case of the debt ratios and the interest coverage ratio. The reason of smaller differences in the capital structure across the regions might be a cautiousness of the cooperatives in the agricultural sector during the monitored period in big investments connected with a higher indebtedness.

The calculated correlation coefficients uncovers that the relationship between the capital structure ratios and profitability ratios is negligible and statistical insignificant during the crisis year and the recovery period. Therefore, it can be said that during this monitored period the factors that influence the profitability are different from the capital structure changes for the cooperatives when adding the regional perspective. There can be also added that there exist factors which influence profitability (such as subsidies) and capital structure, or rather indebtedness, such as investments.

Our findings are consistent with other authors. For example Taani (2013) state that debt to equity ratio is positively correlated return on capital employed. On the other hand Taani (2013) found out that debt to equity ratio is positively correlated with interest coverage ratio and net profit ratio, which is not consistent with our conclusion. Abor (2005) found out that debt to equity has a positive association with debt to assets. Mohammadzadeh et al. (2013) stated the negative relationship between the profitability and the ratios of capital structure.

This paper tried to contribute to the capital structure, capital disparity and the impact of the capital disparity on the profitability of cooperatives in the agricultural sector from the regional perspective during the monitored period of 2009-2013. However, more detailed analysis in each region could be more explanative and complex.

Acknowledgements

The paper was elaborated within the research IGA. The title of the research is Capital and wage disparity in the agricultural sector (registration number: 20141031).

Corresponding author:
Ing. Jana Steklá
Department of Economics, Faculty of Economics and Management,
Czech University of Life Sciences Prague, Kamýcká 129, 165 21, Prague, Czech Republic
E-mail: stekla@pef.czu.cz

References

[1] Abor, J. The Effect of Capital Structure on Profitability: An Empirical Analysis of Listed Firms in Ghana. Journal of Risk Finance. 2005, Vol. 6, No. 5, p. 438-445. ISSN 1526-5943.

[2] Baker, M., Wurgler, J. Market Timing and Capital Structure. Journal of Finance. 2002, Vol. 57, No. 1, p. 1-32. ISSN 1540-6261.

[3] DeAngelo, H., DeAngelo, L. Capital Structure, Payout Policy, and Financial Flexibility. Marshall School of Business, FBE Working Paper. 2007, Vol. 02-06.

[4] Donaldson, G. Corporate Debt Ccapacity: A Study of Corporate Debt Policy and the Determination of Corporate Debt Capacity. Boston: Harvard University, Beard Books. 1961. ISBN 978-158-7980-343.

[5] Fama, E. F., French, K. R. Financing Decisions: Who Issues Stock? Journal of Financial Economics. 2005, Vol. 76, No. 3, p. 549-582. ISSN 0304-405X.

[6] Faulkender, M., Wang, R. Corporate Financial Policy and the Value of Cash. Journal of Finance. 2006, Vol. 61, No. 4, p. 1957-1990. ISSN 1540-6261.

[7] Gill, A., Biger, N., Mathur, N. The effect of capital structure on profitability: Evidence from the United States. International Journal of Management. 2011, Vol. 28, No. 4, p. 3-15. ISSN 1468-2370.

[8] Graham, J. R., Leary, M. T. A review of empirical capital structure research and directions for the future. Annual Review of Financial Economics. 2011, Vol. 3, No. 1, p. 309-345. ISSN 1058-3300.

[9] Gurčík, L′. G-index – the financial situation prognosis method of agricultural enterprises. Agricultural Economics. 2002, Vol. 48, No. 8, p. 373-378. ISSN 1574-0862.

[10] Guthmann, H. G., Dougall, H. E. Corporate Financial Policy, 3th ed. New York: Prentice-Hall, 1955.

[11] Hirschey, M. Managerial Economics. 12th ed. New York: Cengage Learning, 2008. ISBN 978-0-324-58886-6.

[12] Choi, H. The Kraus-Litzenberger Zero-Sum Trade-Off Theory. Social Science Research Network. 2015. ISSN 1556 5068.

[13] Chrastinová, Z. Economic and Financial Position of Agricultural Enterprises in the Period before the Accession to the European Union. Agricultural Economics. 2004, Vol. 50, No. 11, pp. 486-494. ISSN 1574-0862.

[14] Jensen, M. C., Meckling, W. H. Theory of the firm: managerial behavior, agency costs and ownership structure. Journal of Financial Economics, 1976, Vol. 3, No. 4, pp. 305-360. ISSN 0304-405X.

[15] King, B. P., Rosopa, P. J., Minium E. W. Statistical Reasoning in the Behavioral Sciences. 6th ed. New York: John Wiley and Sons. 2011. ISBN 978-1-118137-48-2.

[16] Kraus, A., Litzenberger, R. H. A State Preference Model of Optimal Financial Leverage. Journal of Finance. 1973, Vol. 28, No. 4, pp. 911-922. ISSN 1540-6261.

[17] Lang, T. A., Secic, M. How to Report Statistics in Medicine: Annotated Guidelines for Authors, Editors, and Reviewers. 2nd ed. New York: ACP Press,. 2006. ISBN 1-930513-69-0.

[18] Leavy, A. M. Indexing Distributions of Data: Preservice Teachers' Notions of Representativeness. School Science and Mathematics. 2004, Vol. 104, No. 3, p. 119-134. ISSN 1949-8594.

[19] Lemmon, M. L., Roberts, M. R., Zender J. F. Back to the Beginning: Persistence and the Cross-Section of Corporate Capital Structure. Journal of Finance. 2008, Vol. 63, No. 4, p. 1575-1608. ISSN 1540-6261.

[20] Mohammadzadeh, M. et al. The Effect of Capital Structure on the Profitability of Pharmaceutical Companies The Case of Iran. Iranian Journal of Pharmaceutical Research. 2013, Vol. 12, No. 3, p. 573-577. ISSN 1726-6890.

[21] Minton, B. A., Wruck, K. H. Financial Conservatism: Evidence on Capital Structure from Low Leverage Firms. Ohio State University, 2001.

[22] Morellec, E. Can Managerial Discretion Explain Observed Leverage Ratios? Review of Financial Studies. 2004, Vol. 17, No. 1, p. 257-294. ISSN 1465-7368.

[23] Myers, S. C., Majluf, N. S. Corporate Financing and Investment Decisions when Firms Have Information that Investors do not Have. Journal of Financial Economics. 1984, Vol. 13, No. 2, p. 187-221. ISSN 0304-405X.

[24] Peterson, P. P., Fabozzi, F. J. Analysis of Financial Statements. 1st ed. New York: Wiley, 1999. ISBN 978-1-883249-59-5.

[25] Regionální vyhodnocení výsledků FSS, 2013 [Online]. Available: https://www.czso.cz/documents/10180/26566189/27016815k06.pdf/198a30ba-f379-4723-89e7-f4413d5ac744?version=1.1 [Accessed: 24 August 2015].

[26] Rosochatecká, E. Economic Efficiency of Agricultural Enterprises and Its Evaluation. Agricultural Economics. 2002, Vol. 48, No. 3, p. 97-101. ISSN 1574-0862.

[27] Shivdasani, A., Stefanescu, I. How do Pensions affect corporate capital structure decisions? Review of Financial Studies. 2010, Vol. 23, No. 3, p. 1287-1323. ISSN 1465-7368.

[28] Statistické ročenky, Český statistický úřad, 2014 [Online]. Available: https://www.czso.cz/csu/czso/katalog-produktu [Accessed: 24 August 2015].

[29] Taani, K. Capital Structure Effects on Banking Performance: A Case Study of Jordan. International Journal of Economics, Finance and Management Sciences. 2013, Vol. 1, No. 5, p. 227-233. ISSN 2326-956.

[30] Využití obhospodařované zemědělské půdy, 2013 [Online]. Available: https://www.czso.cz/documents/10180/25404471/27016614086.pdf/84d6c849-884a-4a04-8f84-b14f28f4e3fd?version=1.0 [Accessed: 24 August 2015].

[31] Welch, I. Two Common Problems in Capital Structure Research: The Financial-Debt-To-Asset Ratio and Issuing Activity versus Leverage Changes. International Review of Finance. 2011, Vol. 11, No. 1, p. 1-17. ISSN 1468-2443.

Agris on-line Papers in Economics and Informatics

Volume VII Number 3, 2015

Usability of UX Methods in Agrarian Sector - Verification

P. Šimek, J. Vaněk, J. Pavlík

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

Anotace

Předložený článek pojednává o experimentálním ověření tří metod UX testování webových aplikací pro oblast zemědělství, potravinářství, lesnictví, vodohospodářství, regionálního rozvoje a rozvoje venkova. Pro experimentální ověření, které bylo uskutečněno na Agrárním WWW portálu AGRIS, byly vybrány a kombinovány pětisekundový test, třicetisekundový test a podle předem připraveného scénáře test použitelnosti. Nejlepších výsledků dosáhl test použitelnosti a třicetisekundový test přinesl výsledky uspokojivé. Pětisekundový test byl prokázán jako pro danou oblast nepoužitelný.

Klíčová slova

UX, agrární portál, testování, WWW, uživatel, informační zdroj.

Abstract

The article deals with experimental verification of three distinct UX web application testing methods in areas of agriculture, food industry, forestry, water management and rural development. The verification was conducted using agrarian WWW portal AGRIS. The three analyzed methods were five-second test, thirty-second test and usability test with preset scenario. The usability test yielded best results. The results of thirty-second test were satisfactory while the five-second test proved to be unsuitable for the given area.

Key words

UX, agrarian portal, testing, WWW, user, information source.

Introduction

Recently, the issues of UI (User Interface) and UX (User eXperience) of web applications and software in general have reached the level of basic interaction with ICT (information and communication technologies) (Hassenzahl, 2006). More than before, the design is being tailored to fit end user needs (Moon Hee Jung, 2015). For instance, studies are being conducted that involve scenarios with common user problems (Jung, Min, 2015). Another example could be creation of graphical design and symbols for easy multimedia interaction between the user and the application (Ryo, 2014). Researchers and practitioners from many fields work with the UX conception every day. Despite the fact that UX design focuses on usability and aesthetics, the actual GUI (Graphic User Interface) and user experience are often vastly different (Byung ju, 2015). After many attempts to summarize and define the UX principles, there are still doubts that a unified consensus in this issue had been reached (Lallemand et al., 2015). UX is still quite young field of expertise and its full research scope and the operationalization of experience in general is yet to be determined (law et al., 2015).

UX design also comes with certain risks, such as providing undesired experience to users. UX methods are also missing normative tools to lead designers and developers (Puccilo and Canscini, 2014). Understanding user preferences is essential for both product designers (Chien et al., 2014) and web application developers. There are many techniques in testing UX design. The five-second test, for instance, which involves displaying visual or information output of the web for five seconds followed by a questionnaire, where user is asked about certain aspects (Doncaster, 2014). Other methods include eye tracking, which is commonly used during usability testing (Olmsted-Hawala et al., 2014), user satisfaction evaluation during their interaction with digital content (Zahidi et al., 2014), or usefulness study in terms of contextual and experience factors (MacDonald, Atwood,

2014). In any case, the results are dependent on the target user group, as proven by many studies. For instance, there is huge gap between college students and seniors (Brajnik, Giachin, 2014).

All of the above apply in areas of agriculture, food industry, forestry, water management and rural development as well. UX and UI control element design is very important for effective use of web application by target user group, regardless whether its user group with specific needs or without (Benda, Šmejkalová, 2015).

Materials and methods

For the analysis of UX methods, three testing techniques were used: the five-second test, the thirty-second test and test of usability. The experimental evaluation was conducted using agrarian WWW portal AGRIS, which is one of the most used information sources for agrarian sector (agriculture, food industry, forestry, water management) and countryside area. This portal provides information since 1999 and the current version was built in 2011 according to the latest findings regarding common element layout of similar information sources and with technical equipment, user habits and their information literacy taken into account.

For the evaluation itself, 10 participants were carefully selected based on the following criteria:

- Users having average information literacy (using PC, web browser and internet portals)
- Users having a positive relation to agrarian sector or similar field (rural development, forestry, water management, food industry etc.)
- Users not being regular visitor of agrarian WWW portal AGRIS (in order not to distort results based on regular user habits and familiarity)

UX testing was conducted one individual at a time – always one respondent (user), one moderator, one evaluator and one technical worker being present. The entire process was divided into three parts in the following order (Figure 1):

1. Five-second test
2. Thirty-second test
3. Usability test of preset scenario

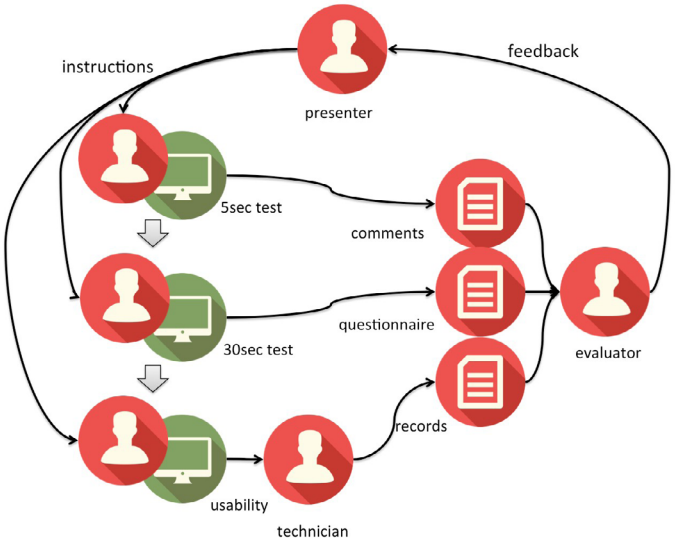
The five-second test was included in the evaluation to allow users to get user accustomed to the portal basics. Users we allowed to scroll through the page (but not click any links) and were asked for their first impression. The thirty-second test that followed had a goal to further improve user's basic orientation in the portal and prepare them for the usability test later. During the thirty-second test users were allowed to move around the portal at will. They were then asked to summarize their experience and fill in short questionnaire, where they marked each individual aspect of the portal on a 1 to 5 scale (1 being the best, 5 the worst). The questionnaire consisted of these five questions:

1. Is the portal graphics palpable?
2. Is the portal easy to navigate through?
3. Are the information widgets useful?
4. Is the information within the widgets relevant?
5. Is the space allocated for the main section big enough?

Besides the scoring system, users were also able to write a comment regarding each question.

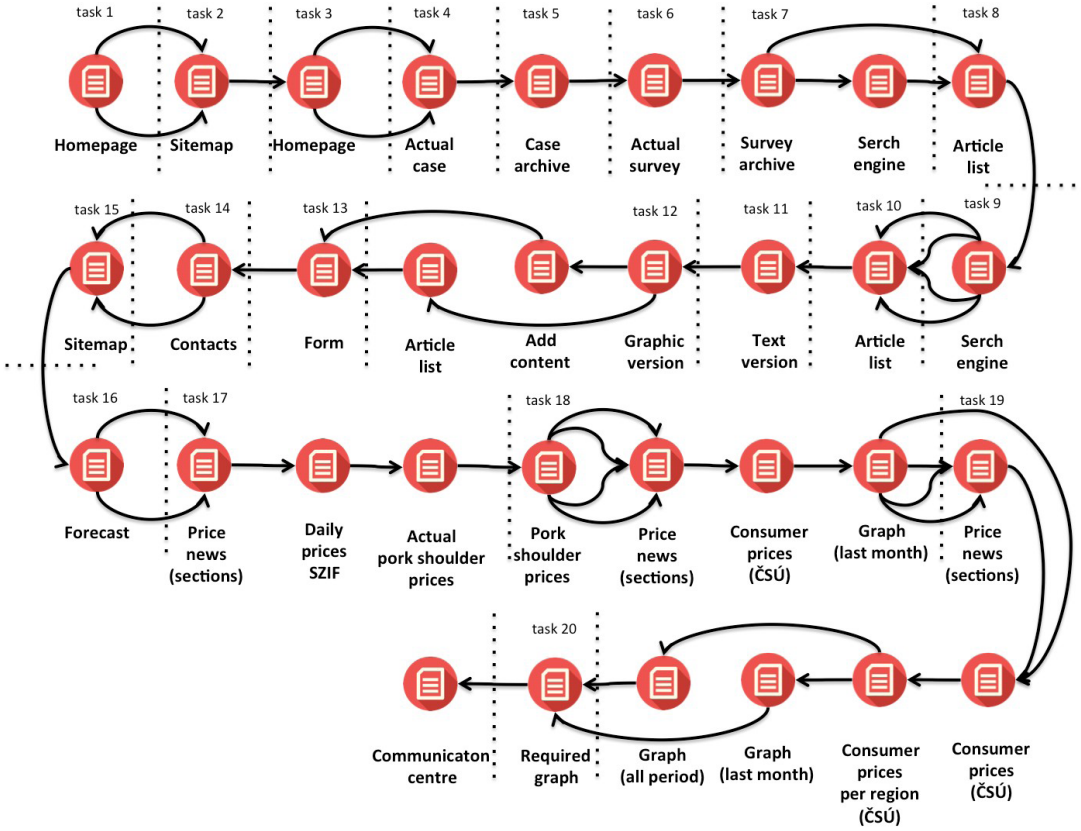
The usability test followed a preset scenario (Figure 2). Users were asked to navigate through the portal while completing a list of task. The moderator always gave the testing subject details for each task and the technical worker then counted number of click required and time spent completing each task.The time needed to explain each step was not included. It was measured from the point when user actually started the task to the moment of its completion. Neither the moderator nor the technical worker were allowed to communicate with the test subjects beyond the basic task explanation to prevent passing of influence (Table 1).

The test was conducted using PC with Windows 7 operating system, Google Chrome web browser and 1355x768 pixel screen resolution.



Source: Own research, icons from pelfusion.com

Figure 1: Usability test process.



Source: Own research, icons from pelfusion.com

Figure 2: Scenario for usability test.

No.	Task	options	optimal	
			clicks	time
1	Display server map	2	1	1
2	Display front page	1	1	1
3	Display articles regarding current issue	2	1	4
4	Display issue archive	1	1	4
5	Vote in current poll	1	2	4
6	Display poll archive	1	1	1
7	Display articles published on 15/04/2015	2	2	5
8	Find link for the advanced search	1	1	1
9	Display articles where the source is ASZ	4	3	6
10	Display text version of the portal	1	1	1
11	Display graphic version of the portal (without using the back button)	1	1	3
12	Display form for adding a link	2	2	5
13	Display contacts	2	1	4
14	Display server map	2	1	1
15	Display current weather forecast	1	1	1
16	Display pricing news	3	1	1
17	Find price of boneless pork shoulder for 15/04/2015 (Daily meat prices in ČR - SZIF)	1	4	12
18	Display graphics for 150 ml white yoghurt price progression during last month (Consumer prices in ČR - ČSÚ)	4	3	9
19	Display graphics for 150 ml white yoghurt price progression in Královéhradecký county during April 2015 (Consumer prices in ČR - ČSÚ)	8	12	22
20	Switch to AGRIS communication center	1	1	3
	Total	-	41	89

Source: Own research

Table 1: Task overview, number of options on how to reach the goal., optimal number of clicks and optimal time.

Results and discussion

The five-second test did not yield any good results. Users were not able to define particular finding that would be usable for further improvement of the portal. Therefore this test was determined to be unsuitable for UX testing of agrarian information sources. Perhaps a questionnaire following the test could improve the results. Nevertheless, this test served as good introduction for users and as a basis for further testing.

The thirty-second test had much more useful results. The increase in allotted time allowed users to scroll the screen and navigate through links more thoroughly which lead to a deeper understanding on how the portal works. After the thirty second of free browsing users filled in a questionnaire, where they gave marks to each individual aspect of the portal on a 1 to 5 scale (1 was the best, 5 was worst).

The clarity of portal graphics was rated very positively, between 1 and 2. One user also commented on the graphics being too conservative. But that is common practice and it is expected by most end users. Portal was rated as very easy to navigate, since all but one user gave it a 1 mark. The usefulness of widgets was rated between 1 and 3, while the relevance of information within the widgets was rated between 1 and 4. One user found the right widget bar unnecessary. The space allocated for the main section was rated as sufficient. Marks for that question were in the range between 1 and 3. One user pointed out that if the right bar was removed it would make the space for main section slightly larger.

The usability test (Table 2) turned out to be the most useful with results relevant for UX testing of agrarian web information sources. Users did not have any issues displaying the server map. Thanks to previous tests and own experience they were able to find the server map with one click spending an average of 5.8 seconds.

Displaying the front page took an average of 9.4 seconds and was also done with one click only by all tested users. Shortest achieved time was 6 seconds, while longest was 12 seconds. Users

No.	Task	clicks		time		
		min	max	min	max	mean
1	Display server map	1	1	4	8	5.8
2	Display front page	1	1	6	12	9.4
3	Display articles regarding current issue	1	1	15	19	17
4	Display issue archive	1	1	3	11	7.2
5	Vote in current poll	2	2	8	13	10.2
6	Display poll archive	1	1	2	6	3.4
7	Display articles published on 15/04/2015	2	4	7	25	14.4
8	Find link for the advanced search	1	1	2	15	7
9	Display articles where the source is ASZ	2	5	8	30	17.2
10	Display text version of the portal	1	1	5	9	6.4
11	Display graphic version of the portal (without using the back button)	1	2	16	30	24.2
12	Display form for adding a link	2	2	8	35	20.2
13	Display contacts	1	3	15	41	26.4
14	Display server map	1	1	3	5	3.6
15	Display current weather forecast	1	1	3	4	3.2
16	Display pricing news	1	1	2	7	4.2
17	Find price of boneless pork shoulder for 15/04/2015 (Daily meat prices in ČR - SZIF)	4	6	18	30	23.8
18	Display graphics for 150 ml white yoghurt price progression during last month (Consumer prices in ČR - ČSÚ)	3	6	20	44	30.2
19	Display graphics for 150 ml white yoghurt price progression in Královéhradecký county during April 2015 (Consumer prices in ČR - ČSÚ)	12	21	49	68	59
20	Switch to AGRIS communication center	1	1	4	25	14.4
	Total					307.2

Source: Own research

Table 1: Task overview, number of options on how to reach the goal., optimal number of clicks and optimal time.

mostly searched for type Homepage link, but after not finding it, they tried clicking the portal logo, where the link actually is. This is a good example of users using common practice and standard conventions and the result is highly determined by user information literacy and own experience.

Link for articles regarding the current issue is located in the Issues widget or under the main news section on front page. Reaching this page took between 15 and 17 seconds and subset of the users did use the second option. Most of the time needed to complete this task was used scrolling through the widgets and searching for the correct link, since most users correctly assumed that the link would be somewhere in the widget.

Fourth task involving displaying of issues archive was completed rather quickly, since users already knew where to search for the proper link. The time needed was between 3 and 11 seconds and the average was 7.2 seconds.

Next task which was voting in a poll took an average of 10.2 seconds. Users found the link in the widget but some time was also spent reading the poll contents before actual voting. The following task of displaying poll archive was completed very quickly thanks to previous experience and was completed in an average of 3.4 seconds.

Searching for articled with given publishing date did not cause any problems. Only one user used the search bar, while the rest used the quick search option directly inside the calendar, which is available on one of the widgets. Time to complete this task was between 7 and 25 seconds.

Time required to find link for advanced search ranged between 2 and 15 seconds, with the average being 7 seconds. The user with the worst time wrote a comment that the advanced search link is located on the right spot (near the basic search) but is not very well distinguished.

