RISK AND PROFITABILITY OF ANIMAL AND CROP PRODUCTION IN SLOVAK FARMS

Marián Tóth[1], Tomáš Rábek[2], Andrea Boháčiková[3], Ivan Holúbek[4]

[1] Ing. Marián Tóth, PhD., Slovak university of Agriculture in Nitra, Faculty of Economics and Management, marian.toth@uniag.sk

[2] Ing. Tomáš Rábek, PhD., Slovak university of Agriculture in Nitra, Faculty of Economics and Management, tomas.rabek@uniag.sk

[3] Ing. Andrea Boháčiková, PhD., Slovak university of Agriculture in Nitra, Faculty of Economics and Management, andrea.bohacikova@uniag.sk

[4] Ing. Ivan Holúbek, PhD., Slovak university of Agriculture in Nitra, Faculty of Economics and Management, ivan.holubek@uniag.sk

Abstract: The paper focuses on profitability and risk of crop and animal production based on an analysis of farms operating in Slovak Republic. The individual farm data used for the analysis are from the database of Ministry of Agriculture and Rural Development of the Slovak Republic. For our analysis, data were selected according to the farm production orientation to the subset of crop farms and animal farms. The selecting criterion for production orientation was the percentage share of revenues from crop production, or revenues from animal production from the overall revenues from own products and services. We analyse profitability of farms divided into groups based on the type of production into crop and animal farms (according to the share in sales from crop or animal production). Using descriptive statistics and portfolio theory we simulate the total farm profitability and volatility of animal and crop production in Slovakia. The modified Markowitz portfolio theory approach was used to estimate the total risk of portfolios of crop and animal farms. Based on the results we conclude that in the long run crop farms are profitable and profit from crop production is used to cover the losses from animal production in mixed farms. Farms focused on animal production only are efficient and profitable, but the profitability is lower in comparison with crop farms. Animal farms results are less volatile than crop farms. Large farms tend to production with lower value added and can generate enough profit for the owner.

Keywords: profitability, risk, crop production, animal production, portfolio theory

JEL Classification: Q14, Q18, G31

INTRODUCTION

After 1989, Slovak agricultural sector was transformed from centrally planned economy to the market economy. Fundamentally, this process was based on privatization. Before 1989, Slovak agriculture consisted of cooperatives and state farms with large acreage, without existence of private companies. Since that number of private companies (Joint Stock Company (JSC.), Limited Liability Company (Ltd.)) has been gradually increasing, because this type of legal form is considered to be more effective. The year 2004, when Slovakia adopted Common agricultural policy and farmers received their first direct payments, became a next milestone in the development of Slovak agriculture. New political regulations, quotas, requirements and single payment system led to the number of substantial changes that have been ultimately impacting economic development in the sector and priorities of farmers. In the years 2003, 2007 and 2009 agricultural production, and in particular crop production, was affected by extraordinarily dry weather, which influenced total agricultural production and the economic situation of farms. Not only the legal structure has been changing, but also the crop production has been year to year on the

increase (except of year 2009), while the animal production has been in general decreasing.
Nowadays, the majority of UAA (74.64% in 2014) is cultivated by large farms with over 500 hectares, while the UAA per farm in the EU is much lower. Therefore, also measures implemented through CAP result different in Slovakia. The individual farm data used for the analysis are from the database of Ministry of Agriculture and Rural Development of the Slovak Republic.
For our analysis, data were selected according to the farm production orientation to the subset of crop farms and animal farms. The selecting criterion for production orientation was the percentage share of revenues from crop production, or revenues from animal production from the overall revenues from own products and services. We analyse profitability of farms divided into groups based on the type of production into crop and animal farms (according to the share in sales from crop or animal production). Using descriptive statistics and portfolio theory we simulate the total farm profitability and volatility of animal and crop production in Slovakia. The modified Markowitz portfolio theory approach was used to estimate the total risk of portfolios of crop and animal farms. We assumed that the return of the investor is based on the profit of the company and the equity invested.

