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Evidence of Spatial Price Transmission in the Case of Kosovo

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Abstract

This study is focused on the analysis of spatial price transmission and market integration of Kosovo agricultural markets with world and EU markets. The paper employs asymmetric error correction model to quantify the extent, speed and nature of price adjustment for the long-run relationship between Kosovo, world and EU agricultural commodity prices. Monthly price data for key cereals (wheat, maize, barley) and beef meat covering the period 2004-2016 are used. Main findings of the study suggest that Kosovo is vulnerable to price transmitting signals from world and EU markets. Empirical results reveal evidence of asymmetry between Kosovo and world prices and signify stronger long-run relationship with the EU prices. Kosovo agricultural markets reacts to positive and negative price deviations, while world and EU prices do not respond on Kosovo price shocks. Kosovo as a price taker and as a country heavily reliant on agricultural and food imports has limited policy instruments to mitigate transmission of global price vulnerability. Under the current liberal trade regime with the regional and EU countries, any trade restrictive actions would have harming welfare effects on domestic consumers. Findings of this study contribute to agricultural and trade policymakers dealing with food prices and food security.

Keywords

Agricultural trade, price transmission, Kosovo, food prices, error correction model.

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Introduction

After three decades of falling real agricultural prices the situation reversed around year 2000 when prices started to grow significantly reaching peak in 2007 and later in 2011. Since then real agricultural prices declined but still remain higher than before year 2000. Furthermore, international agricultural markets became more volatile creating price shocks to consumers and producers (European Commission, 2008; Irwin and Good, 2009). Global agricultural prices and fluctuations are transmitted horizontally to national markets which impacts domestic food security, welfare and agricultural markets. Many countries adopted specific agricultural and trade policies to insulate themselves from volatility of world agricultural markets, which in the end exacerbated price volatility (Tangermann, 2011).

Importing high and volatile world prices into domestic markets affects among others consumers' real income and as a consequence many households fall into poverty, hunger, and malnutrition. Sharp price spikes over a short time period caused aggravating situation of food security (Minot, 2011; Baquedano and Liefert, 2014). Volatile prices enhance risk to farmers which reduces their welfare. As a result of the recent food crisis, additional 150 million people fell into the pool of more than a billion food insecure people worldwide (Dawe et al., 2015).

From the food and agricultural policy perspective, it is essential to understand the extent and speed to which domestic prices in developing and transition countries are affected by fluctuations in world markets. Transmission of world to domestic prices is an important characteristic of market integration and of the relationship between food-deficit and food-surplus areas (Goodwin, 2006; Abdulai, 2007). Information on horizontal price transmission is relevant in designing policy platform for potential government interventions. Recent price shocks

motivated more than 40 countries to impose export restrictions on key food staples (Liefert and Wescott, 2016). These government interventions reduced welfare (i.e. Abbott, 2012; Götz et al., 2013; An et al., 2016) both at a country level and globally.

This paper studies price transmission from world (EU) to Kosovar national agricultural markets. Kosovo is a small transition country heavily dependent on food imports from the world markets. Furthermore, Kosovo suffers from significant food insecurity problems. About a third of total population (29.2 percent) lives with less than 2$ per day and more than 10 percent of the Kosovar population suffer from extreme poverty (World Bank/KAS, 2011). Most of the rural households rely on their own production of food. The share of food expenditures reaches about 40 percent of total expenditures of households (Latruffe and Desjeux, 2014). High dependence on food imports combined with significant poverty rate and food insecurity make Kosovo vulnerable to transmitting high prices and volatility from international markets.

The main objective of the paper is to quantify effects of horizontal price transmission from the world and EU markets into the domestic agricultural markets in Kosovo. We employ price transmission analysis for wheat, maize, barley and beef meat, which are main agricultural commodities in Kosovo. Monthly time series for the period 2004-2016 are utilized to estimate asymmetric error correction models.

The structure of the paper is organized as follows. Section 2 presents overview of previous studies, with special reference on developing economies. This section also provides information on cereal and meat market characteristics in Kosovo. In section 3 we introduce methodology and estimation strategy in measuring effects of spatial price transmission. Section 4 reports results and discusses findings, while in the final section we draw conclusions and make recommendations.