Searching for all articles with ASZ source using the advanced search was not problematic for most of the users. They took between 8 and

30 second to complete this task while most of this time was spent getting accustomed to all the fields of the search form. Two users typed the “ASZ” into the search bar and one used “with all the words” option and the other used “exact match” option. The rest of tested users used the field “source” where they picked ASZ.

Displaying the portal’s text version (not the mobile version) took between 5 and 9 seconds and everyone did it in just one click. Based on previous experience they knew to look for it in the technical navigation next to language selection. However, getting back to the graphic version caused a lot of issues. The time was ranging between 18 and 30 and one user failed to complete the task entirely. Everyone assumed the link would be located at the same position (technical navigation) while it was actually at the end of the website.

Form to add a link was found in average of 20.2 seconds (range between 8 and 35 seconds). Most users easily found the first link to add content but then spent some time reading the instructions on how to select a content type (links, articles, notifications).

Displaying contacts took between 15 and 41 seconds. Almost all users searched for the link near the technical navigation or in footer. Only after not finding it at those location they started to search the widgets. This link is located in one of the last widgets “About server” on the right hand part of the screen. Two users actually followed the link “Communication center” from the footer.

Task number 14 was displaying the server map, which is the same as task number 1. It was included in the testing scenario in order to compare the time on a simple task users have already completed. It took an average of 3.6 seconds to complete, while the first time (task no. 1) it was 5.8 seconds.

To display current weather forecast users instinctively used the option to click forecast images on the top right hand corner widget. Average time was 3.2 seconds.

Pricing news was found in 4.2 seconds on average and always with one click. Most users clicked the “Price” headline or the chart of price development of one of the commodities in a widget. Three users clicked the “Prices” link in the portal’s header. The following tasks involving the pricing news were more difficult. Displaying prices of particular commodity (pork shoulder) for a particular date (15/04/2015) took an average of 23.8 seconds (between 22 and 30 seconds). Displaying prices for another commodity (white yoghurt) in the past month took 30.2 seconds on average (range from 20 to 44 seconds) and was achieved between 3 and 6 clicks. Users spent a lot of time reading through elements of the displayed pricing table. A more specified task involving displaying of the pricing development of the same commodity, but only for a particular county and a specified timespan (April 2015) took almost an entire minute on average and users needed between 12 and 21 clicks to complete it.

The last task was to navigate to the communication center of the AGRIS portal., which took 14.4 seconds on average. The two users who accidentally got to the communication center while searching for contacts managed to complete this task within 4 seconds thank to their previous experience.

Conclusion

Experimental evaluation proved that the five-second test as a standalone UX technique is not suited for testing in area of agrarian information sources. But in conjunction with other methods it can serve as an introduction to get users accustomed to the web application. The thirty-second test followed by questionnaire yielded more useful results, mostly thanks to list of preset topics which users could use to bounce off of.

The most effective UX testing method from the three evaluated was usability test. It depends heavily on each individual user background, information literacy and previous experience with similar web applications. Without proper testing subject selection, it can provide vastly distorted results.

Methods of UX testing were evaluated using agrarian WWW portal AGRIS. The main goal was to determine whether or not these techniques are suitable for testing in agrarian sector and associated fields. However, the obtained results can be also used to improve the actual usability of the portal itself.

Acknowledgement

The knowledge and data presented in the paper were obtained as a result of the Grant No. 20151032 of the Internal Grant Agency titled "UI/UX issues in relation to application for rural development and associated fields".

Corresponding author:
Ing. Pavel Šimek, Ph.D.
Department of Information Technologies, Faculty of Economics and Management,
Czech University of Life Sciences Prague, Kamýcká 129, 165 21, Prague, Czech Republic
E-mail: simek@pef.czu.cz

References

[1] Benda, P., Šmejkalová, M. Web Interface for Education of Mentally Disabled Persons for Work in Horticulture. Agris on-line Papers in Economics and Informatics. 2015, Vol. 7, No. 1, p. 13 – 19. ISSN 1804-1930.

[2] Brajnik, G., Giachin, C. Using sketches and storyboards to assess impact of age difference in user experience. Published in International Journal of Human Computer Studies. 2014, Vol. 72, No. 6, p. 552 – 566. ISSN 1071-5819.

[3] Byung ju, K. Analysis of the GUI Design for the Responsive Web Based on the UX Design Factors -Focused on Male and Female Undergraduates. Journal of the Korean Society of Design Culture. 2015, Vol. 21, No. 2, p. 19 – 30. ISSN 1598-6497.

[4] Chien, C.-F., Lin, K.-Y., Yu, A. P-I. User-experience of tablet operating system: An experimental investigation of Windows 8, iOS 6, and Android 4.2. Computer & Industrial Engineering. 2014, Vol. 73, p. 75 – 84. ISSN 0360-8352.

[5] Doncaster, P. The UX Five-Second Rules: Guidelines for User Experience Design's Simplest Testing Technique. Elsevier Inc., 2014, p. 108. ISBN 978-012800534-7.

[6] Hassenzahl, M., Tractinsky, N. User experience - A research agenda. Behaviour and Information Technology. March 2006, Vol. 25, No. 2, , p. 91 – 97. ISSN 0144-929X.

[7] Junk, E. C., Min, K. UX Scenario Development based on Chatting UI for IoT Home Appliances Enhancing UX for LG HomeChat. Proceedings of the International Seminar on Computation, Communication and Control. 2015, Vol. 4, p. 37 – 40. ISSN 2352-538X.

[8] Lallemand, C., Gronier, G., Koenig, V. User experience: A concept without consensus? Exploring practitioners' perspectives through an international survey. Published in Computers in Human Behavior. February 2015, Vol. 43, p. 35 – 48. ISSN 0747-5632.

[9] Law, E. L.-C., Van Schaik, P., Roto, V. Attitudes towards user experience (UX) measurement. International Journal of Human Computer Studies. June 2014, Vol. 72, No. 6, p. 526 – 541. ISSN: 1071-5819.

[10] MacDonald, C. M., Atwood, M. E. What does it mean for a system to be useful? An exploratory study of usefulness. Proceedings of the Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques, DIS. Association for Computing Machinery, 2014, p. 885 – 894. ISBN 978-145032902-6.

[11] Moon Hee Jung, A. Study on User eXperience(UX) Design in Internet of Things. The Journal of The Korea Institute of Electronic Communication Sciences, 2015, Vol. 10, No. 7, p. 819 – 824. ISSN 1975-8170.

[12] Olmsted-Hawala, E., Holland, T., Quach, V. Usability Testing. Book chapter of Eye Tracking in User Experience Design. Elsevier Inc., 2014. p. 49 – 80. ISBN 978-012408138-3.

[13] Puccilo, F., Canscini, G. A framework for user experience, needs and affordances. Design Studies. March 2014, Vol. 35, No. 2, p. 160 – 179. ISSN 0142-694X.

[14] Ryo, S. H. UX Contents Through Visual Symbol of the Wonhaeng Eulmyo Jeongri Euigwe. Published in Journal of Korean Society of Communication Design. 2014, Vol. 17, No. 2, p. 93 – 108. ISSN 2092-9633.

[15] Zahidi, Z., Lim, Y. P., Woods, P. C. Understanding the user experience (UX) factors that influence user satisfaction in digital culture heritage online collections for non-expert users. Proceedings of 2014 Science and Information Conference, SAI 2014, p. 57 – 63. ISBN 978-098931931-7.

Agris on-line Papers in Economics and Informatics

Volume VII Number 3, 2015

Development of the Czech Farmers' Age Structure and the Consequences for Subsidy Policy

O. Šimpach[1], M. Pechrová[2]

[1] Faculty of Informatics and Statistics, University of Economics Prague, Czech Republic

[2] Faculty of Economics and Management, Czech University of Life Sciences Prague, Czech Republic

Anotace

Jedině na základě znalosti vývoje věkové struktury zemědělských pracovníků v budoucnu je možné formulovat kroky k jejímu zlepšení a plánovat financování opatření pro podporu mladých zemědělců. Cílem článku je s ohledem na programová období Evropské unie projektovat věkové a pohlavní struktury zemědělských pracovníků do roku 2041 a modelovat možné scénáře vývoje dotačních podpor. Pro projekci dvou variant populačního vývoje je použita kohortně-komponentní metoda a data ze Sčítání lidu, domů a bytů v roce 2011.

Počet zemědělců nad 55 let překročí počet mladých v roce 2026. Mladých manažerů nebo vlastníků zemědělských podniků bude nejméně v roce 2035. Pak nastane růst, protože do plodivého období vstoupí druhá generace tzv. Husákových dětí. Důsledkem toho bude možné (a i nutné pro zlepšení věkové struktury) podpořit více žadatelů. Zatímco v roce 2011 bylo 205,7 miliardami Kč podpořeno 12,1 % mladých zemědělců (potenciálních žadatelů o dotaci), v roce 2041 bude stejná částka stačit na 18,6 %.

Klíčová slova

Dotační politika, mladý zemědělec, populační projekce, věková struktura.

Abstract

Only knowing the future development of the farmers' age structure, it is possible to formulate the steps for its improvement and to plan young farmers' support. The aim of the paper is (with regard to the European Union's programme periods) to project the age-and-sex structure of agricultural workers until 2041 and to model the scenarios of subsidies supports. Cohort-component method and data from Census 2011 are used for projection of two variants of population development.

The number of old agricultural workers will exceed the number of young in 2026. It will start to grow after as the second generation of children born during the 70s of the last century (under the strong pro-population policy of the communist regime and the government of President Gustav Husák) will enter the reproduction period. As an implication it will be possible (and necessary) to support more applicants. While in 2011 it there were 12.1% of young farmers (potential applicants for subsidies) supported by EUR 205.7 bil., this amount will be able to cover 18.6% in 2041.

Key words

Age-and-sex structure, population projection, subsidies' policy, young farmer.

Introduction

Unfavourable age structure of the agricultural workers is a long discussed problem. It is desirable that the agricultural holdings are managed by young farmers as they "have a longer planning horizon and tend to invest more heavily in business growth than comparable older age groups" (Davis et al., 2013). Also Galanopoulos et al. (2011) proclaims that „ the old age of the farmers and the lack of successors is often the main reason for poor adoption levels of novel production techniques and improved management systems, which in turn, can only be realized under the presence of economies of scale." Davis et al. (2009) supposed that when the age or the size

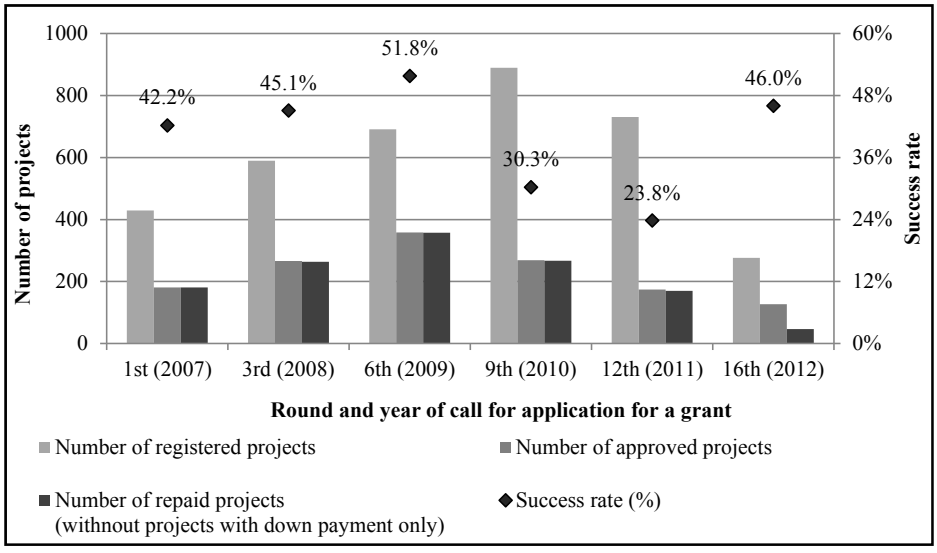
of the holding is correlated with the farm performance that the reduction of the number of the old farmers and increasing average size of other farms will have potential benefits for other farms. However, their analysis of company data did not found any statistically significant differences between farmers dependent on the age. According to Davis et al. (2009) simple replacement of old farmers by young ones would not bring any significant improvement of the company´s performance.

Also the young farmers may tend to experiment less with alternative land management. For example Alexopoulos et al. (2010) surveyed the conversion to organic farms in Greece and concluded that "older farmers owning larger farms are more likely to have adopted organic farming". Polain et al. (2011) deals with the issue of old farmers in Australia from sociological point of view. Existential questions raised by old farmers are solved qualitatively, not quantitatively. The Australian population as a whole is generally old and the problem of aging is frequently discussed topic in other socio-economic issues. Polain et al. (2011) based their research on the original primary data from a sample survey, Alexopoulos et al. (2010) as well as Zawojska (2011) used data from European institutions. Database for our calculation come from Czech Statistical office (Census 2011) and Ministry of Agriculture.

Despite that the impact of the young farmers' management on the farms' performance is ambiguous there is still a clear need to attract new entrants to the agricultural sector. Therefore, there were several measures set under the Common Agricultural Policy of the European Union (EU) in order to reverse the negative trend of agricultural workers population aging and to promote structural changes. One of the schemes was the support for early retirement of farms' owners over 55 years old and the second one the support of young farmers (less than 40 year old). Both measures were part of the Rural Development Program of the Czech Republic for the years 2007–2013 (RDP), but the first mentioned was not implemented in the end.

For the new programming period 2015–2020 there is a similar measure proposed – operation *6.1.1. – Setting up of young farmers' business*. Eligible beneficiary is a starting young farmer under the age of forty who firstly initiating the agricultural activity, have agricultural qualifications (or have the opportunity to obtain it), and run agricultural production for maximum 36 months. He or she will also have to submit a business plan and implement it within nine months after the submission of the grant (Ministry of Agriculture of the Czech Republic – MoA, 2014a).

There were seven calls for submission of the application for a grant (1st round in 2007, 3rd in 2008, 6th in 2009, 9th in 2010, 12th in 2011 and 16th in 2012) announced by the MoA (see Fig. 1). In total, there were 3 606 projects



Source: Own display of data by MoA (2014b)

Figure 1: Projects supported from measure 1.3.2 Setting up of young farmers' businesses of the RDP 2017–2013.

with a value over CZK 3.9 bil. registered, from which 1 286 projects with a value of CZK 1.3 bil. were re-paid so far (as of 30th September 2014). Each farmer had on average CZK 1.1 mil. at his or her disposal. Success rate indicates the possibility for the farmers to obtain the subsidy when they apply for a grant.

For future planning of agricultural policy and support to young farmers, it is necessary for the Steering body of the RDP to know the number of young farmers in the future. In other words, the MoA should know the number of potential beneficiaries of the grants.

As the phenomenon of population ageing concerns all economic developed countries, "not only projections of the whole population, but often special projections of the development of the number and age structure of employees of various professions are computed (Fiala, Langhamrová, 2011). However, as far as the authors of the paper are concerned there has not been done a population projection of agricultural workers yet. Researches are only in other areas – e.g. Fiala, Langhamrová (2011) projected ICT experts, Fiala and Langhamrová (2012) the graduates of informatics field and Šimpach and Pechrová (2014) forecasted the population structures in predominantly rural regions in the Czech Republic.

The detailed analysis with policy implications is so far only mild. On the EU level, there could be mentioned a research of Zawojska (2011) who assessed the age imbalances between EU agriculture workers. She founded the disparity between the age of managers (and agriculture holders) and ordinary workers in agriculture in 27 member states of the European Union. However, her research divides the farmers only into 3 age groups (young, middle-aged and old) and lacks detailed segmentation. The author mainly analyses the possibilities of European policy to change significant disparities between the agricultural managers and ordinary agricultural workers. Despite that Czech Agrocensus surveys observe farmers according to the age groups; the categorization does not match the age borders used for policy formulation (i.e. young farmer under 40 years of age, and "old" farmer over 55 years). The Agrocensus utilizes classification to agricultural workers until 34 years, 35 to 54 years, and over 55 years. However, EU uses division to young (under 40 years) and other farmers. We also consider category of farmers over 55 years as old as this population was eligible for support from RDP measure 1.3.3 Early retirement. The projections calculated in this paper are also adjusted to the policy formulation framework – i.e. consider 7 years intervals of the EU's financial framework. The focus on policy formulation needs is one of the contributions of this paper.

The aim of the paper is to project the age-and-sex structure of agricultural workers and especially young farmers and to discuss the policy implications of the development. The structure of the paper is as follows. Firstly we present utilized data and their sources, and methods used to project the population of agricultural workers. In the next section the results of two population projections are introduced. The implications for agricultural policy are discussed next. Last section summarizes the findings and concludes.

Materials and methods

In the following subsections we present used data and their resources, then the assumptions of the models and their resources, and finally the projections.

1. Used data

The most accurate initial values of age-specific number of economically active farmers in the Czech Republic comes from the complete results of the Census 2011, organized by Czech Statistical Office (CZSO). We utilize them in our paper. There is available the age-and-sex structure of the population of the Czech Republic and of economically active farmers in 5-year age groups from 15–19 to 70+ completed years of life. The projections are done until 2041 in order to follow EU's financial frameworks and programme periods: 2014–2020, 2021–2027, 2028–2034, and 2035–2041. Our results are compared to Agrocensus – a specialized survey on farm structure and on agricultural production methods conducted by CZSO in particular years.

2. Assumptions of the models

Firstly, the assumptions regarding the migration and calculations of the life expectancy, fertility and mortality of the projections are introduced. Then the progress of projections of the population of the Czech Republic is described. Finally we introduce the way of projection of the agricultural workers and of the young farmers (owners or managers of the agricultural holdings).

Population projections of the economically active farmers in the Czech Republic are calculated

on the basis of own population projections of the total population of the Czech Republic. Estimates of future age-and-sex specific population structure of economically active farmers are calculated using the cohort-component method on the basis of two probable scenarios (denoted model A and model B).

Because there were 132 245 economically active persons working in agriculture in 2011 only, this group is enough small that the migration balance can be neglected (or we can assume that a difference of immigrants and emigrants is equal to zero).

Regarding the life expectancy in the Czech Republic, several researches (e.g. Fiala, Langhamrová (2011), Šimpach, Langhamrová, (2012) or Šimpach, Pechrová (2013)) proved, that the standard of living, health, social welfare and other factors affect the length of human life, and thus increase the life expectancy of the population of the Czech Republic. CZSO uses when calculating the population projections three scenarios: low (pessimistic), medium (baseline) and high (optimistic) variant. Medium variant seems to be the most probable expert estimation of life expectancy of 0-year-old persons. It assumes a gradual increase in life expectancy at birth from 74.75 years in 2011 to 81.68 in 2041 for males and 80.82 years in 2011 to 86.93 in 2041 for females (see Figure 2 – left). Both models calculated in this paper, model A and model B, works with expert judgment of evolution of life expectancy at birth according to the CZSO's medium variant. Nevertheless, the variant of life expectancy estimate used in this population projection is also associated with medium variant of the total fertility rate estimate of Czech females. However, the total fertility rate is too high and seems unlikely based on recent studies (see e.g. Šimpach, 2015).

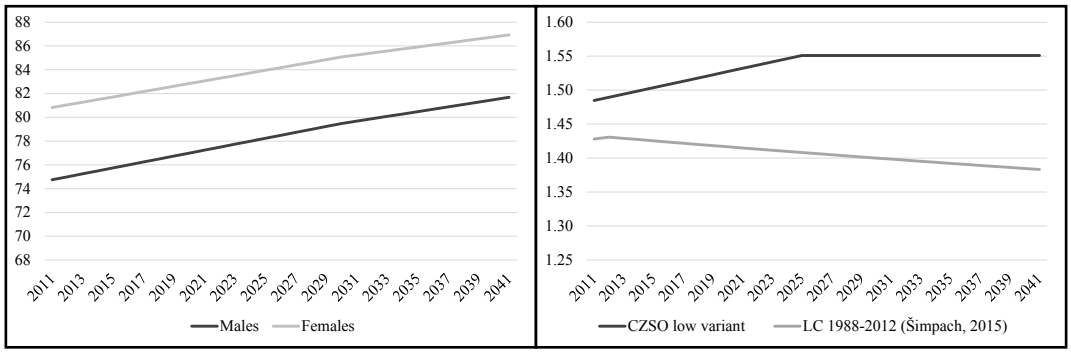
Therefore, we utilized estimates of age-specific fertility rates and the overall total fertility rate which were elaborated by Šimpach (2015) – see his model "LC (Lee-Carter) 1988–2012" based on a highly sophisticated modelling method elaborated by authors Ronald Lee and Lawrence Carter (see Lee, Carter, 1992). The LC model 1988–2012 uses principal components of fertility in the years from 1988 to 2012, and therefore reflects the latest changes in the thoughts of fertility in the Czech society (the trend of having lower number of children, postponing the childbirth to the higher age (30 years and over) etc.). CZSO's low variant expertly judge the a slight increase of the total fertility rate from 1.48 live births in 2011 to 1.55 live births in 2041 per 1 female during her reproductive period. Pessimistic variant of LC model 1988–2012 from paper of Šimpach (2015) assumes gradual decline from 1.43 live births in 2011 to 1.38 live births in 2041. These estimates are shown in Figure 2 (right).

The model A works with the expected development of the total fertility rate of Czech females by CZSO's expert judgment in low variant, model B utilizes the expected total fertility rate from Šimpach (2015).

3. Cohort-component method of population projection

Cohort-component method is based on the assumption that the person at the exact age x years and in calendar year t will be exactly one year older in the followed year with a certain probability (Stauffer, 2002). For the calculation we need to know the current population by age and sex (in one-year or shorter five-year age intervals), the mortality scenario and expected fertility trend.

The algorithm which is not completely universal is specifically derived for this paper. We use complete life tables for males and females in the Czech Republic in 2011, which shows the calculated mortality scenario in the form of table number



Source: own elaboration

Figure 2: Life expectancy at birth in 2017–2013 (left) and total fertility rate of Czech females in 2017–2013 (right).

of surviving males and females $l_{x,t\ =\ 2011}$, where x = 0, 1, ..., 105 are completed years of life. The table with numbers of surviving males and females in the years 2012–2041 are not yet known, but can be estimated based on the aggregate indicator of predicted life expectancy at birth (see e.g. Dotlačilová et al., 2014). Let us denote

$$est\ e_{0,t} = \frac{\sum_{x=0}^{105} l_{x,t} - \frac{l_{0,t}}{2}}{l_{0,t}}, \quad (1)$$

where $e_{0,t}$ is the life expectancy at birth of the person in year t, $l_{x,t}$ is the table number of surviving persons x-year-old in year t. "Radix" (the root) of the mortality tables is normally set on value of 100 000 persons. We calculate the other values $l_{x,t\ =\ 2012–2041}$ together with the estimated coefficient of decrease of the probability of the death. In order to apply a simple equations (2) and expression (3) to estimate the further table number of surviving these coefficients must be set to value of 0.979 for males and 0.977 for females. The auxiliary calculations are as follows:

$$est\ e_{0,t} = e_{0,t}^{CZSO}, \quad (2)$$

where $e_{0,t}^{CZSO}$ are expert estimates of life expectancy at birth of males and females according to the CZSO in Fig. 2 (left),

$$l_{x+1,t+1} = l_{x,t+1} \times \left[1 - \frac{ix^q \times \left(l_{x,t} - l_{x+1,t}\right)}{l_{x,t}}\right], \quad (3)$$

where ix^q is the coefficient of decrease of the probability of death of males or females respectively.