1. LITERATURE REVIEW

Yield, risk and liquidity are the main factors influencing the investment decision making process. According to the essential literature, there are many ways, how the economic performance, profitability and risk can be assessed (Váryová et al., 2015). Generally, risk refers to deviation of the evaluated indicator, and the level depends on the volatility over a certain period. Risk in agriculture has been a matter of worldwide concern since 1933, when the concept of risk analysis had been introduced (Hardaker et al, 2004). Agriculture is a sector facing particularly large risks, resulting mainly from natural factors outside the control of farmers. The resulting variations in farm output, combined with a relatively low price responsiveness of supply and demand, also cause agricultural markets to be rather volatile (Tangermann, 2011).
There have been several approaches to measure agricultural risk resulting from different focus of authors. Some of them are focused on agricultural risk of individual farms, others took into account the whole aggregate level (El Benni and Finger, 2013; Špička and Vilhelm, 2013, Just and Pope, 2003). Because farms can be thought of as assets within an overall portfolio, agricultural producers also paid attention to the concept of diversification and portfolio theory.
In the Markowitz portfolio theory, total risk is standardly measured by the mean-variance model and standard deviation of stock return (Markowitz, 1952). The stocks, considered in the original model, represent the equity securities, and the return on stock reflects simply the return on equity invested into the business. Therefore, it might be assumed that to be able to measure the risk of unquoted agricultural companies, the deviation of return on equity could be considered, as well. In order to focus on other than security market the alternative of Markowitz theory approach, the Simple index model, was created (Sharpe, 1963). In SIM the input variables used in analysis are the accounting fundamentals of companies. SIM approach was applied in the number of studies, such as usage of gross and net returns (Gempesaw et al, 1988), farm equity returns (Baginski and Wahlen, 2003), book to market ratios (Fama and French 1995) or cash flow variability (Cohen et al, 2009; Da, 2009). It empowers our assumption to measure the market risk of unquoted farms, using the return on equity ratio ROE.
The risk analysis of agriculture, using the Markowitz approach or Single index model, has been applied to the number of studies, however many of them did not have aggregate character. They mainly focused on the certain part of agriculture production, for example, Barry (1980) applied the CAPM assumptions to estimate beta for U.S. farm real estate market, Peterson and Leuthold (1987) used the portfolio approach to examine the cattle feeding problem, Prattley et al. (2007) applied the portfolio concept to find appropriate allocation

of surveillance resources in animal populations, Barkley et al. (2010) estimated optimal crop diversification. Also, the more aggregate perspective, when the systematic and non-systematic risk of agriculture of whole country has been estimated, can be found. Gempesaw et al. (1988) applied the model to Delaware farm sector market portfolio, Turvey and Driver (1987) used SIM to study the systematic and non-systematic risk of Canadian agriculture, or in more recent study Libbin et al. (2004) applied the Markowitz portfolio model directly to a series of New Mexico farms. In the recent period, there has been higher attention paid to the topic of risk and return of Slovak agricultural companies (Tóth et al., 2014, Serenčéš et al., 2016). It reflects the political focus on risk management in agriculture and income stabilisation strategies of policy makers of CAP. Therefore, we decided to examine the portfolio risk and return of Slovak agricultural companies, divided based on the production orientation, in our study.

2. MATERIAL AND METHODS

The data used for the analysis are from the database of Ministry of Agriculture and Rural Development of the Slovak Republic, over the period 2004 - 2014. For our analysis, data were selected according to the production orientation to the subset of crop farms and animal farms. The selecting criterion was the share of animal production based on sales. We created 8 portfolios of farms. One for all farms and seven based on share of animal production ranging from 0 to 100%. For calculation 5-years moving averages were used for the period: 2010-2014. From the dataset the following farms were excluded: farms that started or quitted during each observed 5 year period and farms with negative equity (liabilities exceeding total assets) over the observed period.

The modified Markowitz portfolio theory approach was used to estimates the total risk of eight portfolios. We assumed that the return of the investor is based on the profit of the farm and the equity invested. Therefore, we considered return on equity ROEi (Eq. 1) to be equivalent to the return on stocks, generally used in the case of quoted companies. Measuring volatility of return in the Markowitz portfolio theory is based on the average return over the observed period for each investment. We calculated the average return on equity EROEi (Eq. 2) for each individual farm.

$$ROE_i = \frac{Earnings\ After\ Taxes}{Sharesholders\ Equity} \quad (1)$$

$$EROE_i = \sum_{i=1}^{t} ROE_i \cdot d_i \quad (2)$$

Where ROEi is return on equity of farm "i" in observed year, di is a weight of ROEi over the observed period (5 years, di = 0.20), t is number of years in observed period. The individual risk of each farm (σ_i) is calculated using the standard deviation.

$$\sigma_i = \sqrt{\sum_{i=1}^{t} (ROE_i - EROE_i)^2 \cdot d_i} \quad (3)$$

Where σi is standard deviation of the individual return on equity (individual farm risk), ROEi is individual return on equity, EROEi is average individual return on equity.