Literature review

A large number of studies examined the issue of spatial price transmission for selected commodities within a single country (Goodwin et al., 1999; Myers and Jayne, 2012; Burke and Myers, 2014; Ganneval, 2016) or commodity price transmission from world to domestic markets (Rapsomanikis et al., 2006; Dawe, 2009; Minot, 2011; Esposti and Listorti, 2013; Ianchovichina et al., 2014; Baquedano and Liefert, 2014; Ceballos et al., 2017). These studies provided information on extent and speed of price transmission and efficiency of the markets. Empirical findings of these studies are particularly relevant for policymakers in developing and transition economies where expenditures on food are high.

While spatial price transmission has been investigated in a number of transition countries from Central and Eastern Europe and Central Asia (e.g. Götz et al., 2013 for Russia and Ukraine; Clark et al. 2015 for Czech Republic; Bakucs et al., 2015 for Hungary and Slovenia; Ilyasov et al., 2016 for Tajikistan; Bobokhonov et al., 2017 for Tajikistan and Uzbekistan, Rajcaniova and Pokrivcak, 2013 for Slovakia), studies on South Eastern European (SEE) transition countries are limited. Some exceptions are studies on Macedonian tomato market integration with neighbouring countries (Jordanov et al., 2013) and a study on effects of Serbian governmental intervention on the domestic wheat market during the period of recent food crisis (Djuric et al., 2011). This gap in literature presents significant challenge for SEE countries which are negatively exposed to transmission of price shocks from international markets.

Kosovo is a small and open market economy that is relatively well-integrated into global markets. Recently Kosovo reported significant yearly GDP growth rates of about 5 percent. However, the country remains one of the poorest European economies suffering from exorbitant unemployment rate of 35 percent, particularly affecting the young people. About 12 percent of GDP of Kosovo comes from remittances from mainly EU countries. Remittances play an important role in poverty mitigation (Meyer et al., 2012; EFSE, 2014; Braha et al., 2017).

Kosovo is heavily reliant on imports of agricultural commodities (Sauer et al., 2012). Agricultural imports provide the only solution in meeting domestic demand, particularly for cereals, meat and dairy products. Agricultural imports form 22-25 percent of total imports. Due to the high proportion of agricultural imports and liberalized trade regime, local prices are determined by import prices (ARCOTRASS, 2006; MTI, 2009). Import prices have therefore significant impact on food security in Kosovo.

Materials and methods

Horizontal price transmission refers to price linkage between different markets spatially separated unlike vertical price transmission which

refers to price linkage between various stages of the supply chain. Theoretical foundation for empirical estimation of horizontal price transmission is the spatial arbitrage which leads to the workings of the Law of One Price (LOP). Most empirical works in this field, therefore, aim to assess whether the LOP holds true under specific conditions (Listorti and Esposti, 2012).

There are several reasons while the LOP may not hold (Conforti, 2004, Rezitis and Stavropoulos, 2010). First, spatial price arbitrage takes time and therefore there could be price differences between different markets in the short-term despite long-term price equilibrium. Second, transportation costs and transaction costs put a wedge between prices of the same product in different markets. Third, regulations including border regulations like tariffs, quotas or non-tariff measures prevent convergence of prices. Fourth, non-tradability of the product, imperfect competition or market failure like imperfect information can prevent the application of the LOP in practice.

Assuming the LOP holds, in two spatially separated markets the change in one price is instantly transmitted to the other price (Listorti and Esposti, 2012) therefore both markets will have ultimately a unique price (Brown et al., 2012). Models of spatial price transmission suggest that if two markets are associated by trade in a free market regime, excess demand or supply shocks in one market will have an equal impact on price in both markets (Rapsomanikis et al., 2003).

Integrated markets allow for efficient transmission of price signals and prevent market inefficiencies. In contrary, markets that are not integrated can convey inaccurate price information, leading to misguided decisions (Alam and Begum, 2012). Literature on spatial price transmission (Sexton et al., 1991; Conforti, 2004) determines factors affecting price transmission processes and market integration, such as transport and transactions costs, imperfect competition, exchange rates, trade barriers, and domestic policies.