Number of live born persons by age of mother in 2011 is known ($N_{x,t\ =\ 2011}$), as well as the mid-year number of females in 2011 ($S_{x,t\ =\ 2011}$). Age-specific fertility rates of Czech females can be expressed as

$$f_{x,t} = \frac{N_{x,t}}{S_{x,t}}, \quad (4)$$

where x = 15-49 completed years of life. The total fertility rate is simply sum of all age-specific fertility rates in a given year t (see equation 5).

$$tfr_t = \sum_{x=15}^{49} f_{x,t}. \quad (5)$$

Model A, which is based on expert estimates of the total fertility rate according to CZSO, must assume the unchanged distribution of age-specific fertility rates up to the year 2041. (Moreover this assumption is followed by the CZSO itself in its own projections). The distribution for age range from 15 to 49 completed years of life from 2011 is obtained as

$$ix^f_{x,t-2011} = \frac{f_{x,t=2011}}{tfr_{t=2011}}, \quad (6)$$

We use the expert estimates of tfr_t by CZSO for the period 2012–2041 displayed in the Figure 2 (right). The development of age-specific fertility rates of Czech females is extrapolated as

$$f^{Model\ A}_{x,t=2012\ \ 2041} = tfr^{CZSO}_{t=2012\ \ 2041} \times ix^f_{x,t=2011}. \quad (7)$$

For model B we utilize the age-specific fertility rate by Šimpach (2015). The results will be more precise.

Projection coefficients represent the probability with what x-year-old person will be exactly one year older after one year. In the case of live-born persons it is a quotient of infant mortality. Projection coefficient for born persons is denoted as $P_{*,t}$ and is true that

$$P_{*,t} = \frac{L_{0,t}}{l_{0,t}}, \quad (8)$$

where radix of mortality tables $l_{0,t}$ = 100 000 and $L_{0,t}$ is the table number of spent years of 0-year-old persons. Because these numbers are unknown, we have to estimate them. From the algorithm of mortality tables is derived following relation

$$L_{0,t} = l_{0,t} - \left(\alpha \times d_{0,t}\right), \quad (9)$$

where α is the ratio of lower elementary file of deaths, (CZSO commonly use α = 0.85), and $d_{0,t}$ is the table number of 0-year-old deaths. This number is also unknown and must be estimated. The algorithm of mortality tables is

$$d_{0,t} = l_{0,t} \times q_{0,t}, \quad (10)$$

where $q_{0,t}$ is the probability of death of 0-year-old persons – i.e. the probability that 0-year-old person dies before reaches his/her first birthday. This probability is expressed based on the probability calculus as the supplement to 1.0. The probability of death is equal to

$$q_{0,t} = 1 - \left(\frac{l_{1,t}}{l_{0,t}}\right). \quad (10)$$

Substituting the unknown into the formula (10),

and then into (9) we obtain

$$l_{0,t} = l_{0,t} - \left\{ \alpha \times \left[l_{0,t} \times \left(1 - \left(\frac{l_{1,t}}{l_{0,t}} \right) \right) \right] \right\}. \quad (12)$$

Projection coefficient for x-year-old person is expressed as

$$P_{x,t} = \frac{L_{x+1,t}}{L_{x,t}}. \quad (13)$$

Any other tables with numbers of spent years of life, which are unknown, are estimated by the formula

$$L_{x,t} = \frac{\left(l_{x,t} + l_{x+1,t} \right)}{2}. \quad (14)$$

The procedure is further fully managed by the cohort-component method. The number of inhabitants aged x+1 at time t+1 is estimated up to the year 2041 as

$$S_{x+1,t+1} = S_{x,t} \times P_{x,t}. \quad (15)$$

Projection tables begin to be empty over time from the top as they are not any live-born children known. These numbers must be estimated as

$$N_t = \sum_{x=15}^{49} \frac{S_{x,t}^{females} + S_{x,t+1}^{females}}{2} \times f_{x,t}, \quad (16)$$

while from the known proportion of boys and girls at birth is separately calculated as

$$N_t^{Males} = 0{,}515 \times N_t \text{ and } N_t^{Females} = 0{,}485 \times N_t. \quad (17)$$

Empty space in the projection tables is consequently completed by

$$S_{0,t+1} = N_t \times P_{*,t}, \quad (18)$$

which resulting in a complete population projections of the population of the Czech Republic until 2041 based on the model A and model B. This projection is in 1-year age intervals, which must be converted to 5-year intervals for consistency with the data of economically active workers in agriculture.

It is supposed that the share of agricultural farmers on the total population will not change. This assumption is reasonable as "work in agriculture is not for majority of young people too attractive or perspective, average salaries in a sector are long-term under the Czech Republic's average" (CZSO). However, the proportions of young, middle-aged and old agricultural workers do change.

Similar approach was also taken for example by Fiala and Langhamrová (2012) when they assumed that since 2010 the number of students enrolled for bachelor's studies of informatics fields each year will be stable and equal to 11.2 % of people at the age of 19 years.

Therefore, the proportion of the number of farmers in the relevant age group on the total number of persons in the population is expressed as

$$ix_{x,t}^{ag} = \frac{S_{x,t}^{ag}}{S_{x,t}^{population}}, \quad (19)$$

where x = 15–19 ... 70+ respectively x = 15–19 ... 70–74. The last age interval of the economically active farmers is opened, but due to the fact that the frequency in this age group is quite small, we do not make a big mistake when we consider the interval 70+ as comparable to a closed interval 70–74. Moreover, this measure is commonly used e.g. by Šimpach and Pechrová (2013). Estimation for future years is made by using the formula

$$S_{x,t+1}^{ag} = S_{x,t+1}^{population} \times ix_{x,t}^{ag} \quad (20)$$

up to the year t = 2041.

4. Implications for young farmers

For the MoA it is necessary to know the number of potential eligible recipients of the subsidies from operation supporting young farmers. Therefore, it needs to know not only the share and the number of young agricultural workers, but also the number of farmers who are managers or owners of agricultural holdings. They are not specifically observed by CZSO. We utilize two approaches to estimate how many of the young agricultural workers actually are owners or managers. It is an approximate method as the eligible recipients are the beginners in their business and might not be captured in the statistics in Census 2011 (CZSO, 2011). The number of managers or owners was observed together with lawmakers for each age group during this Census.

There were 5 992 of managers in agriculture, forestry and fishery as of 26th March 2011 which accounts for 4.5% of the total workers. The share of managers younger than 40 years was 25.8%. The share of young owners or managers on the total number of employees was 1.2%. For the purpose of estimation we utilize the share of young managers in the category of young agricultural workers which was 3.5%. Hence, for example as in 2011 there were 44 424 of agricultural workers under 40 years, 1 545 (3.5%) of them were managers. We assume the share to stay stable. In other words, the situation where the policy measures stay the same as they were set in the future is modelled.

Results and discussion

1. Results

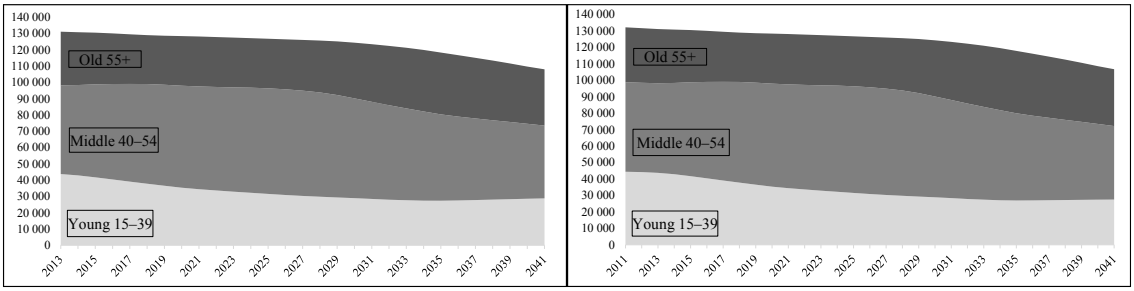
Following chapter give results of the models A and B. Both calculated population projections suggest that the number of agricultural workers will decrease with the decrease of the total number of population in the Czech Republic. While there were 132 245 agricultural workers in 2011, the model A shows that there will be 108 069 or 106 771 based on model B in 2041. The difference in projections is due to the supposed total fertility rate. CZSO is rather optimistic and project increase of total fertility rate. Contrary to that, the model B constructed by Šimpach (2015) projects the decrease of total fertility rate. While total fertility rate was 1.43 in 2011, CZSO set total fertility rate on 1.55 in 2041, and model B predicted the total fertility rate to be 1.38 in 2041. While CZSO considers the fertility rate to increase on average by 0.25% annually, the growth rate of total fertility rate is 0.10% in model B meaning that total fertility rate decreased on average by 0.10% annually. The differences in projections between models are the same throughout the whole article and therefore are not discussed further.

Despite the increase in fertility rate in CZSO model, the population of agricultural workers will decrease. It is due to the population development of the Czech Republic, aging and longevity (see e.g. study by Dotlačilová and Šimpach, 2015). Population structure of the Czech Republic becomes regressive as it is typical for Western European countries with all issues that this change brings.

Regarding the proportion between males and females, it is possible to conclude that it will not change rapidly. In 2011, the females accounted for 30.1% of the agricultural workers, while in 2041 it was only 28.7% (according to both models). This is in line with current development trends. CZSO (2012) reported that the share of females on total regularly employed workers in agriculture did not change too much between 2000 and 2010 – it decreased by 1.0 percentage point (p.p.).

While the proportion of the agricultural workers on the total population is assumed to stay constant overtime, the age structure of the agricultural workers will undergo significant changes. The development in the period 2011 to 2041 is displayed at Fig 2. The share of young farmers under 40 years of age will decrease from 33.6% in 2011 to 26.7% in 2041 (according to model A) or even to 25.8% (model B). According to CZSO model the age category 55+ is the only one where the number of agricultural workers will increase (by 1 197). Otherwise there is a decrease expected in category 40 to 54 years (by 9 754 workers) and in young farmers' category (15 to 39 years, by 15 690). Model B does not differ in higher age categories, but only in the first one (due to different assumed fertility rate). It predicts that the number of young agricultural workers will decrease even by 16 916 workers. This is in line with current trends noted by CZSO. According to the Agrocensus surveys, "the share of young productive generation (i.e. to 34 years) on the total number of regularly employed between 2000 and 2010 decreased from 22.9% to 20.1%" (CZSO, 2012).

As it can be seen from the Figure 3 the age structure of agricultural workers will change within observed period of time. According to the model A the share of young farmers will decrease and be the lowest in years 2032 to 2034 (2034 in case of model B). Then the share will start to slightly grow. Nevertheless, the maximal share of the young farmers already had been in 2011 and 2012 (according to the both models). On the other hand, the number of middle aged agricultural workers will grow until 2026/2027 and will continually decrease since that. The share of old farmers will start to grow since 2018 and will peak in years 2036–2038 (at 32.3% level according



Source: own elaboration

Figure 3: Number of agricultural workers according to the age categories in 2011–2041 (model A – left, model B – right).

to model A) or 2038 (at 32.6% level according to model B).

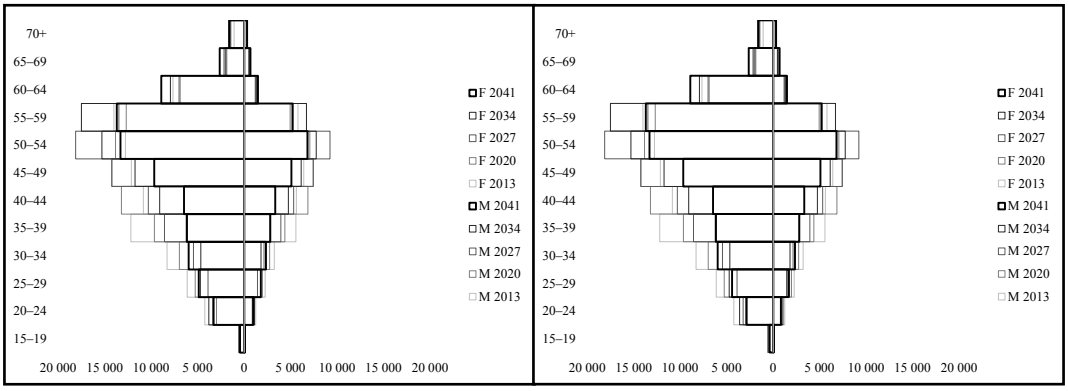
There can be differences observed in the age categories within the same gender group. In the category of young workers, the share of females was lower (31.5%) than the share of males (34.5%) in 2011. There were also more males in category of old agricultural workers (27.0%) than females (21.2%). On the other hand the share of females in middle age category was higher (47.3%) than the share of males (38.5%). The projection displayed in population pyramid at Figure 4 shows how the age-and-sex structure of agricultural workers will develop in the future. The projections are given in 7-year intervals in order to follow the financial framework of the EU.

According to the model A, the share of young males in the total population of male agricultural workers will firstly decrease, but later it will start to grow again. It is due to the fact that the second generation of so-called Husák's children[1] will have children (i.e. children which were born recently will enter the reproduction period). The lowest share of young males in agriculture is expected in years 2033 and 2034 (23.3%). The highest share of males already had been in year 2011. On the other hand, the share of middle aged workers will increase until 2026. Consequently it will decrease till the end of the projected period. The share of old male workers will be in minimum in 2018 (25.4%), but will grow since that until 2038 where the share will reach 35.2%).

The projection of model B differs slightly in later predicted years. The highest share of young farmers is similar (in 2011), but the lowest is in year 2034 (23.1% only – which is more pessimistic than according to the model A). On the other hand the category of male middle aged farmers was the lowest at the beginning (2011, 38.5%) and is increasing since that until 2026 (48.4%) when it will start to decrease again. The only category which share will grow during almost all projection period (until 2038) are the old male workers in agriculture. The highest share will be 35.5% as the lowest was at the beginning (2018, 25.4%). The share of middle age farmers is and still will be the highest, but the share of young farmers will be higher than old farmers only until 2024. Then the shares will switch (see Figure 5 left).

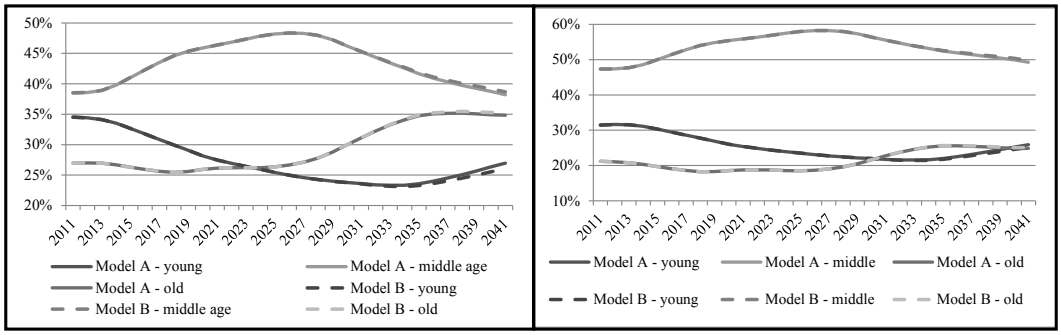
The development of the shares of different age categories in female group will be analogical to male group, but the share of young females will stay higher than the share of old for longer time than in male group (see Figure 5 – right). According to the model A, the lowest share of females in the young category will be the lowest (21.6%) between years 2032 and 2034. It was the highest in 2012 (31.6%). Middle aged group is always the most frequent, the share of females in this category will rise until 2026, 2027 up to 58.2% and then it will decrease again. But it will never be as low as it was in 2011 (47.3%). The share of old females will increase almost continuously and will peak at 25.6 % in 2035, 2036. The lowest share of old females will be already in 2018. Model B gave similar results regarding the years of minimal and maximal shares of each age category at the total number of female agricultural workers.

[1] Between 70s and early 80s of the last century the former Czechoslovakia was under political and economic influence of communist regime. At this time, the government of President Gustav Husák decided to significantly support families with more children using birth allowance and material benefits (strollers, household equipment etc.) Generation that arises after this political population interference is often called "Husák's children", or "Strong generation of 70s".



Source: own elaboration

Figure 4: Projection of age-and-sex population structures of agricultural workers in 2013–2041 by 7year intervals (actual on 1st January, model A – left, model B – right).



Source: own elaboration

Figure 5: Development of the shares of young, middle aged and old agricultural workers in 2011–2041 (males – left, females – right).

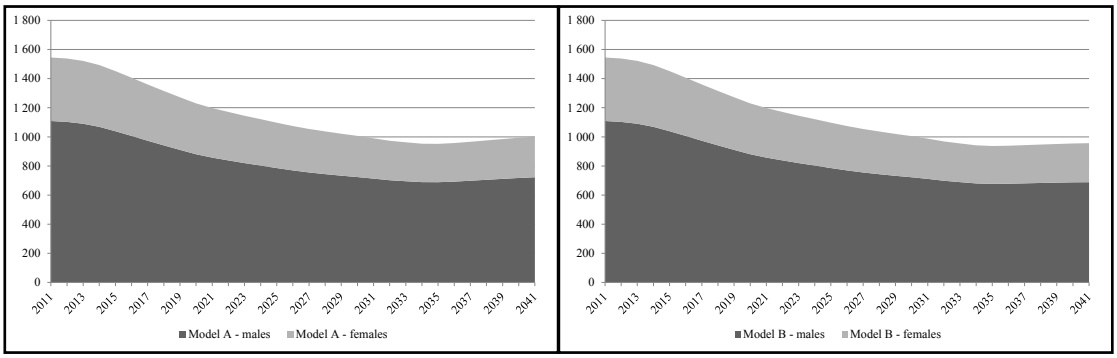
2. Discussion

For the steering body of the RDP (i.e. for the MoA) it is necessary to know the number of potential eligible recipients of the subsidies from particular measures. The number of managers or owners was observed together with lawmakers for each age group in Census 2011. The share of young managers in the category of young agricultural workers was 3.5% which is supposed to be stable overtime. For example in 2011, there were 44 424 of agricultural workers under 40 years from which 1 545 were managers. The number of young managers or owners will decrease as same as the number of agricultural workers in total. At the end of the projected period, there will be only 723 male and 279 female or 688 male and 268 female farms' managers according to the model A and B respectively. Figure 6 shows the development from 2011 until 2041 separately for males and females. In order to provide the decision makers with needed data for creation of the RDP, similar data are provided also in tabular form (see Table 1 in Appendix which displays particular number of young farmers projected for one year before the start of the programme period).

The change of the number of young farmers has implications to the subsidies' policy formulation. The RDP measure 1.3.2 Setting up of young farmers businesses implemented in 2007–2013 supported 1 471 young farmers with 1 484 projects in total. In 2011, 187 farms' owners or managers obtained subsidies in nominal value of CZK 1.1 mil. Each farmer obtained the subsidy for 5 years to implement his or her business plan. According to the projections in this paper, there were 1 545 owners or managers less than 40 years old in 2011; therefore, around 12.1% of the total number of young farmers was supported. The share was 9.1% one year later when 140 young farmers out of 1 538 received finances for setting of their business. Of course that not all supported farmers were already captured by the statistics as they started their business for the first time. In the next RDP for years 2014–2020 it is set that the farmers can run agricultural production for maximum 36 months. Besides the eligible applicant has to comply with the definition of small or micro business and achieve at least the minimal value of standard production (expressed in CZK per annual working unit).

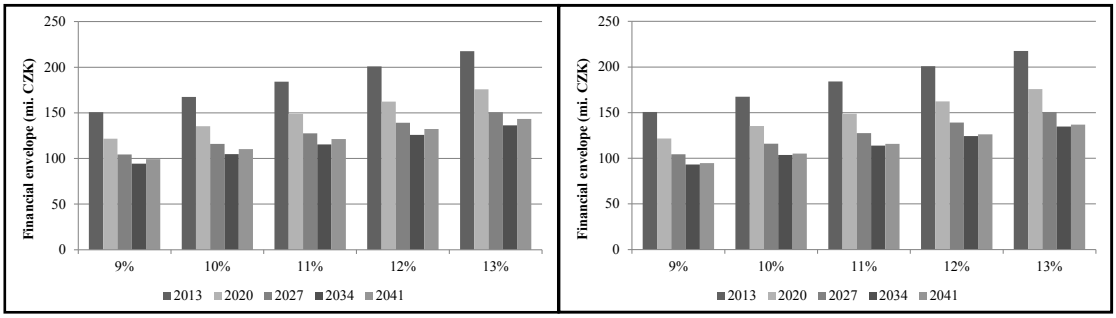
Our population projections suppose no change to the policy conditions as they are difficult to predict. With above stated limitations, we may consider several future scenarios of development of the support for the young farmers. Also some organizations calculate own population projections dealing with questions how many people and farmers will be on the Earth and who will feed the planet. For example Jöhr (2012) considers the situation in 2030 and raise the question how the world will be able to feed 8.2 bil. people who will live on Earth according to OECD at that time. Study done by Zawojska (2011) answered some of these questions, but considered the past development only (until 2010). There is no vision of how the situation in 27 European Union member states might evolve in the future (for example until 2030, or as in our study, until 2041).

Since 2026, the share of the young farmers will be the lowest of all. There were 1 538 young farms' managers or owners in 2013, but only 1 002 (according to model A) or 957 (according to model B) of them in 2034. The total amount of given financial aid to one owner or manager of agricultural holding will remain the same (CZK 1.1 mil.) for this purpose. We calculated the financial envelope for particular year needed in order to support certain percentage of farmers. The share of supported farmers will have to change



Source: own elaboration

Figure 6: Development of the number of the young farmers (owners or managers of agricultural holdings) – model A (left), model B (right).



Source: own elaboration

Figure 7: Financial envelope needed for next programme period to financially support certain share of young owners or managers of agricultural holdings (model A – left, model B – right).

each year as some of them would be already supported in previous years and would not be able to benefit from the subsidies again. There might be also more newcomers to the sector which are not included in the projections. The models assume that the percentage share of agricultural workers on the total population will be the same as in 2011. The simulations are displayed at Figure 7.

It is obvious that with decreasing number of young farmers, there will be less need for support. While in 2011 there were 12.1% of farm managers supported by CZK 205.7 bil., in 2020 would be less money (CZK 162.3 bil.) needed to cover 12.0% of young farmers and managers population. In 2027, the same amount as in 2011 will be sufficient even for more than 17.6%, 2034 for more than 19.5% of young managers or owners. However, the number of young farmers will grow within the programme period of 2035–2041. Hence, in 2041 would the same amount as in 2011 covered only 18.6% of the potential recipients of the support for young farmers.

We must also take into account that public finances devoted to the operation are limited. For the financial framework 2014–2020 it is planned to achieve total public spending in height of EUR 30 mil. on the priority *2B facilitate the entry of sufficiently qualified farmers into the agricultural sector, and in particular the generational renewal in this sector i.e. on measure 6.1.1 Setting up of young farmers' business* (MoA, 2014a). Therefore, the total number of supported young farmers will be dependant also on disposable public finances.

Conclusion

The aim of the paper was to project the age-and-sex structure of agricultural workers until 2041 and to model possible scenarios of the development of subsidies from the European Union's funds which support the entry of the young people to the sector. Despite that Agrocensus surveys observe farmers according to the age groups the categorization does not match the age borders used for policy formulation. Our article uses division to young (under 40 years), middle aged (40 to 55) and old (over 55) farmers. The projections were also calculated until 2041 in order to follow

the programme period of the EU.

A cohort-component method and data from Census 2011 were used for population projection. There were two variants calculated: model A worked with the expertly judged development of the total fertility rate of Czech females in the low variant and model B utilized values calculated by Šimpach (2015). The number of agricultural workers was derived based on their share on the total population in 2011. Similarly the number of young farms' owners or managers was drawn from their share on the total number of young farmers in 2011.