The portfolio risk (σ_p) is determined by three variables: weight of the individual investment in portfolio (wi), standard deviation of the individual investment - individual risk (σi), and covariance, relation between the ROEi of farm i and ROEj of farm j (σij). To take into account market portfolio of all agriculture farms, the weight wi of each farm is determined by farm market share, which is the share of the farm` s equity on the total equity of all farms. The covariance represents the relationship between returns on equity of farms (Eq 4) and Σ covariance matrix (Eq. 5). The portfolio risk is then measured according to eq. 6

$$\sigma_{ij} = \frac{1}{n} \sum_{i=1}^{n} (ROE_i - EROE_i)(ROE_j - EROE_j) \quad (4)$$

$$\sum = \begin{bmatrix} \sigma_{11}\ \sigma_{12}\ \sigma_{13}\ \dots\ \sigma_{1k} \\ \sigma_{21}\ \sigma_{22}\ \sigma_{23}\ \dots\ \sigma_{2k} \\ \sigma_{31}\ \sigma_{32}\ \sigma_{33}\ \dots\ \sigma_{3k} \\ \dots \\ \sigma_{k1}\ \sigma_{k2}\ \sigma_{k3}\ \dots\ \sigma_{kk} \end{bmatrix} \quad (5)$$

$$\sigma_p = \sqrt{\sum_{i=1}^{n} w_i^2 \cdot \sigma_i^2 + \sum_{i=1}^{n} \sum_{j=1}^{n} w_i \cdot w_j \cdot \sigma_{ij}} \quad (6)$$

Where wi is an individual weight of i-farm (farm`s equity) in a portfolio (total equity of all farms) and n is number of farms.

The expected return on equity of portfolio is estimated by the multiplication of k x 1 vector of individual weights of portfolio (w) and k x 1 vector of corresponding individual expected returns on equity (the sum of multiplication of each farm´s expected ROE and its share in the market portfolio).

$$EROE_p = \sum_{i=1}^{n} EROE_i \cdot w_i \quad (7)$$

Where EROEp is expected portfolio return on equity and EROEi is the average return on equity of individual farm.

3. RESULTS

3.1 Structure of Slovak Agriculture

The business structure of agricultural primary sector consists of wide range of business entities, which number, use of cultivated area and size has been constantly changing. In the year 2014 the total number of farms (17 708) together operated on 1 883 220 ha of utilized agricultural area (UAA). It represents only 52% of known owners of agricultural land, consisting of 43.5% individuals, 4.5% firms and 4% state-owned land. The rest of the agricultural land of unknown owners is temporally administrated by the Slovak Land Fund (SPF) and the users of the land pay a rent.

From the point of the size of the farm (the utilized agricultural area size) the structure of farms in Slovakia is different compared to the EU average. It results from the historical development of agriculture in former Czechoslovakia before 1989. Nowadays, the majority of UAA (74.64% in 2014) is cultivated by large farms with over 500 hectares, while the UAA per farm in the EU is much lower. Therefore, also measures implemented through CAP result different in Slovakia. The division of the farms and their percentage share on the total utilized agricultural area is shown in Table 1.

Tab. 1: UAA per farm as a percentage of total area

Years	*Category of the Utilized Agricultural Area*						
	0-5 ha	*5-10 ha*	*10-50 ha*	*50-100 ha*	*100-250 ha*	*250-500 ha*	*over 500 ha*
2010	*0.99*	*0.94*	*3.43*	*2.91*	*6.8*	*7.91*	*77.74*
2011	*0.99*	*0.95*	*3.75*	*2.95*	*6.42*	*8.20*	*76.75*
2012	*0.99*	*0.98*	*3.97*	*2.94*	*6.60*	*8.28*	*76.24*
2013	*1,01*	*1,04*	*4,23*	*2,97*	*7,04*	*8,21*	*75,49*
2014	*1,04*	*1,09*	*4,52*	*3,1*	*7,07*	*8,55*	*74,64*

Source: Data of the Agricultural Paying Agency of Slovakia (2015)