Price transmission studies were strongly motivated by the belief that co-movement of prices in different markets can be interpreted as a sign of efficient (competitive) markets, whereas the lack of co-movement is an indication of market failures (Minot, 2011). Relevant issue in this context is the distinction between short and long run price transmission. Under the occurrence of price difference between two markets, arbitrage activities aim to trigger a reversion process which drives prices to their long-term equilibrium relationship (Ganneval, 2016). The speed by which prices adjust to their long run relationship is critical in understanding the extent to which markets are integrated and efficient in the short run (Rapsomanikis et al., 2003). Particular interest in the price transmission process is devoted to the asymmetry, aiming to identify whether price increases are equally transmitted to other markets as price decreases (Meyer and von Cramon-Taubadel, 2004). Previous research on price transmission exploits sophisticated time series econometric analysis techniques, testing for the co-movement of prices. These techniques include cointegration and error correction models. They became standard tool for analysing spatial market relationships (Rapsomanikis et al., 2003), replacing earlier traditional techniques, such as the correlation and regression analyses (Minot, 2011).

In our paper, we apply time-series modelling techniques to evaluate spatial price transmission from world market to Kosovo and vice versa. In this study, an asymmetric error correction model is employed to quantify the extent, speed and nature of price adjustment.

Initially, we test the stationarity of time series using two unit root tests: the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. The number of lags of the dependent variable is determined by the Akaike Information Criterion (AIC). If both time series are not stationary, they are suitable to test for cointegration relationship between them. We employ the Johansen approach to test for cointegration. The Johansen approach starts with a vector autoregressive model and reformulates it into a vector error correction model:

$$Z_t = A_1 Z_{t-1} + \ldots + A_k Z_{t-k} + \varepsilon_t \quad (1)$$

$$\Delta Z_t = \sum_{i=1}^{k-1} \Gamma_i \Delta Z_{t-1} + \Pi Z_{t-k} + \varepsilon_t \quad (2)$$

where Z_t is the vector of non-stationary variables (producer and consumer prices), A are different matrices of parameters, t is time subscript, k is the number of lags and εt is the error term assumed to follow i.i.d. process with a zero mean and normally distributed $N(0, \sigma^2)$ error structure. The estimates of Γ_i measure the short-run adjustment to changes in the endogenous variables, while Π contains information on the long-run cointegrating relationships between variables in the model.

The above cointegration tests assume symmetric price transmission. In order to capture asymmetric movements in the residuals, Enders

and Granger (1998) and Enders and Siklos (2001) propose to use threshold cointegration approach. Assuming the long run relationship between two nonstationary variables X and Y

$$Y_t=\lambda_0+\lambda_1 X_t+\mu_t \quad (3)$$

where μ is the error term. Engle and Granger (1987) show, that cointegration exists if the null hypothesis $\rho=0$ is rejected in:

$$\Delta\mu_t=\rho\mu_{t-1}+\xi_t \quad (4)$$

where ξ is the error term for the residuals. Adjustment of the series of residuals expressed in (4) would be symmetric. To capture the asymmetry in adjustment process, a two-regime threshold cointegration approach should be used:

$$\Delta\mu_t=I_t\rho_1\mu_{t-1}+(1-I_t)\rho_2\mu_{t-1}+\xi_t \quad (5)$$

where I_t is the Heaviside indicator; $I_t=1$ if $\mu_{t-1} \geq \tau$ or $I_t=0$ if $\mu_{t-1} < \tau$. If μt-1 is bigger than the threshold τ, then adjustment is at the rate ρ_1. If μ_{t-1} is smaller than the threshold τ, adjustment is shown in ρ_2. When $\rho_1=\rho_2$, then the adjustment process is symmetric. If the null hypothesis $\rho_1=\rho_2=0$ is rejected, then X and Y are cointegrated and the following TAR (threshold autoregressive) model is estimated:

$$\Delta Y_t=\theta_Y+\delta_Y^+E_{t-1}^++\delta_Y^-E_{t-1}^-+\sum_{j=1}^{J}a_{Yj}^+\Delta Y_{t-j}^+ +\sum_{j=1}^{J}a_{Yj}^-\Delta Y_{t-j}^-+\sum_{j=1}^{J}\beta_{Yj}^+\Delta X_{t-j}^+ +\sum_{j=1}^{J}\beta_{Yj}^-\Delta X_{t-j}^-+\upsilon_{Yt} \quad (6)$$

where ΔY_t and ΔX_t are dependent and independent variables in their first differences, E is the error correction term, δ represents the speed of adjustment coefficients of ΔY_t if Y_{t-1} is above and below its long-run equilibrium, θ, δ, α and β are coefficients and υ is the error term, t is time subscript and j is the number of lags.