The share of young agricultural workers (both males and females) on the number of total agricultural workers will change within the projected period. The number of agricultural workers over 55 years will continuously grow and of the young under 40 years will decrease until 2026 when the number of old will exceed the young. In the same year, the share of middle aged workers will be the highest. The number of young farms' owners or managers of farms will decrease until 2035. After this year it will start to grow as the second generation of so-called Husák's children will enter the reproduction period.

The change of the number of young farmers has implications to the subsidies' policy formulation. It will be possible (and also necessary in order to improve age-and-sex structure) to support more applicants. While in 2011 it there were 12.1% of young farmers (potential applicants for subsidies) and 23.8% of the real applicants supported by EUR 205.7 bil., this amount will be able to cover 18.6% of young applicants in 2041. However, the models do not account for completely new entrants into the agricultural sector. They assume that the percentage share of agricultural workers on the total population will be the same as in 2011 throughout the whole projected period. Therefore, the challenge for future research is to examine this aspect – possibly by modelling and projecting of the number of graduates from agricultural high schools or universities with relevant field of studies.

Acknowledgements

Authors gratefully acknowledge Czech Science Foundation project No. P402/12/G097 DYME – "Dynamic Models in Economics" and the long term institutional support of the Faculty of Informatics and Statistics, University of Economics Prague for supporting this paper.

Corresponding author:
Ing. Ondřej Šimpach
Faculty of Informatics and Statistics University of Economics Prague,
W. Churchill sq. 4, 130 67 Prague 3 - Žižkov, the Czech Republic
Phone: +420 224 095 273, Mobile phone: +420 737 66 54 61, E-mail: ondrej.simpach@vse.cz

References

[1] Alexopoulos, G., Koutsourisa, A. Tzouramani, I. Should I stay or should I go? Factors affecting farmers' decision to convert to organic farming as well as to abandon it. IFSA: Proceedings of the 9th European IFSA Symposium. 2010, p. 1083-1093. [Online]. Available: http://ifsa.boku.ac.at/cms/fileadmin/Proceeding2010/2010_WS2.3_Alexopouos.pdf [Accessed: 29 Jul 2014].

[2] Czech Statistical Office (CZSO). Pracovní síly v zemědělství, Czech Statistical Office, 2012. [Online]. Available: http://www.czso.cz/csu/2012edicniplan.nsf/t/62002E535B/$File/ 212712k11.pdf [Accessed: 1 Mar 2015].

[3] Davis, J., Caskie, P., Wallace, M. Economics of farmer early retirement policy. Applied Economics. 2009, Vol. 41, No. 1, p. 35–43. ISSN 0003-6846.

[4] Davis, J, Caskie, P., Wallace, M. Promoting structural adjustment in agriculture: The economics of New Entrant Schemes for farmers. Food Policy. 2013, Vol. 40, p. 90–96. ISSN 0306-9192.

[5] Dotlačilová, P., Šimpach, O., Langhamrová, J. DERAS Versus MS EXCEL Solver in Levelling the Life Expectancy at Birth. 13th Conference on Applied Mathematics – Aplimat 2014. 2014, p. 108–114. ISBN 978-80-227-4140-8.

[6] Dotlačilová, P., Šimpach, O. Polynomial functions and smoothing of mortality rates: The Czech Republic and Slovakia during their independent development after their separation. 14th Conference on Applied Mathematics – Aplimat 2015. 2015, p. 221–231. ISBN 978-80-227-4314-3.

[7] Fiala, T., Langhamrová, J. ICT experts in the Czech Republic - development in the past and future prospects. Proceedings of the 19th IDIMT Conference (Interdisciplinary Information Management Talks). 2011, p. 51–58.

[8] Fiala, T., Langhamrová, J. The Expected Development of the Graduates of Informatics Field. Proceedings of the 20th IDIMT Conference (Interdisciplinary Information Management Talks). 2012, p. 257 - 358. ISBN 978-3-99033-022-7.

[9] Galanopoulos, K., Abas, Z. Laga, V., Hatziminaoglou, I., Boyazogluc, J. The technical efficiency of transhumance sheep and goat farms and the effect of EU subsidies: Do small farms benefit more than large farms? Small Ruminant Research. 2011, Vol. 100, p. 1-7. ISSN 0921-4488.

[10] Jöhr, H. Where are the Future Farmers to Grow Our Food? International Food and Agribusiness Management Review. 2012, Vol. 15, Iss. A (special issue), p. 9–11.

[11] Lee, R.D., Carter, L.R. Modelling and forecasting U.S. mortality. Journal of the American Statistical Association. 1992, vol. 87, p. 659-675.

[12] Ministry of Agriculture (MoA). Program rozvoje venkova na období 2014–2020, Ministry of Agriculture, 2014a. [Online]. Available: http://eagri.cz/public/web/file/321101/PRV_do_vlady.pdf [Accessed: 12 Mar. 2015].

[13] Ministry of Agriculture (MoA). 17. zasedání MV PRV 18. 11. 2014, Ministry of Agriculture, 2014b. [Online]. Available: http://eagri.cz/public/web/mze/dotace/program-rozvoje-venkova-na-obdobi-2007/monitorovaci-vybor/podklady-z-jednani/x17-zasedani-mv-prv-18-11-2014.html [Accessed: 12 Mar. 2015].

[14] Polain, J. D., Berry, H. L., Hoskin, J. O. Rapid change, climate adversity and the next 'big dry': Older farmers' mental health. Australian Journal of Rural Health. 2011, Vol. 19, No. 5, p. 239–243. ISSN 1038-5282, E.ISSN 1440-1584,

[15] Stauffer, D. Simple tools for forecasts of population ageing in developed countries based on extrapolations of human mortality, fertility and migration. Experimental Gerontology. 2002, Vol. 37, No. 8–9, p. 1131–1136. ISSN 0531-5565.

[16] Šimpach, O. Fertility of Czech Females Could Be Lower than Expected: Trends in Future Development of Age-specific Fertility Rates up to the Year 2050. Statistika. 2015, Vol. 95, No. 1, (in press). ISSN 1804-8765.

[17] Šimpach, O., Langhamrová, J. Czech Household Computer Facilities as a Reliable Variable in a Life Expectancy Forecast Model up to the Year 2060. Proceedings of the 20th IDIMT Conference (Interdisciplinary Information Management Talks). 2012, p. 143–152. ISBN 978-3-99033-022-7.

[18] Šimpach, O., Pechrová, M. Assessing the impact of standard of living on the life expectancy at birth using Vector Autoregressive Model. Proceedings of Mathematical Methods in Economics 2013. 2013, p. 921–926.

[19] Šimpach, O., Pechrová, M. The Impact of Population Development on the Sustainability of the Rural Regions. Agrarian perspectives XXIII. – The Community-led Rural Development, 2014, p. 129–136. ISBN 978-80-213-2545-6.

[20] Zawojska, A. Policy Challenges in Reducing Age Imbalances in the EU Agriculture. Economic Science for Rural Development: Resources and education, [Book series]. 2011, Iss. 25, p. 144–152.

Appendix

Year	Decision-making for programme period	Model A			Model B		
		Total	Males	Females	Total	Males	Females
2013	2014-2020	6 563	4 701	1 861	6 563	4 701	1 861
2020	2021-2027	5 304	3 798	1 506	5 304	3 798	1 506
2027	2028-2034	4 546	3 258	1 288	4 545	3 257	1 288
2034	2035-2041	4 110	2 972	1 138	4 062	2 934	1 128
2041	2042-2048	4 321	3 117	1 204	4 126	2 969	1 157

Source: own elaboration

Table 1: The number of young owners or managers of agricultural holdings a year before new programme period.

Agris on-line Papers in Economics and Informatics

Volume VII Number 3, 2015

Transformation Econometric Model to Multidimensional Databases to Support the Analytical Systems in Agriculture

J. Tyrychtr, A. Vasilenko

Department of Information Technologies, Faculty of Economics and Management, Czech University of Life Sciences Prague, Czech Republic

Anotace

Aplikace ekonometrických modelů v zemědělských podnicích je velmi složitý proces vyžadující znalost nejen ekonomie, ale i statistických a matematických metod samotnými pracovníky v zemědělství. Řešením může být aplikace ekonometrických problémů do analytických systémů pro podporu rozhodování manažerů farem. Pro takové řešení je nutné navrhnout multidimenzionální databázi pro podporu online analytického zpracování dat (OLAP). V článku je představena nová metoda (nazvaná TEM-CM) pro formální transformaci ekonometrického modelu do konceptuálního modelu dat pro tvorbu multidimenzionálních schémat. Tato nová metoda umožňuje formalizovat proces převodu produkční funkce v zemědělství na multidimenzionální model dat a přispívat tak k efektivnějšímu návrhu datových skladů a OLAP databází pro podporu rozhodování v zemědělských analytických systémech.

Klíčová slova

Multidimenzionální databáze, OLAP, ekonometrický model, produkční funkce, konceptuální návrh, zemědělství.

Abstract

Econometric model application in farms is a very complex process requiring knowledge not only the economy but also statistical and mathematical methods in agriculture workers themselves. The solution may be an application of econometric problems in analytical decision support systems for farms managers. For such a solution is necessary to design a multidimensional database for support online analytical data processing (OLAP). This paper proposes a new method (called TEM-CM) for formal transformation of econometric model to the conceptual data model for creating multidimensional schemes. This new method allows to formalize the process of transferring production function in agriculture to multidimensional data model and thus contribute to a more efficient design of data warehouses and OLAP databases for decision support in the agricultural analytics systems.

Key words

Multidimensional database, OLAP, econometric model, production function, conceptual design, agriculture.

Introduction

Analytical systems in the agricultural sector can help farm businesses to enhance their production potential and production efficiency by the ability to effectively support the management, analysis, planning and decision-making activities of managers and specialists. For example, some analytical issues in the context of precision agriculture (Lips et al., 2013, Cabrera Garcia et al., 2013), econometric (Čechura, Taussigová, 2013, Čechura, 2010, Kroupová, 2010) and information technology (Schulze et al., 2007, Rai et al., 2008) can be easily implemented using the concepts of Business Intelligence. Interdisciplinary approach to agriculture requires very high standards for data management. Special attention should be dedicated to the development of operational and analytical data to support the use of OLAP (Online Analytical Processing). OLAP describes an approach to decision support, which aims to gain knowledge from the data warehouse, or more precisely, from data marts (Abelló, Romero, 2009). There are currently several approaches to store of analytical

data. Among the most important are called multidimensional, relational, hybrid or desktop OLAP (more on this subject deals (Burstein, Holsapple, 2008)).

In this paper, a new method TEM-CM stage data for OLAP is introduced. The aim of the method is to allow formal transformation of econometric model to the conceptual data model for creating multidimensional schemes. This new method allows to formalize the process of transferring production function in agriculture to multidimensional data model and thus contribute to a more efficient design of data warehouses and OLAP databases for decision support in the agricultural analytics systems. In the OLAP approach, data are stored in an analytic database using a special scheme instead of the traditional relational schema. This approach is different compared to the modeling of operational OLTP databases (Online Transaction Processing). At the conceptual and logical level can be OLAP defined by three basic activities (Abelló, Romero, 2009):

- dimension analysis and modeling,
- data warehouse modeling,
- and realization of a dimension changes.

Multidimensional modeling (Burstein, Holsapple, 2008, Novotný et al., 2005, Datta, Thomas, 1999, Codd et al., 1993) is a basic part of OLAP solution. At the farm, the OLAP databases are rather exception. However, it is currently possible to find literature focused on an OLAP databases in agriculture. There are papers (Pardillo et al., 2010, Schulze et al., 2007), in which are described the proposals of OLAP database application in the agricultural context.

The authors of the proposal dealing with OLAP databases, however, do not consider the proposal in the context of production (or cost) functions in agriculture. The production function represents the relationship between the size of inputs (factors of production) and the size of the farm production output. Based on the identified production function, it is possible to create a multidimensional database for the collection of relevant and objective data. However, for the creation of such a database is necessary to transform the production function to conceptual data model.

This reason of the production function in the OLAP solution is that the farm can perform analytical processing of summarized and aggregated data to help answer questions such as the:

- How big was the total production [in thousands of CZK] farm in 2011?
- How big was the milk production [kg] on the farm in 2011?
- How big was the milk production [kg] for Holstein cattle in March 2011?
- Knowledge production function within the Business Intelligence (Tyrychtr et al., 2015) can also help agricultural enterprises in matters:
- How much will change production when you change the workforce of unit?
- How much will change production when you change the acreage of cultivated land unit?

All of these questions can be answered effectively by using OLAP technology. For most database is necessary to formulate model step by step, first step should be to define its structure in general. The overall task of designing a database is to map the real world application into formal data model of the database management system (Rai et al., 2008).

Database design is a process that produces a series of database schema for the particular application (Fahrner, Vossen, 1995).

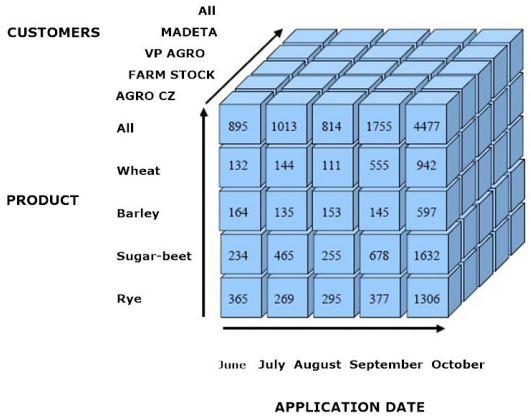
Multidimensional modeling (Mylopoulos, 2009) is the process of data modeling in the universe of discourse with the modeling structure to provide a multidimensional data model. Multidimensional models categorize data, either as facts associated with numerical measure or as dimensions that characterize the facts and are generally in plain text.

Facts are objects that represent the object of required analysis to be analysed to better understand his behaviour. Multidimensional models are currently mostly based on a relational data model, or on the construct of data cubes (Pedersen, 2009a).

Data cube (figure 1) is a data structure for storing and analysing large amounts of multidimensional data (Pedersen, 2009b). It is generally interpreted as a basic logical structure to describe multidimensional databases, as well as relations for the relational databases. Data cube represents the abstract structure but, unlike traditional relational structures in the relational data model is not defined clearly. There are many approaches to the formal definition of the operators' data cubes (comprehensive overview is available on the paper (Vassiliadis, Sellis, 1999). Generally we can tell, that the data cube is constructed of dimensions and measures.

Dimension is a hierarchical set of dimensional values that provide categorical information characterizing a particular aspect of data (Pedersen, 2009c).

Measures (monitored indicators) of data cube are mostly quantitative data that can be analysed.



Source: self-authored

Figure 1: An application context of data cubes.

Materials and methods

In this paper we first formalizes the notation of econometric model and multidimensional data model through mathematical apparatus. Subsequently, we propose a new method of TEM-CM through formal rules. Chapter Conclusion will be focused on a new method of TEM-CM demonstrated by the application of individual rules for the econometric model in analytical systems. Finally, conclusions are formulated article and opportunities for further research proposal OLAP in an agricultural context.

Econometric model

Econometric model (ECM) represent mathematical model, which is a mathematical-statistical formulations of economic hypotheses. It expresses the dependence of economic variables on variables that explain the hypothesis. Most often in the economic literature (Kroupová, 2010) is used Cobb-Dougles production function, which can be characterized by constant elasticity of production factors, invariability in economies of scale among businesses and convexity isoquant function towards the beginning. Cobb-Dougles production function has general form (Felipe, Adams, 2005, Kroupová, 2010):

$$y = \alpha x_l^{\beta_j} x_p^{\beta_p} x_k^{\beta_k}, \text{ where} \quad (1)$$

y… amount of output,

$x_{l,p,k}$ … amount of *l-th, p-th* a *k-th* input,

α, β … parameters of production function.

In the agricultural environment ECM is often composed of more than one equation. There are stochastic equations with random variable and definition equation (identity function).

If we have ECM in symbolic form (Tvrdoň, 2006):

$$y_{1t} = \gamma_{11}x_{1t} + \gamma_{12}x_{2t} + \gamma_{13}x_{3t} + \gamma_{14}x_{4t} + u_{1t}$$
$$y_{2t} = \beta_{21}y_{1t}\gamma_{21}x_{1t} + \gamma_{25}x_{5t} + u_{2t}$$
$$y_{3t} = y_{1t} + y_{2t}, \text{ then} \quad (2)$$

y_s is an endogenous s-type variable and its value in the period *t*- $y_{st,}$ index s = (1, 2, … g), t = (1, …, n). x_r is r-th exogenous variable with value in period *t* - x_{rt}, where number of exogenous variables is equal to k, then r = (1, 2, … k). Delayed endogenous variable express effects of variables of period *t-z*, where z = (1, 2, …, t-z). u_{st} is random variable in s-th equation of explained endogenous variable in period t. β_{is} is structural parameter in i-th equation in s-th model undelayed endogenous variable and γ_{ir} in i-th equation of model of r-th predetermined variable.

Multidimensional model

Data cube is basic structure of multidimensional databases and it is used as basic amount of inputs and output for every operators based on multidimensional databases (Datta, Thomas, 1999).

If we have quaternion <*D,M,A,f*>, where all four components indicate the properties of the data cube. Then, these properties are (Datta, Thomas, 1999):

Set on *n* dimension $D = \{d_1, d_2, ..., d_n\}$, where every d_i in name of dimension obtained from domain $dom_{dim(i)}$.

Set of *k* measures $M = \{m_1, m_2, ..., m_k\}$, where every m_i in name of measure obtained from domain $dom_{measure(i)}$.

Set of names of dimension and measures is disjoint; tj. $D \cap M = 0$.

Set of *t* attributes $A = \{a_1, a_2, ..., at\}$, where every a_i is name of attribute obtained from domain $do_{mattr(i)}$.

Viewing one to many $f: D \rightarrow A$, exists for each dimension and each set of attributes.

The view is such that a set of attributes associated to the dimension in the pair are disjoint i.e. ∀i,j,i ≠ j,f(d_i) ∩ f(d_j) = 0.

Constellation schema

Like the design of conceptual schema operational database is useful for the design of multi-dimensional diagram make use of some type of design approach. The most commonly are used style star schema, Snowflake schema and constellation diagram (or galaxy/integrated/ hybrid scheme). This article uses the constellation diagram (Kimball, 1998), which is formed by the dimension tables shared by two or more fact tables. This is an equivalent star schema or flakes, with the difference that this scheme consists of several fact tables. The constellation schema is obtained when the multidimensional model is composed of two or more cubes, which eventually share some dimensions (Boulil et al., 2014).

Results and discussion

To create a new formal method TEM-CM (Transformation of Econometric Model to the Conceptual Model) is the first to define the representation of the econometric model and multidimensional representations of the proposal scheme, which is based on a constellation diagram type.

Formal representation of econometric model

Let us set Y a X, where

$Y = \{y_s\} \cup \{y_{st}\}$ is a finite set of endogenous variables in the model.

$X = \{x_r\} \cup \{x_{rt}\}$ is a finite set of exogenous variables in the model.

$Rel \subseteq (X \times Y) \cup (Y \times Y)$ is a set of structural relations.

Formal representation of multidimensional schema proposal

Schema Constellation is defined by five elements (*Ent, Key, Att, Ass, getKey*), where:

Ent is a finite nonempty set of data model entities,

Key is a finite nonempty set of data model keys,

Att is a finite nonempty set of data model attributes,

$Fact \subseteq Ent$ is a finite set of separate entities out of constellation scheme

$Dim \subseteq Ent$ is a finite set of entity dimensions

Each entity $e \in Ent$ is described by collection of keys and collection of attributes, i.e. accordingly we can assume that:

$\forall e \in Ent: \exists(\{k \in Key\} \cup \{a \in Att\})$

getKey is function, which returns entity key in constellation schema, i.e. accordingly we can assume that:

$\forall e \in Ent: getKey(e): Ent \rightarrow Key_e \subseteq Key$

$Ass \subseteq (Dim \times Fact)$ is finite set of relation between entities.

New methods TEM-CM

For the defined sets and conditions are proposed following transformation rules, which are divided into two phases. The first phase of transformation provides dimension and facts from econometric variables into the constellation diagram. The second phase is building relationships between dimensions and facts.

Phase 1: Constellation scheme creation

Rule 1.1: Creating facts table in empty constellation scheme for every endogenous variable in econometric model.

$\forall y_s \in Y: c_s\ Fact$ and $\forall y_{st} Y: c_{st} \in Fact$

Rule 1.2: Creating dimensions to constellation scheme for every exogenous variable in econometric model.

$\forall x_r \in X: ds \in Dim$ and $\forall x_{rt} \in X: d_{rt} \in Dim$

Rule 1.3: If there exists time variable in econometric model, we have to create time dimension

$\forall x_{rt} \in X: d_{rt} \in Dim_{time}$

Phase 2: Definition of relationship between entities in conceptual model

Rule 2.1: If there is a relationship between exogenous variable x and endogenous variable y and function getKey that returns a set of keys for these variables, then it will be associations between the fact table and the dimension to which they apply:

$$\forall (x,y) \in Rel: (d,c,K) | (d \in Dim) \wedge (c \in Fact) \wedge ((d,c) \in Ass) \wedge (K \subseteq K_d \cup K_c | (K_d = getKey(d)) \wedge (K_c = getKey(c)))$$

Application of new method TEM-CM

Formally defined rules are demonstrated in the application context. The following example represents a situation where the total production

of the farm is dependent on plant production and livestock production and for each of these productions are monitored difference measurement (indicators).

Let us ECM (2) and simplified case study:

y_{1t} … gross plant production in the period t,

y_{2t} … gross livestock production in the period t,

y_{3t} … gross agriculture production in the period t,

x_{1t} … amount of subsidies,

x_{2t} … fundamental production funds in plant production,

x_{3t} … the amount of labour in plant production,

x_{4t} … weather condition,

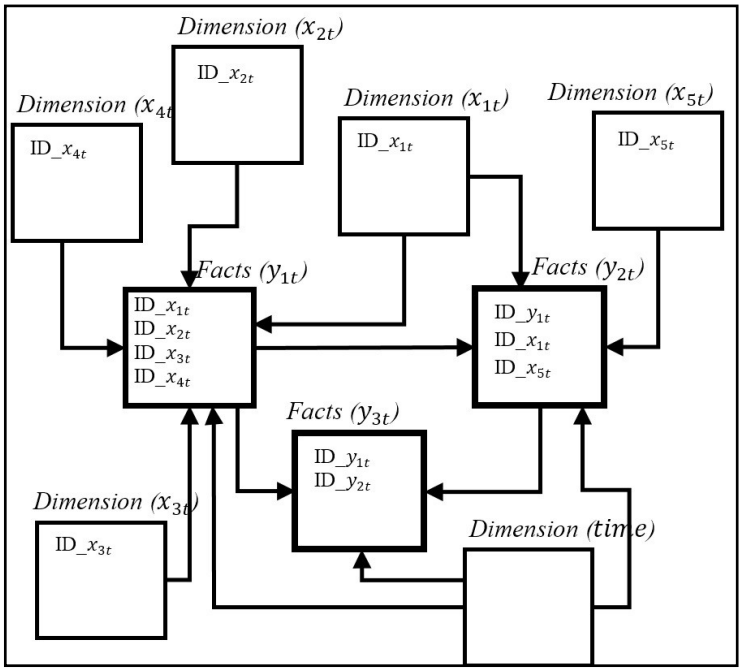
x_{5t} … livestock numbers,

u_{1t}, u_{2t} … random component in the period t,

In first phase is defined fact table into empty constellation scheme for gross agriculture production, gross plant production and gross livestock production (rule 1.1). In next steps are defined dimensions for every exogenous variable in econometric model (subsidies, plant production funds, labour amount in plant production, weather conditions, and number of livestock). If model (2) contain time variable *t,* we have to define time dimension into our model. In second phase (rule 2.1) is defined association between fact table and dimension by generated key. For example equation $y_{2t} = \beta_{21}\, y_{1t}\, \gamma_{21}\, x_{1t} + \gamma_{25}\, x_{5t} + u_{2t}$ express amount of subvention and number of livestock has relation with gross livestock production (fact table y_{2t}). Random parts u_{1t}, u_{2t} (eventually another different variables out of TEM-CM rules) cannot be transformed. For example in application context is such equation express in form: $y_{1t} = 3.45x_{1t} + 1.32x_{2t} + 1.07x_{3t} + 0.43x_{4t} + 284.36$. So random variables u_{1t}, u_{2t} and parameters β, γ are represented by numbers and it is not necessary to contain it to our scheme. Result of TEM-CM method is represented in figure 2.