Since 1989 the former socialist cooperatives and state-owned companies have been transformed into private business companies and cooperatives. The number of independent farmers in the primary sector increased in the first years of the transformation and then stabilised. Structural changes, which had been carried out in Slovak agriculture have led to a decrease of the share of cooperatives on the total number of farms, and to an increase in the number of business companies. In the year 2014 were recorded 2087 private companies (1968 Ltd. and 119 JSC.), and only 566 cooperatives. In comparison to the year 2010 the share of cooperatives decreased by 2.25%, share of joint-stock companies increased by 9.17%, and share of Ltd. increased by 50.23%. Moreover, we can observe the irregular nature of Slovak agriculture, where a minority of farms (14.98 %) owns the vast majority (80,23 %) of

the agricultural land (Table 2). In absolute terms, 2653 agricultural holdings farmed 1,5 million hectares of agricultural land in 2014. This phenomenon was also observed in the Czech Republic, although in Slovakia it was more prominent. This distribution of land, with many small farms sharing a low percentage of agricultural land and a few large holdings farming the vast majority of the UAA, explains the very high average area per holding registered in Slovakia. Large farms generally rent the land and therefore significantly influence the rent and land price. According to the Eurostat, in Slovakia 89% of the land in 2007 was rented (in 2005, 96%). The situation has not been changing in recent years.

Tab. 2. Size structure of Slovak farms

	Number of farms		***Index***	***UAA 2014***		
Legal form	***2010***	***2014***	***Change (%)***	***Land (ha)***	***Land per farm***	***Share on all farms (%)***
Joint stock company	*109*	*119*	*9,17%*	*132 472,01*	*1 113,21*	*0,67*
Cooperative	*579*	*566*	*-2,25%*	*691 054,33*	*1 220,94*	*3,2*
Small – family farm	*9 020*	*9 785*	*8,48%*	*53 291,14*	*5,45*	*55,26*
Ltd.	*1 310*	*1 968*	*50,23%*	*687 429,45*	*349,3*	*11,11*
Farmers	*4 774*	*5 046*	*5,70%*	*303 866,73*	*60,22*	*28,5*
Other	*146*	*160*	*9,59%*	*12,383*	*n.a.*	*0,97*
Total	*15 938*	*17 708*	*11,11%*	*1 883 220,05*	*n.a.*	*100*

Source: Data of the Agricultural Paying Agency of Slovakia (2015)

3.2 The performance of farms in Slovakia according the animal and crop production

In 2004 CAP was implemented in Slovakia. Public funds in form of EU subsidies support farms. New member states including Slovakia opted for single area payment scheme (SAPS) which means, that the majority of support is distributed based on cultivated hectares of the farm. More hectares means more financial support. Only small part is linked to the type of production (crop or animal). This form of support is in combination with large farms in Slovakia changing the performance of farms. Farmers are since 2004 continually decreasing the animal production in favour of crop production. The share of animal production decreased from 57.8% in 2004 to 41% in 2014. EU subsidies are decoupled from production which means they are not production linked. Farmers are not motivated to produce and the intensity of support is increasing. Subsidies per sales and per hectare increased after adopting CAP (see Table 3). Large farms in combination with improved technology result to a decrease of employment in Slovakia. This can be observed on the hectares per employee ratio.

Tab. 3: Characteristics of Slovak farms

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Subsidies per ha	123	184	205	238	267	289	323	298	280	271	272
Hectares per employee	24,6	26,8	27,9	29,0	30,7	31,7	34,6	37,4	40,2	40,7	35,2
Share of animal production	57,8%	54,6%	53,9%	52,8%	49,4%	50,5%	46,7%	44,0%	40,2%	39,6%	41,0%
Number of farms	1285	1410	1364	1364	1317	1382	1304	1412	1480	1483	1490
Income per hectare	21,7	-1,0	8,2	41,4	31,4	-68,0	-7,8	52,2	21,9	-13,0	40,8
Income per employee	534	-26	229	1201	962	-2154	-271	1955	880	-529	1435
Subsidies on total sales (%)	18,1%	25,4%	27,9%	31,1%	32,6%	34,5%	50,8%	43,8%	34,3%	31,1%	32,2%

Source: own calculation

Generally agriculture in Slovakia has very low profitability. There are differences in performance of farms based on the type of production. We observed in period 2010-2014, that the most profitable farms have 0% share of animal production. Mixed farms with share of animal production from "60-80%"
and "80-100%" are generating loss. Farms focused on animal production only are efficient and profitable, but the profitability is lower in

comparison with crop farms. Based on the results we conclude that in the long run crop farms are profitable and profit from crop production is used to cover the losses from animal production in mixed farms. Now crop production is more profitable and therefore farms focus more and more on crop production. Large farms tend to production with lower value added and can generate enough profit for the owner. But production with lower value added has significantly less positive impact on rural development and job creation in rural areas. Therefore policy measures should be applied to motivate individual farmers with large UAA to increase value added of their production.