Two error correction terms are defined as:

$$E_{t-1}^+=I_t\mu_{t-1} \quad (7)$$

$$E_{t-1}^-=(1-I_t)\mu_{t-1} \quad (8)$$

Enders and Granger (1998) and Enders and Siklos (2001) proposed also a model for cointegration, known as momentum threshold autoregressive model (M-TAR). The term "momentum" describes the rate of acceleration of prices and takes into account steep variations in the residuals; it is especially valuable when the adjustment is believed to exhibit more momentum in one direction than in the other. Heaviside indicator in this case is $I_t=1$ if $\Delta\mu_{t-1} \geq \tau$ or $I_t=0$ if $\Delta\mu_{t-1} < \tau$.

Threshold error correction models were used for example by Goodwin and Holt (1999); Goodwin and Harper (2000); Goodwin and Piggott (2001); Serra and Goodwin (2003); Vavra and Goodwin (2005); Liao and Sun (2011) or Ning and Sun (2012). Abdulai (2000, 2002) used both TAR and M-TAR models and found out, that the M-TAR models fit data better than the others.

To summarize, four asymmetric models are considered in our study. They are threshold autoregression model with threshold value equal to zero; threshold autoregression model with threshold value estimated (consistent threshold autoregression model); momentum threshold autoregression model with threshold value equal to zero; and consistent momentum threshold autoregression model with threshold value estimated. A model with the lowest AIC and BIC is used.

Empirical estimates of this study are based on the monthly time series for key agricultural commodities (wheat, maize, barley, and beef meat). Monthly price data for Kosovo are obtained from the Kosovo Agency of Statistics (KAS, 2017) and cover the period from January 2004 to December 2016. On the other hand, world prices for the same group of agricultural commodities were extracted from the World Bank (2017), respectively Global Economic Monitor (GEM) database. EU-28 prices were obtained from the European Commission - DG Agriculture and Rural Development (EC, 2017). EU prices are the prices received by European farmers for their commodities. These prices are in nominal terms and expressed in euro. Two main reasons determined selection of the group of commodities we assess in this paper: their importance on the food diet in Kosovo and data availability. Estimates in this study are based on relative prices. Kosovo and EU prices were denominated in euro, while the world prices in USD. We use monthly exchange rate from European Central Bank (ECB, 2017) to convert Kosovo and EU domestic prices to USD. Detailed information on variable definition and summary statistics are provided in Table 1.

Variable	Definition	Source	Mean	STD.	Min	Max
Wheat (World)	Wheat (US), no. 1, hard red winter, ordinary protein, export price delivered at the US Gulf port	World Bank	219.3	64.4	128.2	419.6
Wheat (EU)	Breadmaking common wheat, average market price and market stages, Reg. EC 1272/2009	EU Agri	224.8	68.7	133.4	406.6
Wheat (Kosovo)	Wholesale prices	KAS	274.5	87.3	165.0	543.4
Maize (World)	Maize (US), no. 2, yellow, f.o.b. US Gulf ports	World Bank	187.8	66.3	93.7	333.1
Maize (EU)	Feed maize, average market price and market stages, Reg. EC 1272/2009.	EU Agri	221.7	61.8	139.5	356.9
Maize (Kosovo)	Wholesale prices	KAS	315.8	87.9	178.8	535.5
Barley (World)	Barley, Canadian no.1 Western Barley, spot price	World Bank	162.4	48.3	85.4	265.7
Barley (EU)	Malting barley, average market price and market stages, Reg. EC 1272/2009.	EU Agri	204.5	60.4	129.6	349.1
Barley (Kosovo)	Wholesale prices	KAS	367.2	103.5	182.0	554.1
Beef (World)	Beef, Australian and New Zealand 85% lean fores, CIF U.S. import price	World Bank	3.5	0.9	2.1	6.0
Beef (EU)	Cow carcase (D), average fat cover, market price paid to supplier, Reg. EC 1249/2008, 1308/2013	EU Agri	3.3	0.5	2.2	4.3
Beef (Kosovo)	Wholesale prices	KAS	7.1	1.1	5.1	9.0

Source: KAS (2017), World Bank (2017) and EC (2017); own elaboration

Table 1: Variable definition and summary statistics.