Conclusion

In paper has been introduce new method TEM-CM for econometric model transformation into conceptual model (constellation scheme) by mathematical apparatus. TEM-CM method represent formalized rules. These rules are to automate the process of designing a conceptual model and streamline the decision-making for agricultural managers. Analytic system can be established with econometric support. Method TEM-CM provide formalized rules for conceptual model for analytic data in agriculture business. This method has impact on analytic expert systems and their application in agriculture. Method TEM-



Source: self-authored

Figure 2: Result of TEM-CM method.

CM represent partial method in whole OLAP design. In future research can be TEM-CM used for process design to make fully automated conceptual model. Questionable also remain current methods for designing logical and physical schema that will be also part of future research. The effort is to streamline and simplify the design process analytical systems with support of econometric for farms, especially considering the current high cost of investment in Business Intelligence.

Acknowledgements

The results and knowledge included herein have been obtained owing to support from the Internal grant agency of the Faculty of Economics and Management, Czech University of Life Sciences in Prague, grant no. 20141040, "New methods for support of managers in agriculture".

Corresponding author:
Ing. Jan Tyrychtr, Ph.D.
Department of Information Technologies, Faculty of Economics and Management
Czech University of Life Sciences in Prague, Kamýcká 129, Prague 6 – Suchdol, Czech Republic
E-mail: tyrychtr@pef.czu.cz

References

[1] Abelló, A., Romero, O. Encyclopedia of Database Systems. Ling L., Özsu, T. M. USA: Springer US, On-Line Analytical Processing. 2008, p. 1949-1954. ISBN 978-0-387-35544-3.

[2] Boulil, K., Le Ber, F., Bimonte, S., Grac, C., Cernesson, F. Multidimensional Modeling and Analysis of Large and Complex Watercourse Data: An OLAP-Based Solution. Ecological Informatics. 2014, vol. 24, p. 90-106. ISSN 1574-9541.

[3] Burstein, F., Holsapple, C. Handbook on decision support systems. 2008, Springer. ISBN 978-3-540-48712-8.

[4] García, S. C., Tamayo, J. E. I., Carbonell-Olivares, J., Cabrera, Y. P. Application of the Game Theory with Perfect Information to an Agricultural Company. Agricultural Economics. 2013, Vol. 59, No. 1. ISSN 0139-570X.

[5] Čechura, L. Estimation of Technical Efficiency in Czech Agriculture with Respect to Firm Heterogeneity. Agricultural Economics. 2010, Vol. 56, p. 183-191. ISSN 0139-570X.

[6] Čechura, L., Taussigová, T. Avian Influenza and Structural Change in the Czech Poultry Industry. Agricultural Economics. 2013, Vol. 59, No. 1. ISSN 0139-570X.

[7] Codd, E. F., Codd, S. B., Salley, C. T. Providing OLAP (on-Line Analytical Processing) to User-Analysts: An IT Mandate. 1993, Codd and Date, Vol. 32.

[8] Datta, A., Thomas, H. The Cube Data Model: A Conceptual Model and Algebra for on-Line Analytical Processing in Data Warehouses. Decision Support Systems. 1999, Vol. 27, No. 3, p. 289-301. ISSN 0975-8887.

[9] Fahrner, Ch. Vossen, G. A Survey of Database Design Transformations Based on the Entity-Relationship Model. Data & Knowledge Engineering. 1995, Vol. 15, No. 3, p. 213-250. ISSN 0169-023X.

[10] Felipe, J., Adams, F. G. "A Theory of Production" the Estimation of the Cobb-Douglas Function: A Retrospective View. Eastern Economic Journal. 2005, Vol. 31, No. 3, p. 427-445. ISSN 0094-5056.

[11] Kimball, R. The data warehouse lifecycle toolkit: expert methods for designing, developing, and deploying data warehouses. 1998, John Wiley & Sons. ISBN 978-0-471-25547-5.

[12] Kroupová, Z. Technická efektivnost ekologického zemědělství České republiky. Ekonomická Revue. 2010, Vol. 2, p. 61-73. ISSN 1212-3951.

[13] Lips, M., Schmid, D., Jan, P. Labour-use Pattern on Swiss Dairy Farms. Agricultural Economics. 2013, Vol. 59, No. 4. ISSN 0139-570X.

[14] Mylopoulos, J. Database design. 2009, Ling L., Özsu, T. M., Springer US, p. 708-710. ISBN 978-0-387-35544-3.

[15] Novotný, O., Pour, J., Slánský, D. Business Intelligence: Jak využít bohatství ve vašich datech. Prague: Grada Publishing, 2005. ISBN 80-247-1094-3.

[16] Pardillo, J., Mazón, J.-N., Trujillo, J. Extending OCL for OLAP Querying on Conceptual Multidimensional Models of Data Warehouses. Information Sciences. 2010, Vol. 180, No. 5, p. 584-601. ISSN 0020-0255.

[17] Pedersen, T. B. Encyclopedia of Database Systems. Ling L., Özsu, T. M. USA: Springer US, 2009a, Multidimensional Modeling, p. 1777-1784. ISBN 978-0-387-35544-3.

[18] Pedersen, T. B. Encyclopedia of Database Systems. Ling L., Özsu, T. M. USA: Springer US, 2009b, Cube, p. 538-539. ISBN 978-0-387-35544-3.

[19] Pedersen, T. B. Encyclopedia of Database Systems. Ling L., Özsu, T. M. USA: Springer US, 2009c, Dimension, p. 836-836. ISBN 978-0-387-35544-3.

[20] Rai, A., Dubey, V., Chaturvedi, K. K., Malhotra, P. K. Design and Development of Data Mart for Animal Resources. Computers and Electronics in Agriculture. 2008, vol. 64, No. 2, p. 111-119. ISSN 0168-1699.

[21] Schulze, Ch., Spilke, J., Lehner, W. Data Modeling for Precision Dairy Farming within the Competitive Field of Operational and Analytical Tasks. Computers and Electronics in Agriculture. 2007, Vol. 59, No. 1, p. 39-55. ISSN 0168-1699.

[22] Tvrdoň, J. Ekonometrie (Econometric). 2006, Prague. Czech University of Life Sciences Prague. ISBN 80-213-0819-2.

[23] Tyrychtr, J., Ulman, M., Vostrovský, V. Evaluation of the State of the Business Intelligence among Small Czech Farms. Agricultural Economics. 2015, Vol. 61, No. 2, p. 63-71. ISSN 0139-570X.

[24] Vassiliadis, P., Sellis, T. A Survey of Logical Models for OLAP Databases. ACM Sigmod Record. 1999, Vol. 28, No. 4, p. 64-69. ISSN 0163-5808.

Agris on-line Papers in Economics and Informatics

Volume VII Number 3, 2015

Human Resource Diversity Management in Selected Czech Agricultural Companies

H. Urbancová[1], H. Čermáková[2], M. Navrátilová[2]

[1] Department of Management, Faculty of Economics and Management, Czech University of Life Sciences Prague, Czech Republic

[2] Department of Trade and Accounting, Faculty of Economics and Management, Czech University of Life Sciences Prague, Czech Republic

Anotace

Cílem článku je zhodnocení diversity managementu v zemědělských podnicích v rámci České republiky a zpracovat soubor doporučujících opatření pro zkoumané zemědělské podniky v této oblasti. Zpracovávaná primární data byla získána v rámci kvantitativního výzkumu prostřednictvím dotazníkového šetření (n = 549, $n_{agriculture}$ = 108). Výsledky naznačují, že v rámci českých zemědělských podniků je využívání diversity managementu na relativně nízké úrovni (36,1 %; n_a = 108). Lze však usuzovat, že se aplikace diversity managementu v rámci agrárního sektoru, vzhledem k jeho specifické situaci v oblasti zaměstnanosti a zvláštnostem pracovní síly v zemědělství na trhu práce, stane v budoucnosti jednou z důležitých oblastí řízení zemědělského podniku.

Tento článek vznikl za podpory celouniverzitního grantu ČZU – CIGA, číslo 20141002 - Budování značky zaměstnavatele pomocí nových strategických trendů v organizacích v České republice.

Klíčová slova

Lidské zdroje, diversity management, zemědělství, Česká republika, pracovní síla, podnik.

Abstract

The aim of this paper is to evaluate human resource Diversity Management in agricultural companies in the Czech Republic and to prepare a set of recommendations for the companies in this area. The primary data for the study was obtained by the use of questionnaires designed for quantitative analysis (n = 549, $n_{agriculture}$ = 108). The results indicate that the use of Diversity Management on Czech companies is relatively low (36.1%; n_a = 108). But in view of the employment situation in the agricultural sector, as well as the characteristics of the workforce engaged in agriculture, it would appear that Diversity Management will become an important feature of company management in the not so distant future.

This contribution is a follow-up to the project of University – wide internal grant agency (CIGA), number 20141002 - Human resource branding using of the new strategic trends in organizations in the Czech Republic.

Key words

Human resources, Diversity Management, agriculture, the Czech Republic, labour fource, company.

Introduction

The current state of the world economy exhibits a high degree of globalization. We can see this in the continuously expanding internationalization of corporations', and other business companies', operations, as well as ever growing numbers of foreign born employees on companies' payrolls. At the same time, economic and social differences are deepening both within individual states, and among the states themselves. The demographic changes that have taken place over the past twenty years are having an impact on the economically developed countries. These states are experiencing low and decreasing birth rates (Gendron, 2011; Žnidaršič, Dimovski, 2009). At the same time, the lifespan in developed countries is increasing due to improved health care and progress in the development of medical treatment methods. The amount of time which young people spend

studying has also increased, which leads them to postpone the start of their working lives. Taken together, this could result in a shortage of qualified workers, as well as causing a crisis in retirement systems (Fiala, 2012). Such long-term adverse effects may be partially ameliorated by the application of new management concepts within companies. One of these is Diversity Management, which has been established as one of the more important trends of the twenty-first century. Managers in both public and private companies are searching for new ways to more effectively lead their employees. To this end they are experimenting with various management approaches in order to find the one that will permit them to react with greater efficiency to the growing diversity of today's workforce (Ivancevich, Gilbert, 2000).

The Diversity Management concept emphasizes the taking of employees' individual personal characteristics into account by company managers. These characteristics include the employees' gender, race, family status and age (Kramar, 2012). Each individual's level of competence, regardless of his/her personal characteristics, contribute to the success of the company. Cummings (2004) says that in structurally diverse work teams; i.e., those in which every individual may contribute his or her unique knowledge for the benefit of the whole; there is an increase in the amount of shared knowledge, thereby creating a synergy effect. An effective exchange of information and knowledge thus brings about greater efficiency, both within the company and in its surroundings.

In a broader context, Diversity Management may also focus on taking other personal characteristics into account, such as sexual orientation, physical and mental abilities; as well as differences within company work groups (Kramar, 2012). Applying Diversity Management within a company brings many positive results. In particular it brings increased prestige and social status, both in the eyes of the public and potential employees. This means ever greater chances for companies to attract and retain the new talent that comes with high quality human resources (Kearney, 2013; International Society for Diversity Management, 2007). According to Choi and Rainey (2010), Diversity Management may have an impact on the overall performance of a company, thus bringing the company a competitive advantage. Diversity Management also becomes a tool for improving employee motivation and creativity. This, in turn, contributes to the creation of innovative processes within the company (Kearney, 2013; International Society for Diversity Management, 2007).

Currently, Diversity Management is an integral part of HR management strategy in companies in all economic sectors. The agricultural sector is characterized by the specific long-term lowering of interest by potential candidates in open positions. This is also supported by data supplied by the Czech Statistics Office (CSO) in 2014, concerning employment statistics in the primary sector, specifically in the agricultural sector.

This paper evaluates human resource Diversity Management in agricultural companies in the Czech Republic and to prepare a set of recommendations for these agricultural companies in this area. The first part of the article presents theoretical background together with comparisons of secondary resources. The chapter Results and Discussion includes an analysis and synthesis of the survey targeted at Diversity Management in agrarian sector in the Czech Republic. A comparison of results with results of similar surveys conducted abroad and draft recommendations are also included in this chapter.

Theoretical background of the work

Falling employment has been characteristic for the agricultural sector since 1989. The year-on-year reduction of employees in agricultural concerns has also continued into 2013, when it stood at 1.8%. Agricultural employees represented 2.1% of the total workforce of the Czech Republic; a value identical to that of 2012 (Agricultural Chamber of the Czech Republic, 2014). The total number of people employed in agriculture, forestry and fisheries amounted to 149,600 persons in 2013; of which 105,300 were men and 44,300 were women, under the CZ NACE classification (CSO, 2013).

In 2009 the National Observatory of Employment and Training of the National Training Fund stated that in the coming years the percentage of people employed in the Czech agricultural sector would be comparable to that of the developed Western countries, accounting for 2.45% of the working population. So, from the point of view of future long term employment prospects, agriculture may be considered an area with relatively low employment opportunity potential. It is forecast that total employment in the agricultural sector will drop by approximately one quarter by 2020, compared to 2008 (CSO, 2014; National Observatory

of Employment and Training of the National Training Fund, 2009). In spite of this unfavourable outlook, and the minor role played by agriculture in the total performance of the national economy, this interesting sector is very important. Agriculture is a bearer of a number of functions not related to production, and agricultural facilities play an essential role in the development of rural areas.

Spěšná et al. (2009) state that, in spite of the anticipated future decrease in employment, the introduction of innovative management processes and trends would lead to increased demand for employees who have completed their secondary and tertiary education. According to the National Observatory of Employment and Training of the National Training Fund, current trends in agriculture show that it may be expected that employers will increase their requirements for higher, as well as a broader spectrum of, qualifications, particularly in the areas of biofuels, organic farming, as well as agro tourism.

In the study, Spěšná et al. (2009) state that over the long term, the situation in agriculture – focusing on diversity, and particularly employment – has been much less favourable to women. While the level of male unemployment has not significantly differed over the long term from the indicator value for the entire national sector; the level of unemployment of women in the agrarian sector was high in the period 2001-2008, and several times the level approached double the number of women unemployed within the entire national economy. The proportion of women in agriculture has oscillated around 30% over the long term (Agricultural Chamber of the Czech Republic, 2014; Agro-census, 2010). This is lower than the average proportion of women in employment in the entire national economy of the CR (43.5% in the 4th quarter 2013). It is also lower than the proportion of women employed in agriculture in EU (37.4% in EU27 in 2011). There has also been a reduction in the number of positions for women in the Czech agricultural sector, particularly in relation to the reduced scope of the manufacture of agricultural products; the traditional framework in which they (women) found employment (Agricultural Chamber of the Czech Republic, 2014).

The increasing age of the farming population is an issue not only in the CR, but also in most other European countries. In the 4th quarter of 2013, the greatest number of employees in the sector was, as usual, in the 45-59 age group (44.2%), followed by those in the 33-44 age group (33.8%). A smaller proportion was accounted for by employees in the youngest category; the 15-29 age group (11.7%), with the oldest employees (60+ age group) accounting for 10.3% of the farming population (Agricultural Chamber of the Czech Republic, 2014).

Year-on-year, the proportion of workers in the 15-29 age group increased slightly (by 1.2%), as it also did in the 30-44 age group (by 0.8%), and in the 60+ category (by 0.5%), while the proportion of workers in the 45-59 age group decreased (by 2.5%). Overall, the proportion of workers in the 45+ age group was 54.5% in the agricultural sector; whereas it came to 41.3% in the wider national economy, while this age group accounted for 40.2% of workers in the industrial sector, including construction. Although the proportion of employees in the 45+ age group has decreased by 2% year-on-year, the age structure of employees in the sector remains significantly more restricted than in the national economy, or in the manufacturing sector (Agricultural Chamber of the Czech Republic, 2014). Changing the age structure of agrarian employees thus is one of the most pressing tasks for the sector. In the 4th quarter of 2013, the proportion of women in the structure of employment in the agrarian sector amounted to 29.1% and increased by 1.6% year-on-year. In agriculture (including game management and related activities), this proportion amounted to 31.2% and increased by 0.6% (Agrarian Chamber of the Czech Republic, 2014). So, changing the age structure of agricultural employees is one of the most pressing tasks for that sector. In the 4th quarter of 2013, the proportion of women employed in the agricultural sector amounted to 29.1%, and has increased by 1.6%, year-on-year. In agriculture (including game management and related activities), this proportion amounted to 31.2%, and it has increased by 0.6% (Agrarian Chamber of the Czech Republic, 2014).

Since 2000, the proportion of foreigners employed in the agricultural sector has not changed significantly, even though the total number of employees of non-Czech origin has declined in the sector (Ministerstvo zemědělství, 2014). Overall, the number of foreigners employed in farming remains insignificant. In 2013, it accounted for only 2.2% of workers in the sector (CSO, 2013).

Based upon the facts above, the statistical correlation between the application of Diversity Management

in selected companies and the qualitative features identified in the theoretical basis were explored.

Materials and methods

Our data was mainly extracted from secondary sources, and our analysis and discussion are linked to the outcome synthesis, as well as the evaluation of the research results. The primary data used in the study was obtained as part of a quantitative research project, which was carried out using a questionnaire survey. The companies were selected on a random basis and the sample included n = 549 companies in all sectors as classified by CZ-NACE of which $n_{agriculture}$ = 108 were agricultural companies (primary sector). Randomly selected companies were contacted by e-mail. The questionnaire consisted of four parts that include 48 questions in total. Only the second part of questionnaire was on human resource Diversity management and the last part was focused on Classification questions. Most of the questions were closed questions.

In each company a single respondent was addressed. Questionnaires were filled out on behalf of individual companies by employees in managerial positions (with at least one direct subordinate), by a HR manager. Others who could fill the questionnaire were: the person responsible for HR management in the company, or a line manager. Company owners and middle or top-level managers also performed this task.

As of 30th June, 2014, a total of 108 companies had taken part in the research. Their structure is as follows:

- Classified by size, based upon the number of employees, this group of businesses included 73 small companies (68.2%) with up to 50 employees; along with 28 medium sized companies (26.2%) with 51 to 249 employees. 6 large agricultural concerns with 250 or more employees accounted for 5.6% of the total number of entities included in the survey.
- In terms of the share of ownership, the overwhelming majority of companies in the research was Czech (95.3%, i.e., 102 enterprises). Only 5 of them (4.7%) had a foreign majority shareholder, or shareholders. Most of the companies are located in the Central-Bohemia (44.4%); Prague (14.8%) and Ústí nad Labem regions (8.3%). The average for other regions was 2%.
- In 64.8% of the companies, more men are employed than women. Only in 15.7% of the companies did women prevail over men; while in 19.4% of the agricultural companies the proportion of women and men is equal. In 80.4% of the agricultural companies, more than 6% of the employees are older than 55. Only in 1.9% of them was the number of foreigners employed there greater than the number of Czechs.

The data were evaluated using the tools of descriptive statistics and the methods of comparison, induction, deduction, and synthesis. Descriptive statistics used to test t he results included absolute and relative frequency, correlation analysis, and a non-parametric Pearson Chi-square test. 2 null hypotheses were tested:

- $H_0$1: The use of human resource Diversity Management does not depend on the sector.
- $H_0$2: The use of human resource Diversity Management does not on sector size.

If the p–value calculated by means of the χ^2 test (Pearson Chi-Square) was lower than the selected level of significance $\alpha = 0.05$, null hypothesis was rejected (Hendl, 2012). The analysis was carried out using the IBM SPSS Statistic Desktop 22.

Results and discussion

This section contains the evaluation of the data, their interpretation, and recommendations. It focuses on the assessment of the current situation as regards the Diversity Management in Czech agricultural companies. The "Results" section is followed by the discussion and conclusions, which summarize the recommendations indicated by the results.

Because of the specific focus of Diversity Management on companies in agrarian sector, the relationship between the use of Diversity Management and the economy in general (n = 549) was determined. Statistics show that the p-value equals 0.006, and for this reason the null hypothesis may be rejected, and the alternative hypothesis that the feature exists may be accepted. The use of Diversity Management thus depends upon the sector (H01). The dependency strength (Cramer's V) is 0.136 (weak dependency). Therefore, Diversity Management is mostly used by companies in the tertiary sector, and it is used the least by those in the primary sector. This is because most agricultural enterprises are family businesses, traditional in nature, and, so, the employment of foreigners under conditions of Diversity

Management would not be pertinent.

The connection between the size of the company and the use of Diversity Management in Czech companies was also determined. The p-value is equal to 0.000, and the null hypothesis may thus be rejected and the alternative hypothesis accepted. The use of Diversity Management, therefore, depends upon sector size (H02). Dependency strength (Cramer's V) is 0.210 (weak dependency).

Evaluation of Diversity Management in Czech agricultural companies

The results show that only 36.1% of the agricultural companies addressed currently makes use of Diversity Management. Most agricultural companies have not paid much attention to the concept of Diversity Management, mainly because they have inadequate information. Only 15.7% of the agricultural companies addressed indicated that they, in fact, knew something about the concept of Diversity Management. Meanwhile, according to the Czech Statistics Office (2014), the lack of jobs in agriculture, and the employee structure by age and gender, clearly show the presence of employment issues on Czech agricultural companies. Table 1 shows the absolute frequency of agricultural companies' (according to size) use of Diversity Management.

Of the large agricultural companies, which participated in the research, 50% use Diversity Management in their personnel management practices. For medium size agricultural companies the figure is 42.9%, while only 32.4% of small agricultural companies use Diversity Management. These results show that the smaller the agricultural company, the less it focuses on Diversity Management. Agricultural companies are mostly only small family businesses (with up to 20 employees). For this reason, it may be deduced that they do not make much use of the Diversity Management strategy due to their having insufficient information at their disposal, as well as the existence of misconceptions about Diversity Management (e.g., that it is costly), in addition to its being time consuming. Table 2 summarizes the final number of agricultural company employees by gender.

Of the 29.4% of Czech agricultural companies that do use Diversity Management, women employees outnumber the men. 38.1% of Czech agricultural companies have an equal, or nearly so, number of women and men employees; while in 37% of agricultural companies, there are more men employees than women. Overall, within the set of agricultural companies selected for the survey, 15.7% of them employ more women. This slightly contradicts the data provided by Agro-census (2010), which indicates that the number of women employed in agriculture has been oscillating around 30% over the long term. This slight discrepancy may be due not only to the different time periods during which these independent studies were carried out, but also to the manner in which the agricultural companies were selected from the database maintained by the Agricultural Chamber of the Czech Republic. Statistics show that the correlation between the use of Diversity Management in selected

	Company size by the number of employees			Total
	Up to 50 employees	51-249 employees	250 + employees	
Yes	24 (32.4%)	12 (42.9%)	3 (50%)	39 (36.1%)
No	50 (67.6%)	16 (57.1)	3 (50%)	69 (63.9%)
Total	**74**	**28**	**6**	**108**

Source: own survey

Table 1: Application of Diversity Management in agricultural companies by number of employees.