Measuring volatility of return in the Markowitz portfolio theory is based on the average return over the observed period for each subset of farms. Animal farms results are less volatile than crop farms (see table 4). The most profitable farms are the most risky, what correspondence with the theory. Generally, the animal production is considered to be less risky when compared to crop production. In crop production is higher impact of weather and nature factors.

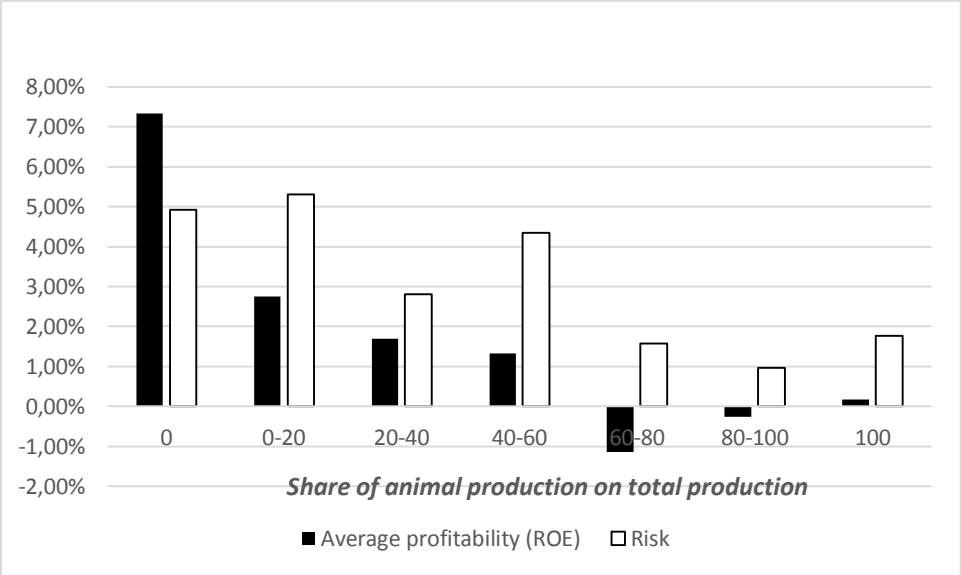
Tab. 4: Situation in agriculture in period 2010-2014

2010-2014	*All farms*	***Share of animal production on total production***						
		0	*0-20*	*20-40*	*40-60*	*60-80*	*80-100*	*100*
Average profitability (ROE)	*1,60%*	*7,33%*	*2,76%*	*1,70%*	*1,32%*	*-1,14%*	*-0,26%*	*0,18%*
Risk	*1,95%*	*4,92%*	*5,31%*	*2,81%*	*4,34%*	*1,58%*	*0,97%*	*1,77%*
Share on number of farms	*100,00%*	*21,04%*	*16,70%*	*14,10%*	*13,45%*	*11,71%*	*16,49%*	*6,51%*
Number of farms	*922*	*194*	*154*	*130*	*124*	*108*	*152*	*60*
Subsidies per ha	*288,86*	*220,36*	*247,17*	*270,3*	*293,26*	*323,62*	*364,72*	*371,1*
Hectares per employee	*39,75*	*58,7*	*55,26*	*39,06*	*33,36*	*35,24*	*34,27*	*31,76*
Income per hectare	*26,24*	*120,47*	*40,22*	*33,56*	*-6,4*	*-10,69*	*5,11*	*10,43*
Income per employee	*1043,2*	*7071,07*	*2222,36*	*1310,83*	*-213,43*	*-376,62*	*174,96*	*331,4*
Subsidies on total sales (%)	*0,34*	*0,22*	*0,35*	*0,29*	*0,32*	*0,42*	*0,5*	*0,46*
Sales per employee	*33309,46*	*59526,23*	*38559,86*	*36307,46*	*30267,09*	*27149,96*	*24994,56*	*25413,66*

Source: own calculation

It can be observed that the profitability of farms differs based on the share of animal production (Figure 1). In the period 2010-2014 the most profitable farms, measured by ROE were those with "0%" share of animal production. The integration and globalization of Slovak agriculture is resulting in specialization of farms and farms are limiting animal production to limit the loss. The most profitable farms are the most risky. The situation in 2010-2014 in Slovakia agrees with this assumption.