Results and discussion

Price development during the time period covered in this study is characterized by strong price fluctuations and high volatility. The first wave of agricultural price volatility took place between 2007 and 2008. Such a price development can be attributed to the impact of the global food price resiliency. The second wave of price volatility is recorded between 2010 and 2011. This is particularly true for cereals (wheat, maize and barley). Similarly, prices of the observed commodities revived once again during the period 2012-2013 with the tendency to calm down in the following years. Interestingly, price development of agricultural commodities in Kosovo followed the world and EU-28 price trends. It indicates a significant degree of co-movement and subsequent similarity in the price volatility between the local and international prices. However, despite the analogous price movement there is evidence of a price gap, particularly in the case of maize, barley and beef meat. Main determinants describing differences between the world and domestic prices are influenced by transport costs and profit margin.

As the initial step of our empirical approach we test stationarity of time series employed in the analysis using two unit root tests: Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test. Results of the tests confirmed that all time series are non-stationary. We stationarized them by taking first differences. The tests indicate that all variables are stationary in first differences. Lags of the dependent variable in the tests were determined by Akaike Information Criterion (AIC).

The stationarity tests showed that the original time series are non-stationary and can be used for cointegration analysis. Johansen cointegration test revealed that there are only two pairs of prices cointegrated between the world market and Kosovo market; however, the long run relationship between EU and Kosovo market was confirmed for all commodities analysed.

Threshold cointegration tests suggest that there is a strong evidence of cointegration relationship between the world and local prices as well as between the EU and local prices of all commodities. As seen from the results, the pairs of prices that have not proved to be cointegrated with the Johansen test are cointegrated with threshold adjustment. This means that Enders and Granger model with threshold fits our data better. From the tests, it also follows that there is weak evidence of asymmetry for world and local prices of wheat and beef. Asymmetric relationship between EU and local prices is highly significant for wheat and barley and weakly significant for other commodities. Thus, one can see that

the link between EU and Kosovo market is much stronger than the relationship between world and local prices. Note that the absolute values of the speed of adjustment of positive price deviations are lower for all cases (except for EU barley and Kosovo barley prices) than the speed of adjustment of negative price deviations. Thus, deviations from the long-term equilibrium resulting from price increases (above the threshold) would be less persistent compared to price deviations resulting from price decreases (below the threshold) Table 2 and 3).

	Rank	Johansen trace statistics	Trend specification	Lags
World - Kosovo				
Wheat	0	34.157	Restricted trend	2
	1	5.288***		
Maize	0	13.497	Restricted constant	2
	1	2.706		
Barley	0	24.270	Restricted constant	3
	1	6.956**		
Beef	0	14.312	Restricted constant	2
	1	3.195		
EU - Kosovo				
Wheat	0	21.083	Restricted constant	2
	1	8.626**		
Maize	0	33.400	Restricted constant	2
	1	7.366***		
Barley	0	29.277	Restricted constant	3
	1	8.937***		
Beef	0	20.452	Restricted constant	2
	1	4.898**		

Note: *,**,*** denote significance at the 1%, 5% and 10% significance levels.
Source: KAS (2017), World Bank (2017) and EC (2017); own elaboration

Table 2: Johansen cointegration test results.