	The proportion of men and women in agriculture			Total
	More women than men	50% : 50%	More men than women	
Yes	5 (29.4%)	8 (38.1%)	26 (37.1%)	39 (36.1%)
No	12 (70.6%)	13 (61.9%)	44 (62.9%)	69 (63.9%)
Total	**17**	**21**	**70**	**108**

Source: own survey

Table 2: Use of Diversity Management on Czech agricultural companies by employee gender.

agricultural companies and the proportion of men and women employed was not statistically significant (p-value=0.819). The use of Diversity Management according to the number of foreign born employees is depicted in Table 3.

The results clearly show that most workers (96.3%) on Czech agricultural companies are Czech. This is something which has also been confirmed by studies carried out by the Trade Union of Food and Agriculture Workers (2014) showing that foreigners account for only 2.2% of employees in the agricultural sector (CSO, 2013).

Another no less important aspect of Diversity Management in the agricultural sector is the employee structure. Table 4 provides a detailed breakdown of the employee composition on the agricultural companies which were studied.

The results show that people working in agriculture are mostly members of the older age group. 59.3% of the participating agricultural companies have more than 51% of their employees in the 55+ age group. These results support the statements of the Agricultural Chamber of the Czech Republic (2014) that the aging agricultural population is an issue which confronts not just the CR, but most other European countries. The research results agree with the official figures given by the Agricultural Chamber of the Czech Republic (2014), which state that the overall proportion of workers in the 45+ age group stands at 54.5% in the agricultural sector.

These facts show that the areas covered by Diversity Management (employee age, gender, number of foreign born employees, etc.) must be addressed, not only by the tertiary sector, where the situation is relatively positive, but it must also be dealt with by the primary sector, where the long-term prospects for the employment situation are problematic. This was confirmed by Spěšná et al. (2009), as well as by Urbancová and Hlavsa (2014).

Discussion

Total 33.3% of the participating agricultural companies have stated that Diversity Management gives them a competitive advantage. These were mainly small agricultural companies (80.6%). 69.4% of them employ mostly men.

Globalisation has an impact on all current economic processes. It is also reflected in the demographic changes, and for this reason, diversity should be taken into account in business companies in every sector of the economy. Diversity includes variety in the composition of the labour force, as well as

	Proportion of foreigners employed vs. Czechs			Total
	More Czechs	50% : 50%	More foreigners	
Yes	36 (34.6%)	2 (100%)	1 (50%)	39 (63.9%)
No	68 (65.4%)	0 (0%)	1 (50%)	69 (63.9%)
Total	**104**	**2**	**2**	**108**

Source: own survey

Table 3: The use of Diversity Management in agricultural concerns according to the number of foreign born employees.

Number of employees in category 55+	Diversity Management implemented		Total
	Yes	No	
0 - 5%	4	17	21
6 - 10%	7	9	16
11 - 15%	5	11	16
16 - 20%	7	9	16
21 - 30%	6	10	16
31 - 40%	4	5	9
41 - 50%	5	2	7
51% and more	1	6	7
Total	**39**	**69**	**108**

Source: own survey

Table 4: Use of Diversity Management in agricultural facilities by employee age structure.

eradicating discrimination (on grounds of age, race, gender, etc.), while emphasizing the various needs of customers and business partners.

Thus, this paper makes the following recommendations to agricultural companies:

- In terms of human resources, it is recommended that the focus be placed directly on work performance, and the work-related behaviour of employees, and that discrimination on the usual grounds (age, gender, race, etc.) be avoided.
- Concerning education, workshops should include themes related to Diversity Management. Kormanik and Rajan (2010) recommend paying attention primarily to higher level management. This is usually the instigator and bearer of corporate culture. Thus, a gradual implementation of Diversity Management practices in the economic life of every enterprise in all sectors of the economy may be anticipated.
- In terms of communication, emphasis must be placed upon active communication with employees about Diversity Management, taking their opinions into account, and making them active participants in important organizational decisions. This was confirmed in a study by Sabharwal (2014). This will increase employee self-confidence, personal commitment and feelings of loyalty for corporate policy.

The proposed recommendations cover the various areas of company management and their implementation at all levels of management must be taken into account. Introduction of these measures is conditional upon the company's ability to flexibly adapt to change, as well as upon a positive approach by management. Thus, diversity in the workplace may become a competitive advantage which will contribute to building up the employer's brand (Kormanik, Rajan, 2010).

Most enterprises operating in the agricultural sector will consider Diversity Management as being prestigious but, to some extent, also essential, given the specifics of employment in this sector. The abovementioned facts show that Diversity Management is a suitable, and important tool for HR management on agricultural companies. Therefore, it is advisable to pay attention to it in good time.

Conclusion

In the current competitive environment, Diversity Management may be considered one of the strategies which HR managers have at their disposal. The research results show that the use of Diversity Management depends upon the sector in which a given business operates (p-value = 0.006; Cramer's V = 0.136). It also depends upon the size of the particular business (p-value = 0.000; Cramer's V = 0.210). Regarding the agricultural sector, only 36.1% of the agricultural companies which participated in the research currently make use of Diversity Management. 33.3% of participating agricultural companies indicated that making use of Diversity Management leads to their acquiring a competitive advantage. They were particularly small businesses (80.6%), of which 69.4% were agricultural companies employing mostly men. It must be noted that appreciating and supporting the human potential of each person in a diverse workforce is an economic and social benefit for every business. It is also something that reinforces the employer's brand.

The theoretical benefit of this paper is the verification and support which it offers for the theoretical requirements for introducing Diversity Management into the agricultural sector. On the practical level, this paper presents results obtained from the 108 agricultural companies which were observed, as well as recommending a set of measures to be taken by agricultural companies which are still only in the planning stages of introducing the Diversity Management concept.

Acknowledgements

This contribution is a follow-up to the project of University – wide internal grant agency (CIGA), number 20141002 - Human resource branding using of the new strategic trends in organizations in the Czech Republic.

Corresponding author:
Ing. Hana Urbancová, Ph.D.
Department of Management, Faculty of Economics and Management,
Czech University of Life Sciences Prague, Kamýcká 129, 165 21 Prague 6, Czech Republic
Phone: +420 22438 2026, E-mail: urbancova@pef.czu.cz

References

[1] Agrarian Chamber of the Czech Republic, Souhrn ke zprávě o stavu zemědělství za rok 2013, [Online]. [cit. 2015-01-29]. Available: http://www.apic-ak.cz/data_ak/14/l/pr/ZelZprava2013.pdf [Accessed: 15 Jan. 2014].

[2] Agrocenzus 2010, Počty zemědělců klesají, Czech Statistical Office, August 2011. [Online]. Available: http://www.czso.cz/csu/tz.nsf/i/agrocenzus_2010 [Actualized: 26. 8. 2011] [Acessed: 10 Jan. 2015].

[3] Czech Statistical Office, Klasifikace ekonomických činností (CZ-NACE), [Online]. Available: http://www.czso.cz/csu/klasifik.nsf/i/klasifikace_ekonomickych_cinnosti_(cz_nace) [Actualized: 18.9.2014] [Acessed: 10 Jan. 2015].

[4] Cummings, J. N. Work groups, structural diversity, and knowledge sharing in a global organization. Management science. 2004, Vol. 50, No. 3, p. 352 – 364. ISSN 1526-5501.

[5] D'Netto, B., Shen, J., Chelliah, J., Manjit, M. Human resource diversity management practices in the Australian manufacturing sector, The International Journal of Human Resource Management. 2015, Vol. 25, No. 9, p. 1243-1266. ISSN 0958-5192.

[6] Fiala, T., Langhamrová, J., Miskolczi, M., Pavlík, Z. Vývoj některých demoekonomických charakteristik zohledňujících zvyšování důchodového věku v ČR. RELIK 2012 Reprodukce lidského kapitálu - vzájemné vazby a souvislosti. Slaný: Melandrium, 2012. ISBN 978-80-86175-82-9.

[7] Gendron, B. Older workers and active ageing in France: the changing early retirement and company approach. The International Journal of Human Resource Management. 2011, Vol. 22, No. 6, p. 1221 - 1231. ISSN 0958-5192.

[8] Hendl, J. Přehled statistických metod: analýza a metaanalýza dat. 4., enlarged ed., Prague: Portál, 2012, ISBN 978-80-262-0200-4.

[9] Choi, S., Rainey, H. G. Managing Diversity in U.S. Federal Agencies: Effects of Diversity and Diversity Management on Employee Perceptions of Organizational Performance. Public Administration Review. 2010, Vol. 70, No. 1, p. 109 – 121. ISSN 0033-3352.

[10] International Society for Diversity Management, Diversity Management: Training Manual, Idm - International Society for Diversity Management, Sep. 2007 [Online]. Available: http://www.idm-diversity.org/files/EU0708-TrainingManual-cs.pdf [Accessed: 21 Jan. 2015].

[11] Ivancevich, J. M., Gilbert, J. A. Diversity Management Time for a New Approach. Public Personnel Management. 2000, Vol. 29, No. 1, p. 75-92. ISSN 0091-0260.

[12] Kramar, R. Diversity management in Australia: a mosaic of concepts, practice and rhetoric. Asia Pacific Journal of Human Resources. 2012, Vol. 50, No. 2, p. 245 – 261. ISSN 1744-7941.

[13] Kearney, E. Diversity und Innovation. Kreativität, Innovation, Entrepreneurship. Germany: Springer Fachmedien Wiesbaden, 2013, p. 193-213. ISBN 978-3-658-02551-9.

[14] Kormanik, M. B., Rajan, H. Ch. Implications for Diversity in the HRD Curriculum Drawn From Current Organizational Practices on Addressing Workforce Diversity in Management Training. Advances in Developing Human Resources. 2010, Vol. 12, No. 3, p. 367-384. ISSN 1552-3055.

[15] National Observatory of Employment and Training of the National Training Fund. Předvídání kvalifikačních potřeb trhu práce. Prague: Linde nakladatelství, s.r.o., 2009. ISBN 978-808-6131-849.

[16] Ministry of Agriculture. Zemědělská výroba [Online]. Available at: http://eagri.cz/public/web/mze/zemedelstvi/ [Accessed: 5 June 2015].

[17] Sabharwal, M. Is Diversity Management Sufficient? Organizational Inclusion to Further Performance. Public Personnel Management. 2014, vol. 43, No. 2, p. 197-217. ISSN 0091-0260.

[18] Spěšná, D., Pospěch, D., Delín, M., Nohel, F., Drlík, J. Agrární trh práce: (research study). Prague: Institute of Agricultural Economics and Information, 2009. ISBN 978-808-6671-703.

[19] Urbancová, H., Hlavsa, T. Age Management Principles in Czech Agrarian Sector. AGRIS on-line Papers in Economics and Informatics. Prague: Faculty of Economics and Management, Czech University of Life Sciences Prague, 2014, Vol. 6, No. 3, p. 93-102. ISSN 1804-1930.

[20] Žnidaršič, J., Dimovski, V. Retaining Older Workers: Fields of Action–Constituting A Comprehensive Age Management Model. Journal of Applied Business Research. 2009, Vol. 25, No. 4, p. 85 – 97. ISSN 2157-8834.

Agris on-line Papers in Economics and Informatics

Volume VII Number 3, 2015

Differences in the Economic Situation of Organic and Conventional Winemaking Enterprises

E. Vlašicová, Z. Náglová

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

Anotace

Stejně jako se v České republice rozrůstá základna ekologických zemědělců, také ekologičtí vinaři a biovíno získávají na významu. Článek se zabývá hodnocením a srovnáním ekonomické situace ekologických a konvenčních vinařských podniků v České republice. Mezi lety 2007 a 2011 byla na účetních datech 75 vinařských podniků provedena ekonomická analýza, tj. byly vypočteny ukazatele finanční analýzy, bankrotní modely, ukazatel efektivnosti a ukazatele používané pro hodnocení výkonnosti podniků. Pro porovnání hodnot daných ekonomických ukazatelů mezi konvenčními a ekologickými podniky byl použit t-test. Analýza prokázala lepší ekonomickou situaci ekologických vinařských podniků. Vinařské podniky, ať už ekologické, či konvenční, by měly být schopny hospodařit a generovat zisk i bez dotací.

Článek vznikl v rámci řešení projektu IGA 20141046.

Klíčová slova

Vinařství, ekonomická analýza, t-test, dotace.

Abstract

The number of organic farms in the Czech Republic is increasing as well as the number of organic winemaking enterprises. The article deals with an evaluation and comparison of the economic situation of organic and conventional winemaking enterprises in the Czech Republic. An economic analysis of the 75 enterprises accounting data from 2007 to 2011 has been done. The financial analysis indicators, bankruptcy models, efficiency indicator and performance indicators were calculated. In order to compare the values of the respective indicators the t-test was used. The performed analysis confirmed a better economic situation of organic winemaking enterprises. Winemaking businesses – whether organic or conventional – are capable of a good financial management and generate profit even without the aid of any subsidies.

This article was created as a part of IGA 20141046 project.

Key words

Wineries, economic analysis, t-test, subsidies.

Introduction

Vine growing and wine production in some parts of the Czech Republic, especially in southern Moravia, is not only an important part of traditional and cultural practices, but it also significantly contributes to local and regional economies. The current production potential of the Czech Republic is almost 20 thousand hectares of vineyards, however, 17.5 thousand hectares have been utilised. The base of organic farmers as well as the number of organically cultivating winemaking enterprises has been growing. According to the Public Land Register, more than 1,000 ha of organic vineyards are currently registered, which is ca. 6% of vineyards in the Czech Republic. In 2011 the area of organically cultivated vineyards was half as low.

Wine production in the Czech Republic between 2000 and 2013 was 560 thousands of hectolitres in average, two thirds of which consisted of white wine and one-third of red wine. The annual wine consumption per capita in the Czech Republic continues to grow, currently ranging around 20 litres. „The Czech Republic belongs to the wine-producing countries that are predominantly dependent on imports

of this commodity. Approximately one third of the consumed wine volume originates from the home production of the Czech Republic and two thirds are imported.“ (Tomšík and Sedlo, 2013).

Several authors are involved in research of the winemaking sector in the Czech Republic (and elsewhere). Tomšík and Sedlo (2013) analysed production, consumption, export and import of Czech wine. Chládková et al. (2009) or Pyšný et al. (2007) identified the main indicators affecting the trends in demand for wine. In previous years several surveys were performed dealing with wine production and consumption in the Czech Republic, e.g. Šperková and Duda (2009), Sedlo and Tomšík (2012), Hejmalová et al. (2011), Hincl (2012), Kučerová (2014). Hambálková (2006), Kučerová and Žufan (2008), Tomšík and Prokeš (2011a; 2011b), Šperková and Skýpalová (2012), or Vanka and Hejman (2013) examined the winemaking sector from the point of view of methods used in management or marketing. Šperková and Ulbrich (2013) analysed the impact of historical winemaking factors on the current development of the wine sector in the Czech Republic. Koráb (2012), Unwin (2012), Meloni and Swinen (2012) studied the winemaking and winegrowing policies.

Giraud-Héraud and Pichery (2013) wrote a book, which is a summary of scientific articles written by experts from around the world dealing with the economic aspects of the wine sector. Náglová et al. (2014) dealt with the issue from the point of view of a company’s economy. These authors explored the impact of capital structure indicators on the economic result of winemaking enterprises.

Development of organic winemaking induces issues concerning the economic efficiency of organic winemaking enterprises. Apart from Náglová’s et al. (2014) study, winemaking enterprises have not been detailed examined with regard to their economic or financial situation. The article aims at evaluating and comparing the economic situation of organic and conventional winemaking enterprises. It is a highly specific issue filling in the gap in the area of economic research of winemaking enterprises. The results of the research may be useful for policy makers as well as for the actual wineries, or for the new entrepreneurs in the wine sector.

Based on previous researches dealing with the differences between conventional and organic farming, such as Brožová (2011), Kroupová and Malý (2010), Delbridge et al. (2013) or Lobley et al. (2009), we assumed different economic results in the economic situation of organic and conventional winemaking enterprises.

Materials and methods

The financial data was obtained from the Albertina database, according to the Classification of Economic Activities (CZ-NACE), the groups “Wine Production from Wine Grapes” (Section C, Class 11.02) and “Grapes Growing” (Section A, Class 01.21) were selected. The missing accounting data was added from the Public Register and the Collection of Deeds administered by the Ministry of Justice. The accountancy data was combined with information from the Register of Organic Farmers and data from the Subsidies Recipients Register (both registers are administrated by the Czech Ministry of Agriculture). The acreage data of enterprises was gathered from the Subsidies Recipients Register and Public Land Register (also administrated by the Czech Ministry of Agriculture).

The total number of winemaking and winegrowing holdings in the Czech Republic is about 11 000 of which 98% are natural persons, however, 60% of the Czech vineyards are utilised by legal persons. According to the survey of vineyards performed by Czech Statistical Office in 2009, the total number of legal persons was 231.

The final sample of the Czech winemaking and winegrowing enterprises (hereinafter jointly referred to as winemaking enterprises) was selected on the basis of the entirety of all data and information necessary for analysis. Therefore we had a balanced dataset because all of the data in each year were observed. All of the selected enterprises were the legal persons. In total, we selected 75 winemaking enterprises (i.e. 32% of the legal persons in the Czech Republic), which had been receiving subsidies either from the EU, or from the Czech national grants from 2007 to 2011. From these, 65 enterprises were conventional and 10 organic.

We performed an analysis of the economic situation of organic and conventional winemaking enterprises using the financial analysis indicators, economic efficiency indicator and performance indicators. All of the indicators were calculated for each enterprise and for each year (2007-2011), however, for purposes of the article the average values of these indicators per every year were used.

The financial analysis methods used included: profitability ratios (return on assets - ROA, return

on sales - ROS and return on equity - ROE), leverage ratios (total debt to total assets, equity ratio, time interest earned ratio and interest expenses to EBIT), liquidity ratios (current ratio, quick assets ratio and cash position ratio), activity ratios (creditors payment ratios, average collection period, inventory turnover and assets turnover) and bankruptcy models (Altman's model, IN95, G index, Ch index). For more details about this models and their construction see Altman (1968), Neumaierová and Neumaier (2002), Gurčík (2002) and Chrastinová (1998). Efficiency of winemaking enterprises (economic efficiency indicator) was calculated as a ratio of costs to revenues. As the performance indicators were used: total costs, operating costs, production consumption, personal expenses, total revenues, operating revenues, sales, production, profit, EBIT (earnings before interest and taxes), added value and subsidies. The performance indicators were recalculated per hectare of agricultural land.

Statistical testing was used to compare the values of above mentioned indicators. Normality of distribution for each indicator was verified by the Shapiro-Wilk test. Data had the normal distribution. The Levene's test for assessing the equality of variances was used. An independent t-test at 5% and 10% statistical significance was used for comparison the individual indicators between the conventional and organic winemaking enterprises.

All the tables show for each indicator: median, minimum value, maximum value, 2011 to 2007 percentage change, arithmetic mean, standard deviation, standard error and t values and p-values of the t-test. The number of observation (N) was for each indicator 5 due to the fact that the average values of indicators were used for each year of the time period 2007-2011 (N value was in the tables omitted).

SPSS programme was used for the analysis.

Results and discussion

Table 1 captures the results of selected indicators of the financial analysis. Profitability ratios were decreasing in time for both organic and conventional winemaking enterprises. However, the drop was more visible for conventional enterprises. Statistically significant difference on 10% significance level was confirmed in ROS of organic and conventional enterprises. Higher ROS was achieved by organic farms thanks to higher profit, which is a proof of their more favourable economic situation.

Differences on 10% significance level are visible for total debt to total assets ratio. This leverage ratio is decreasing in time in the case of organic winemakers. It is also somewhat lower than the leverage ratio of conventional enterprises. The leverage ratio of non-organic enterprises is higher and growing in time. However, in both cases total debt to total assets ratio ranges within the recommended values - up to 60% (Knápková et al., 2013). Statistically significant differences on 5% significance level were confirmed for time interest earned ratio and interest expenses to EBIT ratio. Organic winemakers are able to better cover interest expenses by their profit (in average profit exceeds these interests 28.44 times). Organic winemakers can be considered as financially stable. Conventional enterprises are also able to cover the interests. The minimum value of time interest earned ratio is 5 (according to Knápková et al., 2013), it means that profit should exceed interest expenses 5 times. In average, interest expenses draw 4% from the profit of organic enterprises and 14% from the profit of conventional enterprises. The ideal value of interest expenses to EBIT is up to 10% (Synek et al., 2011).

In the area of liquidity both categories of enterprises show similar results. However, slightly better values are again achieved by organic enterprises and the indicator values are growing in time. Current ratio and quick asset ratio is deteriorating in the case of conventional enterprises. Both groups of enterprises have normal average values of current ratio (the recommended values of this indicator should be between 1.5 and 2.5). On the other hand,from the quick assets ratio point of view, organic and conventional winemaking companies are slightly below the suggested limit, which should be between 1 and 1.5 (organic enterprises have 0.93 and conventional businesses have 0.91). Based on the cash position ratio results, both groups of winemakers presumably have a problem with paying their liabilities, since the recommended values may range from 0.2 to 0.5, but the organic companies' average value of this indicator is 0.14 and in the case of conventional enterprises it is 0.1. The recommended values of liquidity ratios were obtained from Knápková et al. (2013).

Organic winemakers are able to pay their debts earlier (in 152 days in average) than conventional winemakers (in 160 days). The values of this indicator statistically significantly differ between the analysed groups of enterprises on 10%

significance level. The sales achieved by organic enterprises contribute to better values of this indicator. Better solvency is also evidenced by the liquidity ratio values that are also higher in case of organic winemakers.

Organic winemakers collect their receivables in 119 days in average (conventional enterprises in 125 days). Statistically significant differences were proved for the assets turnover ratio on 5% significance level. Higher assets turnover ratios are reported by businesses of organic winemakers due to higher value of assets that reflect better equipment or higher investment activity of these enterprises.

Although the results of the t-test showed the significant differences between the bankruptcy models indicator's values, both groups of enterprises had the same results (see the note under table 2). Altman's model and Index IN95 assessed these enterprises as thriving. Ch index and G index classified organic and conventional winemaking enterprises in the grey zone. The grey zone means that the situation, in which enterprises are, cannot be clearly defined. More information and results of particular models are shown in Table 2.