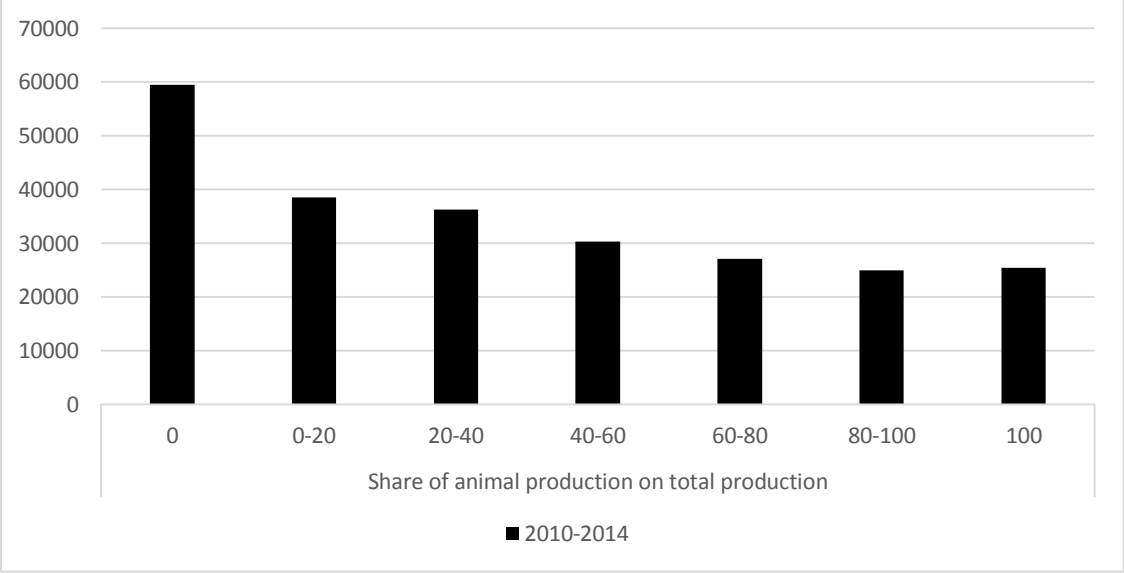
Fig. 1: Average profitability and risk of farms based on the share of animal production on total production



Source: own calculation, table 4

Increased competition caused by globalization and integration resulted in increased productivity. Sales per employee in portfolio of all farms are 33 309 € per year. The highest are in portfolio with "0" share of animal production. Also the income (profit) per employee is increasing from the loss -376,62 in portfolio "60-80%" to profit 7071€ in portfolio "0%" share of animal production (Table 4). Crop farms are more productive than animal farms. Other farms have lover productivity than specialized crop farms. The productivity of animal farms is lower. The higher the share of animal production on total farm production the lower the productivity. It can be reasoned by the fact, that the animal production is more labor demanding.

Fig. 2: Sales per employee based on the share of animal production on total production



Source: own calculation, table 4

CONCLUSION

In 2004 Slovakia joined the EU. The agricultural market became a part of the EU agricultural market. The protection in form of customs and administrative restrictions was abolished and the market became global and integrated. Farms in Slovakia are large when compared to

EU average. Therefore the system of support in form of subsidies has different effects in Slovakia. We observed the structural changes in production and farms based on the integration and globalization.

Crop farms are more productive than animal farms. Profitability of farms differs based on the share of animal production. The most profitable farms have 0 share of animal production. Mixed farms with share of animal production from "60-80%" and "80-100%" are generating loss. The integration and globalization of Slovak agriculture is resulting in specialization of farms and farms are limiting animal production to limit the losses. In the long run, crop farms are profitable and profit from crop production is used to cover the losses from animal production in mixed farms. The most profitable farms are the most risky. Generally the animal production is considered to be less risky when compared to crop production.