	Model	Threshold	Lags	ρ_1	ρ_2	$\Phi(H_0;\rho_1=\rho_2=0)$	$F(H_0: \rho_1=\rho_2)$
World - Kosovo							
Wheat	cMTAR	-0.02	4	-0.059	-0.200***	5.404***	3.099*
						[0.005]	[0.080]
Maize	cTAR	-0.437	3	-0.079*	-0.202***	4.976***	2.111
						[0.009]	[0.149]
Barley	cMTAR	-0.012	3	-0.04	-0.084**	3.915**	1.022
						[0.022]	[0.314]
Beef	cMTAR	-0.004	1	-0.004	-0.105***	5.278***	5.543**
						[0.006]	[0.020]
EU - Kosovo							
Wheat	cMTAR	-0.045	3	-0.056	-0.430***	11.717***	14.327***
						[0.000]	[0.000]
Maize	cMTAR	-0.029	1	-0.043	-0.234***	7.813***	6.630**
Barley	cMTAR	0.048	3	-0.221***	-0.025	8.878***	11.479***
						[0.000]	[0. 001]
Beef	cMTAR	0.006	3	0.005	-0.072***	4.333**	3.867*
						[0.015]	[0.051]

Note: *,**,*** denote significance at the 1%, 5% and 10% significance levels, with P values in the brackets
Source: KAS (2017), World Bank (2017) and EC (2017); own elaboration

Table 3: Threshold cointegration test results.

Because there is strong evidence of cointegration relationship between the world and local, and EU and local prices, we have estimated error correction models for these commodities following equation (6). Results reveal that EU market is more influential than the world market from the short run as well as from the long run perspective. Presumably, negative and significant error correction terms of Kosovo prices show a tendency to come back to the long run equilibrium after the shock in world or EU market. Lastly, point estimates of coefficients for the error correction terms in Kosovo imply that prices in Kosovo react with somewhat different speed to positive and negative deviations.

Discussion and policy implications

Our results confirm a strong influence of international agricultural markets on Kosovar domestic prices. Domestic prices for key food staples, particularly wheat and maize, are extensively affected by world and EU markets. In the case of food deficit economies, such as Kosovo, consequences of absorbing international price shocks are usually translated into diminishing domestic welfare effects. As noted by McLaren (2015) adverse effects are particularly vigorous in the case of countries where subsistent farmers often live close to the poverty line.

During and after the period of the global food price shocks, governments in many developing countries pursued a wide range of policies in attempt to mitigate transmission of higher international prices to the domestic markets. Profound literature (Zorya et al., 2014; Baltzer, 2014) draws critical attention on governmental isolationist policy responsiveness during the recent global price shocks. Policy instruments, such as trade restrictions, import tariffs or export bans deterred transmission of price signals from international markets. For example, Götz et al. (2013) quantify effects of wheat export controls in Russia (export tax) and Ukraine (export quota) during the recent global food crisis. They find out reduction of the degree of integration of Russian and Ukrainian domestic markets into world wheat markets. Furthermore, negative market effects discouraged private investors, preventing Russia and Ukraine from maximizing their grain potential and contributing to global food security. Similarly, Djuric et al. (2011) estimate effects of Serbian government intervention on domestic wheat market during the period of food crisis. The authors demonstrate that export restrictions influenced negatively market equilibrium as well as domestic market stability. As a result, domestic wheat price increased above the world price level, despite the short-run decline of the wheat price. Baffes et al. (2017) provide evidence on adverse impact of Tanzanian export bans on its maize markets. The authors suggest that, comparatively to external factors, domestic restrictive policies exert a greater influence on Tanzanian maize markets. Porteous (2017) investigate effects of 13 short-term export bans on maize in the case of five countries in East and Southern Africa. According to the study export bans appear to increase prices and volatility in the implementing country, and therefore policy-makers should reconsider the use of bans for price stabilization purposes. Deuss (2017) suggests that impact of export restrictive policies during the recent commodity price spikes was not limited only to countries applying these measures, these policies influenced heavily consumer prices of importing partners too. Results of the study stress out long-lasting effects of export bans, despite their temporary nature. The author reveals that export bans have significantly higher aggravating effects on import reliant countries compared to self-sufficient countries.