Based on the economic efficiency indicator (see Table 3), both examined groups of winemaking enterprises – organic and conventional – are evaluated as efficient, since their revenues

Indicator	Group	Median	Min. value	Max. value	11/07 % change	Ar. mean	Std. dev.	Std. error	t-test	
									t	p-value
Profitability ratios										
ROA (%)	Org.	4.32	3.42	8.88	-19.95	5.82	2.52	1.13	1.862	.134
	Conv.	3.74	3.22	4.11	-21.65	3.70	0.33	0.15		
ROS (%)	Org.	6.28	5.59	12.27	-11.08	8.29	3.20	1.43	2.407	.072
	Conv.	4.83	4.42	5.36	-17.44	4.83	0.35	0.16		
ROE (%)	Org.	9.04	7.18	16.23	-4.32	11.29	4.17	1.87	1.903	.129
	Conv.	7.73	7.28	8.21	-6.74	7.72	0.33	0.15		
Leverage ratios										
Total debt to total assets (%)	Org.	40.90	19.27	51.45	-62.55	39.70	12.59	5.63	-2.056	.074
	Conv.	50.09	49.58	57.51	15.99	51.66	3.32	1.48		
Equity ratio (%)	Org.	50.66	39.59	60.12	-16.33	51.11	8.28	3.70	0.797	.448
	Conv.	49.55	42.04	50.04	-15.99	47.93	3.35	1.50		
Time interest earned ratio	Org.	24.81	15.24	50.47	42.34	28.44	13.42	6.00	3.489	.024
	Conv.	7.37	6.01	9.40	-20.57	7.41	1.26	0.56		
Interest exp. to EBIT (%)	Org.	4.03	1.98	6.56	-29.75	4.10	1.69	0.76	-7.830	.000
	Conv.	13.57	10.63	16.65	25.89	13.79	2.19	0.98		
Liquidity ratios										
Current ratio	Org.	2.09	1.79	2.44	36.23	2.05	0.27	0.12	1.932	.089
	Conv.	1.83	1.64	1.91	-14.40	1.80	0.10	0.05		
Quick assets ratio	Org.	0.93	0.80	1.05	16.94	0.93	0.11	0.05	0.368	.723
	Conv.	0.93	0.71	1.01	-27.10	0.91	0.12	0.05		
Cash position ratio	Org.	0.13	0.07	0.21	173.41	0.14	0.06	0.03	1.224	.256
	Conv.	0.10	0.07	0.15	26.41	0.10	0.03	0.01		
Activity ratios										
Creditors payment period	Org.	143.91	132.86	176.84	-18.62	151.69	18.79	8.40	-1.023	.354
	Conv.	163.33	152.31	167.07	6.49	160.78	6.50	2.90		
Average coll. period	Org.	124.64	103.59	127.78	-18.93	118.71	11.09	4.96	-0.610	.559
	Conv.	129.35	96.84	136.91	-27.99	124.06	16.16	7.23		
Inventory turnover	Org.	156.11	139.45	216.73	23.44	168.18	30.05	13.44	1.728	.122
	Conv.	146.10	126.06	153.28	5.26	143.64	10.30	4.61		
Assets turnover	Org.	512.63	500.30	595.78	11.08	529.90	39.38	17.61	2.843	.022
	Conv.	470.99	467.22	501.50	5.38	476.60	14.36	6.42		

Source: own processing

Table 1: Financial analysis of organic and conventional winemaking enterprises.

Indicator	Group	Median	Min. value	Max. value	11/07 % change	Ar. mean	Std. dev.	Std. error	t-test	
									t	p-value
Altman's model	Org.	4.34	4.03	4.61	14.23	4.29	0.25	0.11	43.658	.000
	Conv.	-1.04	-1.25	-0.95	21.07	-1.07	0.11	0.05		
IN95	Org.	3.18	3.01	3.24	-5.34	3.14	0.10	0.04	8.952	.000
	Conv.	0.03	-1.55	0.58	-368.05	-0.17	0.82	0.37		
Ch index	Org.	0.36	0.31	0.37	-13.06	0.35	0.02	0.01	3.964	.004
	Conv.	0.25	0.23	0.32	-2.01	0.27	0.04	0.02		
G index	Org.	0.31	0.09	0.39	-72.00	0.28	0.12	0.05	6.315	.000
	Conv.	-1.18	-2.45	-1.04	135.03	-1.42	0.59	0.26		

Note: Rating scale for Altman: Z>2.9 thriving; 1.23< Z<2.9 grey zone; Z<1.23 risk of bankruptcy. For IN95: IN95>2 no problems with paying liabilities; 1<IN95<2 grey zone; IN95<1 problems with paying liabilities. For Ch index: Ch>2.5 thriving; 2.5>Ch>-5 grey zone; Ch<-5 risk of bankruptcy. For G index: G>1.8 thriving; 1.8>G>-0.6 grey zone; G< -0.6 risk of bankruptcy.

Source: own processing

Table 2: Bankruptcy models of organic and conventional winemaking enterprises.

Indicator	Group	Median	Min. value	Max. value	11/07 % change	Ar. mean	Std. dev.	Std. error	t-test	
									t	p-value
Economic efficiency (%)	Org.	109.47	106.21	116.57	-2.97	111.31	4.52	2.02	2.296	.082
	Conv.	106.67	106.14	107.18	0.48	106.65	0.37	0.17		

Source: own processing

Table 3: Economic efficiency of organic and conventional winemaking enterprises.

in all examined years exceeded their costs. Organic farms were on average in the given time series by 4% more efficient than conventional businesses. The development of the indicator for conventional farms can be described as constant, while the economic efficiency of organic farms varied between 2007 and 2011. The statistically significant difference between organic and conventional enterprises in the economic efficiency indicator can be seen on 10% significance level.

The results of performance indicators are shown in Table 4. On 5% level of significance we can state a significant difference between organic and conventional winemakers in the total revenues, operating revenues and production parameter. On 10% level of significance we observed significant differences in operating costs, production consumption, sales, profit, EBIT and added value.

The average total costs of an organic winemaking enterprise per hectare of vineyard or hectare of agricultural land are 1,227 thousand CZK and average total costs of a conventional enterprise are 1,139 thousand CZK per hectare. The higher total costs of organic enterprise are caused by the higher production consumption (especially by consumption of material and energy). However, the difference is not significant. The share of production consumption in total costs of both groups of winemaking enterprises is 75%, the share of personal expenses is 10% and the share of consumption of material and energy is 50%. The average costs of viticulture (costs of running a vineyard) are around 100 thousand CZK annually (Sedlo, 2009) and in the case of organic winemakers it is approximately 10% higher. Moreover, the yield of hectare of organic vineyard is lower than the conventional one. For instance, according to Ministry of Agriculture, the national average vineyard hectare yield in 2011 was 5.7 tonnes per hectare, whereas the organic vineyard produced approximately 3.4 tonnes of grapes per hectare. Nevertheless, the costs of growing grapes do not constitute a major share in the total cost. According to the Ministry of Agriculture (2012) only about 20% of Czech wine producers are involved in winegrowing and in-house processing of the harvested grapes without purchasing additional grapes from other winegrowing businesses (the survey was performed on a sample of 100 enterprises). Some companies are more focused on production of grapes for further sale while other specialize in winemaking and purchase grapes. Other activities generating costs and later also revenues are related to processing of vine and grapes, production of wine, promotion and distribution, and activities related to gastronomy and tourism.

The average total revenues of winemaking enterprises are 1,364 thousand CZK/ha

Indicator	Group	Median	Min. value	Max. value	11/07 % change	Ar. mean	Std. dev.	Std. error	t-test	
									t	p-value
Total costs	Org.	1209.81	1099.50	1364.60	24.11	1227.17	98.97	44.26	1.790	0.111
	Conv.	1118.97	1090.72	1190.48	-8.26	1139.45	46.98	21.01		
Operating costs	Org.	1196.71	1084.53	1353.91	24.84	1215.87	100.54	44.96	2.083	0.071
	Conv.	1093.85	1064.97	1164.54	-7.90	1113.58	44.20	19.76		
Production consumption	Org.	902.61	796.86	1032.72	29.60	908.20	83.92	37.53	2.051	0.074
	Conv.	811.60	801.99	875.15	8.48	826.35	30.30	13.55		
Personal expenses	Org.	135.63	109.94	138.80	26.26	128.49	12.84	5.74	-0.699	0.504
	Conv.	133.05	117.99	150.57	27.61	133.96	11.92	5.33		
Total revenues	Org.	1385.09	1203.57	1449.37	20.42	1364.23	93.64	41.88	3.180	0.013
	Conv.	1192.12	1169.04	1268.29	-7.83	1215.11	47.16	21.09		
Operating revenues	Org.	1377.62	1187.82	1442.39	21.43	1350.48	95.96	42.92	3.168	0.013
	Conv.	1181.87	1160.66	1247.95	-6.92	1201.93	42.24	18.89		
Sales	Org.	1256.76	1055.13	1362.19	14.72	1244.80	122.52	54.79	1.873	0.098
	Conv.	1148.45	1110.14	1168.54	4.11	1140.02	25.21	11.28		
Production	Org.	1213.78	1036.59	1268.11	22.34	1189.69	88.98	39.79	3.311	0.011
	Conv.	1051.88	1020.84	1096.55	-3.43	1050.67	29.98	13.41		
Profit	Org.	82.64	66.29	164.30	2.01	104.49	45.41	20.31	2.432	0.071
	Conv.	54.85	51.13	59.49	-14.05	54.98	3.02	1.35		
EBIT	Org.	112.61	88.48	186.59	-14.34	134.61	46.22	20.67	2.225	0.089
	Conv.	88.02	83.41	95.69	5.52	88.35	5.08	2.27		
Added value	Org.	337.99	267.62	346.15	3.85	313.63	37.61	16.82	2.473	0.052
	Conv.	272.79	243.64	285.58	2.15	268.18	16.57	7.41		
Subsidies	Org.	49.45	21.98	78.77	-72.10	48.78	23.62	10.56	1.759	0.117
	Conv.	28.65	17.46	38.77	-39.06	29.00	8.60	3.85		

Note: All indicators were recalculated per hectare of agricultural land.

Source: own processing

Table 4: Performance indicators of organic and conventional winemaking enterprises.

for organic enterprises and 1,215 thousand CZK/ha for conventional enterprises. The share of production in these revenues is 87% for organic and 86% for conventional enterprises. The difference between the evaluated groups of companies is obvious in the profit indicator (but not statistically significant). Organic winemaking enterprises achieve almost twice as high average annual profit per hectare (104 thousand CZK/ha) as conventional enterprises (55 thousand CZK/ha). The average annual added value of organic enterprises is 50 thousand CZK per hectare higher than that of conventional enterprises (average added value of organic winemaking enterprises is 314 thousand CZK/ha, whereas by conventional it is 264 thousand CZK/ha). The higher profit of organic winemaking enterprises is mainly due to the better quality of wine, which is on the market for higher prices sold. Furthermore, organic enterprises more tend to diversification their activities that can insure them, for instance, against a loss caused by natural and climatic conditions.

The differences are noticeable for the subsidies parameter too, however, regarding to the t-test, the differences are not statistically significant. Organic winemaking enterprises have average subsidies per hectare of almost 49 thousand CZK, while conventional winemaking enterprises annually received by 20 thousand CZK less of subsidies in average. In addition to subsidies, which are intended for winemakers, organic enterprises may also apply for a higher amount of subsidies than conventional businesses, in particular the support for organic farming, which is part of the Agri-environmental measure of the Rural Development Programme. Subsidies allocated to support organic agriculture are intended to compensate for the higher positive externalities induced by organic farming in comparison with conventional agriculture, and to pay for internalization of negative externalities. Due to the existence of positive externalities a lower quantity of goods is produced than what is required for social welfare (Soukupová et al., 2004;

Kroupová and Malý, 2010).

Both groups of companies are able to cover their production consumption and personal expenses by the generated output. We can state that winemaking enterprises are able to financially manage and generate profit even without the aid of subsidies, because after removing agricultural subsidies from economy of these enterprises, a certain reserve in profit still remains for both organic and conventional winemaking enterprises, however, their profit was decreased ca. by 50%. Kroupová and Malý (2010) observed during modelling of organic farming with and without subsidies, that subsidies directed to organic enterprises have a negative impact on the profit of these companies. Organic enterprises receiving subsidies may eventually achieve by 15% lower profit than had they not received any subsidies. Subsidies provided to organic enterprises may also increase the level of costs and reduce technical efficiency. However, we have not done any deeper analysis related to subsidies impact on the economic situation of winemaking enterprises. Therefore we cannot claim that subsidies can be removed in the case of winemaking enterprises. For this reason, a questionnaire survey or interviews with winemaking enterprises should be done. The survey could bring more data as well as information about the subsidies usage, such as for what purposes they were used and whether they were used effectively, or whether subsidies brought winemakers what they expected.

When comparing winemaking and winegrowing enterprises with agricultural businesses, we can say that winemaking enterprises are economically more efficient than businesses focusing on the production and processing of agricultural commodities (except wine and wine grapes), (authors' own research or can be compared with data from FADN, or e.g. with the results Lososová and Zdeněk, 2014). It would thus seem advisable for agricultural business to try to diversify their agricultural commodities and include production of grapes. However, a detailed analysis of the economy of grape production indicated that winegrowing is unprofitable, the purchase prices of grapes are not high enough and the return per hectare of grapes fluctuates year-on-year (authors' own research or e.g. Sedlo, 2009; Ministry of Agriculture, 2012). Due to this reason winemaking and winegrowing enterprises diversify their activities and often add some services to their production, e.g. accommodation, hospitality and retail (authors' own research).

Conclusion

Certain differences in the economic situation of organic winemaking enterprises and conventional winemaking enterprises were observed. Organic winemaking enterprises have a slightly better economic situation. Their profitability and solvency are higher and indebtedness is lower. Organic winemaking enterprises have a higher economic efficiency indicator as well as all of the performance indicators. Their profit and subsidies per hectare are almost twice as high. Both groups of winemaking enterprises were assessed as thriving according to the Altman's model and Index IN95, however, Ch index and G index classified them in the grey zone.

Winemaking business – whether organic or conventional – are capable of good financial management and generate profit even without the aid of any subsidies. Nevertheless, a deeper analysis related to subsidies impact on the economic situation of winemaking enterprises may be done. We suggest performing a deep questionnaire survey or interviews with winemaking enterprises about their economic situation. The survey could bring more data as well as information about the subsidies, input or output usage.

We recommend adding into the Czech Winemakers Association survey more enterprises (annually they collect data from 100 winemakers) as well as extending the surveyed information about economic data. It could help better understand the economic aspects in the winemaking sector and help in decision-making within the wine policy.

Acknowledgements

This article was created with the support of the Internal grant agency of the Faculty of Economics and Management of the Czech University of Life Sciences Prague. Grant title: Economic efficiency of the winemaking and winegrowing sector in the Czech Republic – opportunities for development of the sector. Registration number 20141046.

Corresponding author:
Ing. Eliška Vlašicová, Ing. Zdeňka Náglová
Department of Economics, Faculty of Economics and Management
Czech University of Life Sciences in Prague, Kamýcká 129, Prague 6 – Suchdol, Czech Republic
E-mail: vlasicova@pef.czu.cz, naglova@pef.czu.cz

Ing. Zdeňka Náglová
Department of Economics, Faculty of Economics and Management
Czech University of Life Sciences in Prague, Kamýcká 129, Prague 6 – Suchdol, Czech Republic
E-mail: naglova@pef.czu.cz

References

[1] Altman E. I. Financial Ratios, Discriminant Analysis, and the Prediction of Corporate Bankruptcy. Journal of Finance, 1968, Vol. 23, No. 4, p. 589-609. ISSN 1540-6261.

[2] Brožová I. The economic performance analysis of organic farms in the Czech Republic. Agriculturae et Silviculturae mendelianae Brunensis, 2011, Vol. 56, No. 2, p. 297-308. ISSN 1211-8516.

[3] Delbridge, T. A., Fernholz, C., King, R., Lazarus, W. A whole-farm profitability analysis of organic and conventional cropping systém.. Agricultural Systems, 2013, Vol. 122, p. 1-10. ISSN 0308-521X.

[4] Chládková H., Tomšík P., Gurská S. The development of main factors of the wine demand. Agricultural Economics – Czech, 2009, Vol. 55, No. 7, p. 321-326. ISSN 1805-9295.

[5] Chrastinová Z. Metódy hodnotenia ekonomickej bonity a predikce finančnej situácie poľnohospodárských podnikov. VÚEPP, Bratislava, 1998. ISBN 80-7079-641-3.

[6] Giraud-Héraud E., Pichery M. C. Wine Economics: Quantitative Studies and Empirical Applications. Palgrave Macmillan, London, 2013. ISBN 978-1-137-28951-3.

[7] Gurčík L. G-index – metóda predikcie finančného stavu poľnohospodárských podnikov. Agricultural Economics – Czech, 2002, Vol. 48, No. 8, p. 373-378. ISSN 1805-9295.

[8] Hambalková M. The factors of competitiveness and the quantification of their impact on the export efficiency of grape and wine in the Slovak Republic. Agricultural Economics – Czech, 2006, Vol. 52, No. 8, p. 389–394. ISSN 1805-9295.

[9] Hejmalová H., Šperková R., Duda J. The Role of the Wine-Production Industry in South Moravia. Agrarian Perpsectives, International Scientific Conference, Prague, 2011, p. 209-216. ISBN 978-80-213-2419-0.

[10] Hicl Z. Evaluation of viniculture in the Czech Republic from the perspective of industry and prediction of development until 2020 according to selected variables. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 2012, Vol. 60, No. 7, p. 89–100. ISSN 1211-8516.

[11] Knápková, A., Pavelková D., Šteker, K. Finanční analýza: komplexní průvodce s příklady. 2013, Grada, Prague. ISBN 978-80-247-4456-8.

[12] Koráb P. European Wine Policy and Perceptions of Moravian Winemarkets a Pilot Study in the Czech Republic. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 2012, Vol. 60, No. 4, p. 207-214. ISSN 1211-8516.

[13] Kroupová Z., Malý M. Analysis of Agriculture Subsidy Policy Tools - Aplication of Production Function. Politická ekonomie, 2010, No. 6, p. 774-794. ISSN 0032-3233.

[14] Kučerová R. Factors of the attractiveness of Slovak wine market and their influence on the Czech wine export to Slovakia. Agricultural Economics – Czech, 2014, Vol. 60, No. 9, p. 430–439. ISSN 1805-9295.

[15] Kučerová R., Žufan P. Market position of selected competitors of the Czech wine market. Agricultural Economics – Czech, 2008, Vol. 54, No. 7, p. 343–346. ISSN 1805-9295.

[16] Lobley M., Burtler A., Reed M. The contribution of organic farming to rural development: An exploration of the soci-economic linkages of organic and non-organic farms in England. Land Use Policy, 2009, Vol. 26, p. 723-735. ISSN 0264-8377.

[17] Lososová J., Zdeněk R. Key Factors Affecting the Profitability of Farms in the Czech Republic. Agris on-Line Papers in Economics and Informatics, 2014, Vol. 6, No. 1, p. 21–36. ISSN 1804-1930.

[18] Meloni G., Swinnen J. The Political Economy of European Wine Regulations. LICOS Discussion Paper Series. 2012, Discussion Paper 320/2012. Leuven.

[19] Ministry of Agriculture. Situation and Outlook Report: vine and wine. Ministry of Agriculture Czech Republic, 2012. ISSN 1211-7692.

[20] Náglová Z., Vlašicová E., Gürtler M., Gryčová M. The Impact of Indicators of Capital Structure on Profit of Viticulture and Viniculture Enterprises. European Financial Systems 2014 - Proceedings of the 11th International Scientific Conference, Masaryk University, Lednice, 2014, p. 409–416. ISBN 978-80-210-7153-7.

[21] Neumaierová, I., Neumaier, I. Výkonnost a tržní hodnota firmy. 2002, Grada, Prague. ISBN 80-247-0125-1.

[22] Pyšný T., Pošvář Z., Gurská S. Analysis of selected demand factors of wine market of the Czech Republic. Agricultural Economics – Czech, 2007, Vol. 53, No. 7, p. 304–311. ISSN 1805-9295.

[23] Sedlo J., Tomšík P. Strategic development of varietal vineyards in the Czech Republic. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 2012, Vol. 60, No. 2, p. 325–334. ISSN 1211-8516.

[24] Sedlo J. Ekonomika vinohradnictví ČR (2009); (Economy of viniculture in the Czech Republic). 2009, Svaz vinařů ČR. www.svcr.cz

[25] Soukupová J. et. al. Mikroekonomie. 2004, Management Press, Prague. ISBN 80-7261-061-9.

[26] Synek M., Kislingerová E. Podniková ekonomika. 2010, Beck, Prague. ISBN 978-80-7400-336-3.

[27] Šperková R., Duda J. Preliminary situation analysis of wine production industry in the Czech Republic since 1989. Acta Universitatis agriculturae et silviculturae Mendelianae Brunensis, 2009, Vol. 57, No. 6, p. 287-296. ISSN 1211-8516.

[28] Šperková R., Skýpalová, R. Strategic options for newly entering companies into the wine sector in the Czech Republic. Acta Universitatis Agriculturae et Silvicul¬turae Mendelianae Brunensis, 2012, Vol. 60, No. 7, p. 387–398. ISSN 1211-8516.

[29] Šperková R., Ulbrich T. History and Present of the Viticulture branch in the Czech Republic. The International Scientific Conference INPROFORUM 2013, 2013, p. 323-328. ISBN 978-80-7394-440-7.

[30] Tomšík P., Prokeš M. Formation of Regional Associations of Wine Producers in the Czech Republic. Agrarian Perpsectives, International Scientific Conference, Prague, 2011a, p. 263-270. ISBN 978-80-213-2419-0.

[31] Tomšík P., Prokeš M. New Strategic Alliances of Wine Producers in the Czech Republic. Agricultural Economics - Czech, 2011b, Vol. 57, No. 12, p. 573-579. ISSN 1805-9295.

[32] Tomšík P., Sedlo J. Management of wine production with regard to its implementation into the wine markets of the Czech Republic. Agricultural Economics - Czech, 2013, Vol. 59, No. 5, p. 202-210. ISSN 1805-9295.

[33] Unwin T. Wine and the Vine: An Historical Geography of Viticulture and the Wine Trade. 2012, Taylor & Francis, London. ISBN 0-415-03120-6.

[34] Vanka G. M., Hejman W. J. M. The Kosovar wine cluster: A booster for regional development? Agricultural Economics – Czech, 2013, Vol. 59, No. 4, p. 167–182. ISSN 1805-9295.

Agris on-line Papers in Economics and Informatics

Volume VII Number 3, 2015

Competitiveness Improvement Strategy of Soybean Commodity: Study of Food Security in East Java - Indonesia

A. Zainuri[1], A. Wardhono[1], Sutomo[2], J. A. Ridjal[3]

[1] Department of Economics, Faculty of Economics, University of Jember, Indonesia

[2] Department of Administrative Science, Faculty of Social and Politic Science, University of Jember, Indonesia

[3] Department of Agribusiness, Faculty of Agriculture, Unviersity of Jember, Indonesia

Abstract

The increase in soybean prices is caused by an imbalance between the ability to produce soybeans in the country and the increase in demand, so that scarcity of soybean is an issue in an agricultural country like Indonesia. The purpose of this study was to determine the mapping and competitiveness of soybean in East Java, as well as to find out alternative government policies to increase the fair competitiveness of soybean in East Java. Based on the results of the analysis, the recommendation on the most effective policy is the development of competitiveness of local soybean and maintaining the performance of the existing farmer groups, as well as the stabilization of local soybean prices.

Key words

Competitiveness, food security, government policy, soybeans.

JEL Code: Q02, Q11, Q18

Introduction

Price fluctuations of soybean commodity become a crucial issue in Indonesia each year. Empirically the increase in soybean prices is caused by the element of scarcity on the supply side, or domestic soybean production is slower compared to the demand (Elizabeth, 2007; Zakaria et al, 2010; Eden et al, 2012). The imbalance between the ability to produce soybeans and the increase in domestic demand has actually occurred within a fairly long period (Adisarwanto, 2008; Nuryanti, Kustiari, 2007). The empowerment efforts to increase soybean production require reorientation on strict and problem-facing policies, for example through the intensification, extensification, and integrated soybean crop diversification (Sumarno, 2010; Suradisastra, 2008). In addition, it is necessary to carry out and in-depth study of the determination of policies to enrich the knowledge of the various factors that influence farmers' decisions grow soybeans.