ACKNOWLEDGMENT
This paper has been prepared within the projects:
1/0912/14 "Common Agricultural Policy from 2014 to 2020 and its impact on the financial situation of farms in Slovak Republic"
1/0796/14 „Transmission mechanism of CAP instruments and their impact on the financial situation of farms"
Slovak Research and Development Agency under the contract No. APVV-15-0552 with the title Impact of financial markets and agricultural policies on the agri-food sector

REFERENCES

Baginski, S. P., Wahlen, J. M. (2003). Residual income risk, intrinsic values, and share prices. *The Accounting Review*. 78(1), 327-351.

Barkley, A., Hawana Peterson, H., Shroyer, J. (2010). Wheat variety selection to maximize returns and minimize risk: an application of portfolio theory. *Journal of Agricultural & Applied Economics.* 42(1), 39-55.

Barry, P. J. (1980). Capital asset pricing and farm real estate. *American Journal of Agricultural Economics*. 62(3), 549-553.

Cohen, R. B., Polk, C., Vuolteenaho, T. (2009). The price is (almost) right. *The Journal of Finance.* 64(6), 2739-2782.

Da, Z. (2009). Cash Flow, Consumption Risk, and the Cross-section of Stock Returns. *The Journal of Finance*. 64(2), 923-956.

El Benni, N., Finger, R. (2013). Gross revenue risk in Swiss dairy farming. *Journal of dairy science*. 96(2), 936-948.

Fama, E. F., French, K. R. (1995). Size and book-to-market factors in earnings and returns. *The Journal of Finance*. 50(1), 131-155.

Gempesaw, C. M., Tambe, A. M., Nayga, R. M., Toensmeyer, U. (1988). The Single Index Market Model in Agriculture. *Northeast Journal of Agricultural and Resource Economics*. 17(2), 147-155.

Hardaker, J., Huirne, R., Anderson, J., Lien, G. (2004). Coping with risk in agriculture. CABI Publishing. 140 – 156. ISBN 0-85199-831-3.

Just, R. E., Pope, R. D. (2003). Agricultural risk analysis: adequacy of models, data, and issues. *American Journal of Agricultural Economics*. 85(5), 1249-1256.

Libbin, J. D., Kohler, J. D., Hawkes, J. M. (2004). Does modern portfolio theory apply to agricultural land ownership? Concepts for farmers and farm managers. *Journal of the American Society of Farm Managers and Rural Appraisers*. 67(1), 85-96.

Markowitz, H. M. (1952). Portfolio Selection. *Journal of Finance*. 7(1), 77-91.

Peterson, P. E., Leuthold, R. M. (1987). A portfolio approach to optimal hedging for a commercial cattle feedlot. *Journal of Futures Markets*. 7(4), 443-457.

Prattley, D. J., Morris, R. S., Stevenson, M. A., Thornton, R. (2007). Application of portfolio theory to risk-based allocation of surveillance resources in animal populations. *Preventive veterinary medicine*. 81(1), 56-69.

Serenčéš, P., Čierna, Z., Piterková, A. (2016). The development of value-added and net income of farms in Slovakia. The agri-food value chain: challenges for natural resources management and society: *International scientific days 2016.* Nitra: Slovak University of Agriculture, 378-388.

Sharpe, W. F. (1963). A simplified model for portfolio analysis. *Management science*. 9(2), 277-293.

Špička, J., Vilhelm, V. (2013). Determinants of the Risk Environment in Agricultural Enterprises in the Czech Republic. *Acta Oeconomica Pragensia*. 21(2), 69-87.

Tangermann, S. (2011). Risk management in Agriculture and the Future of the EU's Common Agricultural Policy. ICTSD, Issue Paper 34.

Tóth, M., Lančarič, D., Piterková, A., Savov, R. (2014). Systematic risk in Agriculture: A case of Slovakia. *Agris on-line Papers in Economics and Informatics*. 6(4), 185-193. ISSN 1804-1930.

Turvey, C. G., Driver, H. C. (1987). Systematic and nonsystematic risks in agriculture. *Canadian Journal of Agricultural Economics.* 35(2), 387-401.

Váryová, I., Ferenczi Vaňová, A., Košovská, I., Krajčírová, R. (2015). Information tools of cost controlling in entities of agricultural primary produce in Slovakia. Agrarian Perspectives XXIV. Prague: Czech University of Life Sciences Prague, 502-509. ISBN 978-80-213-2581-4.