Taking into account findings of this study, as well as empirical evidence from transition economies, we argue that policymakers in Kosovo have limited trade instruments to mitigate transmission of high prices from international markets. Firstly, Kosovo is a price taker in international agricultural markets. Secondly, Kosovo has liberalized trade regime with neighbouring region through CEFTA 2006 free trade agreement, as well as with EU common market through SAA (Stabilization and Association Agreement). Thirdly, net importer of food position of Kosovo significantly limits the use of border measures as their use would harm consumers and worsen food security situation in the country. Therefore, we recommend that Kosovo should intensify accomplishment of its development agenda, with special reference on incentives to improve agricultural productivity, restructure actual small and subsistent farms, provide know-how through establishment of extension institutions, and offer direct support to agricultural sectors in which Kosovo has comparative advantage. Lastly, social protection policies (such as income transfers and food safety nets), despite budgetary restrictions, should target in particular vulnerable social cohorts. Targeting support programs to the poor and vulnerable cohorts is essential to provide social protection without jeopardizing fiscal sustainability. Investing in safety nets before the laps of crisis allows their rapid and cost-efficient scale-up.

Conclusion

This study aims to provide empirical evidence for policymakers in the field of agricultural trade policy analysis. Kosovo is self-insufficient in meeting domestic demand for key food staples. Self-sufficiency ratios for key agricultural commodities served as a proxy to determine vulnerability of the food system in Kosovo. Despite its potential to contribute to national food security, actual contribution of agricultural sector at this level remains weak and neglected from governmental institutions. Underinvestment and non-supportive environment turned local farmers into non-competitive actors towards heavily subsidized EU imports.

Empirical estimates affirm close relationship between world and domestic market, especially in case of maize and barley. In cases with identified presence of price transmission process we also investigated symmetry of this process. We confirmed that there is strong evidence of asymmetry for world and local prices of wheat and beef and weak evidence of asymmetry for barley. Based on results of error correction models for these commodities it can be concluded that prices in Kosovo react with different speed to positive and negative deviations, while world prices do not react to shocks in Kosovo prices, as expected due to tiny size of Kosovo markets.

Kosovo as a small country is a price taker in the global trade, therefore transmission of food price volatility from world (and EU) markets into the domestic market has been empirically evidenced. Spatial price transmission analysis found that Kosovo is vulnerable to price transmitting signals from the international markets. Based on findings of this study, under the current conditions of the liberalized trade regime it is difficult for policies to respond adequately. Indeed, Kosovo is a part of EU preferential autonomous trade measures (ATMs) and part of the regional Central European Free Trade Agreement (CEFTA 2006) and most of the Kosovo imports have their origin from EU and CEFTA 2006 member states.

Furthermore, Kosovo has limited budgetary resources to undertake robust social and welfare improving policies to respond to transmitting effects of global food price shocks. In the short run, food assistance programs, food safety nets and income transfers might serve as attractive policy instruments to mitigate the impact of transmitted high prices. But in the long run, policy actions should incentivize farmers and consumers in order to respond to market signals. This should be achieved through continuous investments in agricultural sectors with comparative advantage. In the case of Kosovo, protectionist driven trade policies would generate negative price and welfare effects.

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Appendix

	Wheat		Maize		Barley		Beef	
	World	Kosovo	World	Kosovo	World	Kosovo	World	Kosovo
(Intercept)	-0.012	-0.037***	-0.006	0.034	-0.005	-0.004	0.005	0.003
X.diff.world.t_1.pos	0.256*	0.474***	0.249	0.175	0.364**	0.156	0.380***	-0.014
X.diff.world.t_2.pos	-0.271*	0.130	0.212	0.132n	-0.366**	-0.384**	-	-
X.diff.world.t_3.pos	-0.115	0.061	0.434**	-0.178	0.120	-0.316**	-	-
X.diff.world.t_4.pos	-0.138	0.279*	-	-	-	-	-	-
X.diff.world.t_1.neg	0.067	-0.024	0.309	-0.056	0.257*	-0.183	0.498***	0.081
X.diff.world.t_2.neg	-0.046	-0.093	0.008	0.558	-0.017	0.049	-	-
X.diff.world.t_3.neg	-0.148	0.057	-0.163	0.215	-0.162	-0.036	-	-
X.diff.world.t_4.neg	-0.050	0.116	-	-	-	-	-	-
X.diff.domestic.t_1.pos	0.352**	0.077	-0.075	0.213	0.076	0.460***	-0.091	0.161
X.diff.domestic.t_2.pos	-0.020	0.145	-0.015	-0.166	0.093	0.075	-	-
X.diff.domestic.t_3.pos	-0.001	-0.131	-0.018	-0.063	-0.031	0.136	-	-
X.diff.domestic.t_4.pos	0.372***	0.156	-	-	-	-	-	-
X.diff.domestic.t_1.neg	0.031	0.002	-0.046	0.087	-0.039	-0.132	-0.085	0.232
X.diff.domestic.t_2.neg	0.012	-0.053	0.043	-0.161	-0.091	0.054	-	-
X.diff.domestic.t_3.neg	-0.080	-0.174	0.027	0.348**	-0.007	0.098	-	-
X.diff.domestic.t_4.neg	0.039	0.067	-	-	-	-	-	-
X.ECT.t_1.pos	-0.115*	-0.144***	-0.102**	0.074	-0.060**	-0.081***	0.019	0.012
X.ECT.t_1.neg	-0.022	-0.182***	-0.038	0.326***	-0.010	-0.80**	0.123	-0.047