Trade liberalization provides new opportunities and challenges in the development of an agricultural commodity, including soybean (Ahmad, Tawang, 1999; Firdaus et al, 2012). The new opportunities are because the increasingly larger market and the elimination of trade barriers between countries (Lee, Swagel, 1994). The significance of the impact of trade liberalization will also cause problems if the commodity produced is not able to compete in world markets. In this regard, it is necessary to study in depth the institutional arrangement of soybean farming since the farmers' declining motivation for planting soybean is presumably affected by market actors' agreement and regulations that have no direct positive impacts on soybean farmers (Rante, 2013; Huang, Rozelle, 2004). Thus, the farmers feel that they get less even no protection from external conditions. The purpose of this study was to determine the mapping and competitiveness of soybean in East Java and to find out alternative government policies to increase the fair competitiveness of soybean in East Java.

Review of literature

Empirical study brings the framework of understanding of the problems of soybean in Indonesia with a variety of conclusions. Handayani et. al. (2009) studying the policy simulation of local soybean competitiveness

in domestic markets argue that the strategies used in improving competitiveness and domestic soybean production through increasing productivity by implementing farming technology and extending the planting area to increase cropping index. However, the productivity improvement program must also be accompanied by price protection policy by the government to strengthen the competitiveness of domestic soybeans (Song et al, 2009). In contrast, Rante's study (2013) which analyses the soybean crop development strategies for the economic empowerment of rural people in Keerom Regency recommends the financial feasibility of local soybean farming. Strategies used in increasing production of local soybean and processing industry development on the basis of local soybean by the capital assistance of either bank or non-bank financial institutions (Sudaryanto et al, 2001).

The study by Zakaria et al (2010) on the analysis of the competitiveness of soybean commodity based on agro-ecosystem: cases in three provinces in Indonesia show that soybean farming still has a sufficient competitive advantage as an import substitution commodity. The decline in soybean production is prompted by the low participation of farmers in planting soybeans due to lack of motivation and ability of farmers to manage their farming (Budhi, Aminah, 2010). Meanwhile, to increase the participation of farmers in soybean farming, it is important to overcome obstacles such as lack of quality seeds, farmers' fairly high risk and the absence of incentive for appropriate soybean selling prices.

Materials and methods

Types and sources of data

Sources of data in this study consisted of primary data and secondary data. The primary data were obtained through empirical studies on a number of economic actors using in-depth interview technique. Secondary data were obtained through written reports of related institutions, literature collection, and papers relating to the existing problems and supporting the primary data.

Research location and analysis unit

The study was located in East Java, and the research objects were determined by multi-stage cluster sampling on soybean production centres, such as Banyuwangi and Jember. The unit of analysis of this study was representatives of soybean farmers, soybean trade actors, and stakeholders from the concerned government agencies, especially agriculture department in each selected district.

Method of data analysis

The methods used in analysing the mapping and competitiveness of soybeans as well as alternative government policies to increase the fair competitiveness of soybean in East Java fair consisted descriptive analysis method and causal analysis method. Descriptive analysis was obtained from in-depth interviews aimed to portray the competitiveness of soybean. A comprehensive description of the research objects is supported by the results of the analysis using Force Field Analysis (FFA) method which is able to strengthen the results of previous descriptive analysis.

FFA is developeed by Lewin (1951) and is used broadly to inform about decision making especially in planning and running management program in an organization. This analysis is a good method to gain comprehensive pictures of all power on main issues of policy. It also predicts sources and power level of the policy. First step on FFA is dealing with changing field agreement which will be discussed. The changing field can be written as the goal of policy which is needed by the researcher. Next step is determining what kinds of effort to overcome the power. The most significant effect will be gained by increasing weak supported- power while decreasing strong inhibitors.

Results sand discussion

Development of competitiveness of soybean commodity

The development of soybean competitiveness can be determined by analysing the driving and inhibiting factors using Field Force Analysis. The results of FFA will bring policy recommendations that minimize the inhibiting factors by optimizing the driving factors toward the goal to be achieved. Based on in-depth interviews, there are six driving factors and six inhibiting factors in the development of soybean competitiveness. The explanation of the driving factors and inhibiting factors can be seen in Table 1.

The driving factors in the development of soybean competitiveness can be defined as things that become strengths and opportunities. These factors

No.	Driving factors	No	Inhibiting factors
D1	The existence of farmer groups	H1	Soybean prices are uncertain
D2	Partnership with Bulog (Logistic enterprise	H2	There is no cooperative
D3	Land suitability for cultivation	H3	Lack of support of banking/credit institutions
D4	Seedling by farmer groups	H4	Limited extension and training to farmers
D5	The need of soybean for agroindustry is always stable	H5	Helplessness of farmer groups in facing middlemen
D6	Availability of production facilities	H6	Limited market information

Source: Field survey 2013

Table 1: Driving factors and inhibiting factors of soybean competitiveness.

will be determined to be the key power to success in the development of soybean competitiveness. These factors are as follows:

1. The existence of farmer groups. Famer group is a body of farmers based on similarity, harmony of one socio-cultural environment to achieve the same goal. Farmer group is a means for farmers to obtain additional information on good cultivation of soybean crops. The existence of farmer groups also facilitates the coordination of farmers regarding the assistance provided by the government in the form of seeds, fertilizers, and drugs. Through cooperation within and between farmer groups it is expected expected that the activities performed are in better coordination, efficiency and ability to deal with threats, challenges, obstacles and interferences in the future.
2. The existence of partnership with Bulog. Partnership with Bulog is a supporting factor in the development of soybean competitiveness. The partnership that exists between soybean farmers and Bulog will further increase farmers' motivation to increase production and will certainly add the interest of other farmers to do soybean farming because of the certainty of goods produced to be bought by Bulog; in addition, the price is agreement of farmers and Bulog.
3. Land Suitability for Cultivation. Land suitability for cultivation becomes a special value for soybean planting because not all locations can be planted soybean plants. Soybean which is actually sub-tropical climate a plant is developed in Indonesia by adjustment to be planted in the tropical climate of Indonesia. Land suitability for the soybean crop in Banyuwangi and Jember makes the two towns be one of the soybean producing centres in East Java. The land suitability should be used as a motivation to the farmers especially in Banyuwangi and Jember to increase the acreage of soybean plants.
4. The self-seeding by Farmer Groups. Self-seeding by farmers becomes a supporting factor for developing soybean competitiveness. Seeding done by farmer groups also becomes cooperation between farmers and Bulog. Seeds produced by seeding managed by farmer groups will be sold to Bulog (a government body). The seeds will be given back to the farmers in the form of assistance for the coming soybean planting season. The seeding shows that the existing farmer groups has been developed in thought because it not only focuses on the cultivation and sale but also thinks about the coming planting by self-seeding.
5. The need of soybeans for agro-industry is always stable. The need of soybeans to meet agro-industry demands is the supporting factor in the development of soybean competitiveness. Farmers do not worry about performing soybean production due to the certainty of soybean sale produced for agro-industries, especially tofu agro-industry. The stable need of soybean can trigger farmers to continue to farm soybeans adapted to the condition of the area. However, the soybean prices

which are unstable or tend to decrease when the harvest time should be government's concern to stabilize the price of soybeans in the harvest time.

In addition to the driving factors, the development of soybean competitiveness also needs to consider the inhibiting factors in which the factors can be defined as things that become the weaknesses and threats in improving the product competitiveness. These factors are as follows:

1. Uncertain selling price of soybean. The selling price uncertainty is absolutely the major inhibiting factor which makes the low competitiveness of soybean. The uncertainty of the selling price of soybean is caused by several things such as the quality of local soybean, the amount of imported soybeans, the availability of soybean domestic supply, soybean price played by middlemen or traders and number of related market chains in the marketing process of local soybeans. The fluctuating or unstable selling prices of soybeans can cause farmers' reluctance to continue soybean plant cultivation.
2. Non-existence of cooperatives. The existence of cooperating in a farming group can serve as a provider of precise production facilities and a marketing channel where farmers can sell their yields at a reasonable price. This is what is not available in most of the soybean farmer groups in East Java. The non-existence of cooperative institutions makes soybean farmers find it difficult particularly in marketing. Most of the soybean farmers sell their produce to middlemen at very low prices, so it is not in balance with what they performed.
3. Lack of support from credit/banking institutions. One of the highly-needed factors by soybean farmers in soybean farming is capital. In running the soybean farm, they certainly large amount of capital. Soybean farmers who basically earn low incomes often experience difficulties in terms of capital. The credit/banking institution which is one of capital providers gives very little support to soybean farmers. This lack of support is mostly because of lack of trust from the institution to soybean farmers.
4. Limited extension and training to farmers. Extension and training are basic necessities to soybean farmers in order to improve his farming. Limitation or lack of active extension workers to soybean farmers leads to the weakening competitiveness of soybean. Without training and extension in soybean farming, farmers find it difficult to absorb information and adopt modern technology, so that they seem to run the farm conventionally.
5. The helplessness of farmer groups to face the middlemen. Middleman plays the price arbitrarily. This is because most of the farmers sell their produces to middlemen, so the soybeans cultivated by farmers do not have high bargaining power. The mechanism of soybean selling by farmers to middlemen is often done by tebas system where the middlemen go directly to the farmers who are harvesting. Farmers who are basically still conventional-minded will certainly sell their produce directly without thinking of other possibilities if the results are processed or sold to any other parties other than the middlemen.
6. Limited market information. Farmers who sell their produces obtain information on the market, such as the selling price of soybeans, only from a single source, that is, the middlemen. Middlemen determine the prices of farmers' soybeans based on the selling back to wholesalers. The system has surely inflicted a financial loss for soybean farmers because they cannot compare soybean prices with the other regions. It takes an active role of agricultural institutions such as farmer groups in order that market information can be absorbed well by the farmers so that the bargaining power of the cultivated soybean is higher.

Identification was continued to assessment of the driving factors and the inhibiting factors of soybean competitiveness. The results of the assessment would result in the values that can be used in formulating appropriate policy recommendations. The assessment conducted in the process of FFA analysis was a qualitative assessment quantified at the scale values of 1-5. The assessment was through brainstorming of the respondents who were experts in the improvement of local soybean competitiveness. The results of the assessment

are included in the evaluation table of the driving and inhibiting factors.

Based on the FFA analysis in the evaluation of the driving factors and inhibiting factors as listed in the table of driving factors and inhibiting factors, the value of Total Value Weight (TNB) of each factor can be identified. Based on the total value weight, Key Success Factors (FKK) in the development of local soybean competitiveness in East Java can be determined by considering the highest weight value. Key success factors (FKK) are divided into two, namely driving FKK and inhibiting FKK. Below is the table of evaluation of the driving factors in the improvement of soybean competitiveness in East Java.

Based on Table 2 above, it is recognized that the driving FKK with the highest value is D1 (the existence of farmer groups) gaining a total value weight of 1.57. The farmers' group can motivate farmers to increase the production of farm produces. In the process of soybean farming, farmer groups take a role as one of the providers and distributors of production facilities such as soybean seeds, fertilizers, drugs or farming devices that support soybean farming activities (Wahyuni, 2003; Reimer et al, 2009). Farmers' group also has a role in marketing. Despite its small role, the existence of the farmers' group also has an important role as the source in the delivery of market information such as soybean price to farmers. The highest value support (ND) in Table 2 is also on the first driving factors, namely the existence of farmer groups (D1) and adequate availability of production facilities (D6). This shows that both factors are the most relevant factors in supporting the development of soybean competitiveness, particularly in East Java. In addition to driving factors, there are inhibiting factors that hinder the development

No.	Driving factors	BF	ND	NBD	NRK	NBK	TNB	FKK
D1	The existence of famer groups	0.29	5	1.47	3.91	1.15	2.62	*1
D2	Partnership with Bulog	0.12	4	0.47	2.91	0.34	0.81	6
D3	Land suitability for cultivation	0.18	4	0.71	2.91	0.51	1.22	3
D4	Seeding by farmer groups	0.12	4	0.47	3.27	0.39	0.86	5
D5	The soybean need for agroindustry is always stable	0.24	3	0.71	3.18	0.75	1.45	2
D6	Availability of production facilities	0.12	5	0.59	3.64	0.43	1.02	4

Notes:

*): Priority (FKK)

BF: Weight Factors
ND: Value Support
NRK: Average Value Linkage
NBD: Weight Value Support
NBK: Weight Value Linkage
TNB: Total Value Weight
FKK: Key success factors

Source: Field survey 2013

Table 2: Evaluation of driving factors in the improvement of local soybean competitiveness in East Java.

No.	Driving factors	BF	ND	NBD	NRK	NBK	TNB	FKK
H1	Uncertainty of soybean selling price	0.28	5	1.39	2.82	0.78	2.17	*1
H2	No cooperatives	0.22	4	0.89	3.27	0.73	1.62	2
H3	Lack of support from credit/banking institutions	0.11	3	0.33	2.18	0.24	0.58	6
H4	Limited extension and training to farmers	0.11	3	0.33	2.73	0.30	0.64	5
H5	Helplessness of farmer groups to face tengkulak (middlemen)	0.17	4	0.67	2.64	0.44	1.11	4
H6	Limited market information	0.22	4	0.89	2.91	0.65	1.54	3

Notes:

*): Priority (FKK)

Source: Field survey 2013

Table 3: Evaluation of inhibiting factors in the improvement of local soybean competitiveness in East Java

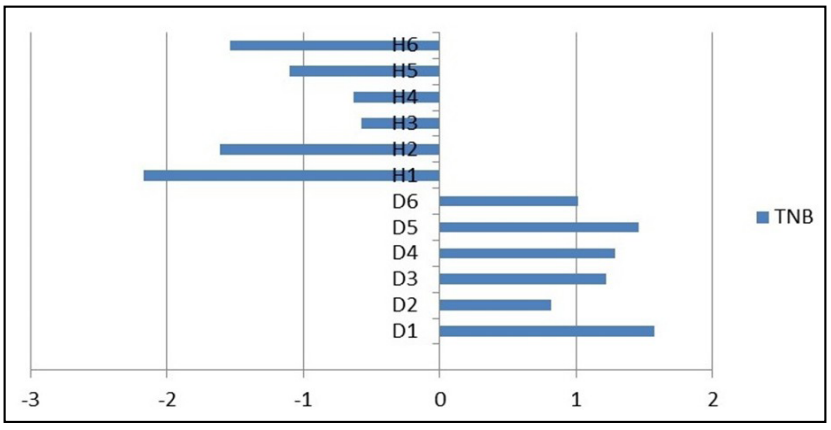
of agro-industry. Below is the table of evaluation of the inhibiting factors in the improvement of soybean competitiveness in East Java.

Based on Table 3, it can be identified the inhibiting FKK in the improvement of soybean competitiveness in East Java, namely H1 factor (uncertainty of soybean selling price) with the total value weight or the urgency factor of 2.17. The uncertainty of soybean selling price is a vital thing for farmers and agro-industry actors. For farmers, the uncertainty of soybean selling price will surely affect the sustainability of farming activities. The fluctuating price of soybeans will make soybean farmers who basically grow local soybean plants find it difficult to compete with imported soybeans which are nowadays widely used as raw materials by the agro-industry actors (Graham et al, 2010; Zakaria et al., 2010). The highest ND in the inhibiting factors is also available in the first factor, that is, not the uncertainty of soybean selling price. This shows that the factor is closely related in the development of the soybean competitiveness, particularly in East Java. The level of TNB of each driving and inhibiting factor can be visualized in a diagram called force field diagram with the condition to be achieved. Whereas, the force field of the driving factors and inhibiting factors in the development of soybean competitiveness in East Java is presented in figure 1 below.

The figure 1 shows that the highest driving factor is D1, that is, farmers' motivation, and the highest inhibiting factor is H1, that is, Uncertainty of soybean selling price. The total number of BNP of driving factor is 7.98, and that of inhibiting factor is 7.64. This shows that the total value of TNB of driving factor is higher than that of TNB of inhibiting factor, which means that the local soybean still has the advantage to improve the competitiveness.

It is explained that the results of FFA analysis will bring a policy recommendation that minimizes the inhibiting factors by optimizing the driving factors toward the goal to be achieved. Formulation of policy recommendation is directed in accordance with the results of FKK. The selected driving FKK is the existence of farmer groups, and the focus is to maintain the performance of the existing farmer groups. The method that can be used to maintain the performance of soybean farmer groups is by maintaining trust between the members and the group or between members and the other group members. Trust is considered as the primary means to maintain the performance of farmer groups since it is the most important social capital (Paul & Seok, 2009; Elizabeth, 2007). In addition to increasing the trust between internal members, the encouragement of the external environment of the groups is also badly needed to maintain the performance of soybean farmer groups such as training and extension from the related agencies, especially in the case of soybean production and marketing activities of the local soybean itself. The existence of a synergistic relationship between the department of agriculture and soybean farmers will be very helpful to increase the soybean competitiveness in East Java.

The inhibiting Key Success Factor (FKK) is uncertainty of selling price, and the focus is on the stabilization of local soybean prices in order to compete with imported soybeans. This can be done by providing subsidies for soybean



Source: Field survey 2013

Figure 1: Force field in the improvement of local soybean competitiveness in East Java.

production facilities, determining the lowest retail price for soybean farmers to protect them, and setting the highest retail price to protect the soybean processing industry. In addition, the government and stakeholders also need to review the policy of soybean import if they want to make possibility of national self-sufficiency of soybeans (Joshi, Maharjan, 2007; Sudaryanto, 2001).

Conclusion

Performance of soybean farming in the country is not satisfactory considering some constraints in both economic institutional arrangement and farmers' traditional culture. The efforts to improve soybean farming are started from the local government's political will. Based on the results of FFA analysis, it can be seen that the key success factors (FKK) in the development of local soybean competitiveness is the existence of farmer groups; the focus is to maintain the performance of the existing farmer groups. Meanwhile, the inhibiting key success factors (FKK) is uncertainty of selling price, and the focus is on the stabilization of local soy prices in order to compete with imported soybeans. In addition, the reciprocal relationship is important in the cooperation between the institutions developing soybean farming in East Java, farmers, middlemen, farm stalls, government and agro-industry.

Corresponding author:
Ahmad Zainuri
Department of Economics, Faculty of Economics, University of Jember,
Jalan Kalimantan 37 Kampus Bumi Tegalboto, Jember, 68121 East Java, Indonesia
E-mail: zainuri.unej@gmail.com

References

[1] Adisarwanto. Budidaya Kedelai Tropika. Penebar Swadaya, Jakarta, 2008. ISBN 978-979-0023-550

[2] Ahmad, T. M. A., Tawang, A. Effect of Trade Liberalization on Agriculture in Malaysia: Commodity Aspect. CGPRT Working Paper Series 46, 1999. [Online]. Available: http://ageconsearch.umn.edu/bitstream/32694/1/wp990046.pdf [Accessed: 15 Dec. 2014].

[3] Budhi, G. S., Aminah, M. Self-sufficiency in Soybean: The Hope and the Reality. Forum Penelitian Agro Ekonomi. 2010, Vol. 28, No.1, p. 55-68. ISSN 0216-4361.

[4] Elizabeth, R. Penguatan dan Pemberdayaan Kelembagaan Petani Mendukung Pengembangan Agribisnis Kedelai. Proceedings of Pusat Analisis Sosial Ekonomi dan Kebijakan Pertanian, Bogor, 2007, p. 165-173. [Online]. Available: http://pse.litbang.pertanian.go.id/ind/pdffiles/Pros_2007-C_2.pdf [Accessed: 2 Feb. 2015].

[5] Firdaus, M., Semaoen, M. I., Hanani, N. dan Syafrial. The Impact of Trade Liberalization on the Soybean Economic Performance in Indonesia. Journal of Basic and Applied Scientific Research, 2012. ISSN 2090-4304.

[6] Graham, B., Yu, T. H., Tokgoz, S., Elobeid, A. The Production and Price Impact of Biotech Corn, Canola, And Soybean Crops. AgBioForum, 2010, Vol. 13, No. 1, p. 25-52. ISSN 1522-936X.

[7] Handayani, D., Bantacut, T., Munandar, J. M., dan Budijanto, S. Simulasi Kebijakan Daya Saing Kedelai Lokal pada Pasar Domestik. Jurnal teknologi Industri Pertanian, 2009, Vol. 19, No. 1, p. 7-15. ISSN 0216 – 3160.

[8] Huang, J., Rozelle, S. Trade Liberalization, Rising Import and China's Food Economy: The Case of Soybean. Report Submitted to the American Soybean Association, Freeman Spogli Institute (FSI) Stanford, 2004.

[9] Joshi, N. P., Maharjan, K. L. Assessment of Food Self-Sufficiency and Food Security Situation in Nepal. Journal of International Development and Cooperation, MPRA paper, 2007, Vol. 13, No. 1, p. 209-230.

[10] Lee, J.W., Swagel, P. Trade Barriers And Trade flows Across Countries and Industries. International Finance Discussion Paper, 1994, Num. 476. [Online]. Available: http://www.federalreserve.gov/pubs/ifdp/1994/476/ifdp476.pdf [Accessed: 22 Nov. 2014].

[11] Nuryanti S., Kustiari R. Meningkatkan Kesejahteraan Petani Kedelai dengan Kebijakan Tarif Optimal. Proceedings of Pusat Analisis Sosial Ekonomi dan Kebijakan Pertanian, Bogor, 2007. [Online]. Available: http://pse.litbang.pertanian.go.id/ind/pdffiles/Pros_2007-A_3.pdf [Accessed: 15 Dec. 2014].

[12] Paul, S. A., Seok, W. K. Social Capital: Prospects for a New Concept. Academy of Management, 2009, Vol. 27, No.1, p. 17 - 40. ISSN 0363-7425.

[13] Rante, Yohanis. Strategi Pengembangan Tanaman Kedelai Untuk Pemberdayaan Ekonomi Rakyat Di Kabupaten Keerom Provinsi Papua, Jurnal Manajemen dan Kewirausahaan, 2013, Vol. 15, No. 1, p. 75-88. ISSN 1411-1438.

[14] Reimer, A., Downey, A. S., Akridge, J. Market Segmentation Pratices of retail Corp Input Firms. International Food and Agribusiness Management Review, 2009, Vol. 12, No 1. ISSN 1096-7508.

[15] Song, B., Marchant, M. A., Reed M. R., Xu S. Competitive Analysis and Market Power of China's Soybean Import Market. International Food and Agribusiness Management Review, 2009, Vol.12, No. 1. ISSN 1096-7508.

[16] Sudaryanto, T., Rusastra, I. W., Saptana. Prespektif Pengembangan Ekonomi Kedelai di Indonesia. Forum Agro Ekonomi, 2001, Vol. 19, No. 1. p. 1-20. ISSN 0216-4361.

[17] Suradisastra, K. Strategi Pemberdayaan Kelambagaan Petani. Forum Penelitian Agro Ekonomi, 2008, Vol. 26, No. 2. p. 82 - 91. ISSN 0216-4361.

[18] Sumarno. Pemanfaatan teknologi genetika untuk peningkatan produksi kedelai. Pengembangan Inovasi Pertanian, 2010, Vol. 3, No. 4. p. 247 - 259. ISSN 1979-5378.

[19] Wahyuni, S. Kinerja Kelompok Tani dalam Sistem Usaha Tani Padi dan Metode pemberdayaannya. Jurnal Penelitian dan Pengembangan Pertanian, 2003, Vol. 22, No. 1. p. 1-8. ISSN 0214-4418.

[20] Zakaria, Amar K., Wahyuning K., Kustiari R. Analisis Daya Saing Komoditas Kedelai Menurut Agro Ekosistem: kasus di Tiga Provinsi di Indonesia, Jurnal Agro Ekonomi, 2010, Vol. 28, No. 1, p. 21 - 37. ISSN 0216-9053.

Agris on-line Papers in Economics and Informatics

Volume VI Number 3, 2014

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