Source: own elaboration

Table A.1: Results of the asymmetric error correction model with threshold cointegration (World - Kosovo prices).

	Wheat		Maize		Barley		Beef	
	World	Kosovo	World	Kosovo	World	Kosovo	World	Kosovo
(Intercept)	-0.002	-0.020**	0.002	-0.010	0.004	-0.013	-0.003	-0.002
X.diff.world.t_1.pos	0.677***	0.697***	0.380**	0.370	0.716***	0.189	0.401**	0.033
X.diff.world.t_2.pos	-0.367**	-0.367	-	-	-0.195	-0.382	0.081	-0.011
X.diff.world.t_3.pos	0.206	0.577**	-	-	0.015	0.084	0.036	0.071
X.diff.world.t_4.pos	-	-	-	-	-	-	-	-
X.diff.world.t_1.neg	0.634***	0.381*	0.600***	0.020	0.574***	-0.120	0.515***	0.045
X.diff.world.t_2.neg	0.159	0.173	-	-	-0.095	-0.213	-0.030	-0.133
X.diff.world.t_3.neg	-0.110	-0.109	-	-	-0.022	-0.125	0.100	0.302*
X.diff.world.t_4.neg	-	-	-	-	-	-	-	-
X.diff.domestic.t_1.pos	0.166*	0.025	0.051	0.031	-0.112	0.450***	-0.150	0.113
X.diff.domestic.t_2.pos	-0.062	0.038	-	-	-0.127	0.060	-0.029	0.271
X.diff.domestic.t_3.pos	-0.068	-0.168	-	-	-0.227**	0.069	0.095	-0.080
X.diff.domestic.t_4.pos	-	-	-	-	-	-	-	-
X.diff.domestic.t_1.neg	0.024	-0.042	-0.012	-0.013	0.017	-0.036	-0.098	0.158
X.diff.domestic.t_2.neg	-0.233**	-0.135	-	-	0.009	0.059	-0.236	-0.053
X.diff.domestic.t_3.neg	0.055	-0.180	-	-	-0.020	0.078	-0.191	-0.181
X.diff.domestic.t_4.neg	-	-	-	-	-	-	-	-
X.ECT.t_1.pos	-0.017	-0.095*	-0.045	-0.138***	-0.079**	-0.283***	-0.050	-0.032
X.ECT.t_1.neg	-0.176**	-0.584***	-0.030	-0.265***	-0.027*	-0.058**	0.016	-0.058*

Source: own elaboration

Table A.2. Results of the asymmetric error correction model with threshold cointegration (EU - Kosovo prices).

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E-Commerce Framework for Strategic Marketing of Udupi Jasmine

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Abstract

Udupi jasmine cultivation plays an important role towards economic and social growth for the jasmine growing community-based enterprise of coastal Karnataka, India. It helps in promoting rural livelihoods, food security and poverty reduction. Due to the significant socio-economic impact of jasmine cultivation, the promotion and marketing of jasmine is inevitable for the sustenance of this community-based enterprise This study aims in developing an e-commerce framework for strategic marketing and promotion of Udupi jasmine. Study found that the benefits of e-business was nowhere applied in the existing system. As Udupi jasmine is a unique crop with a geographical indication tag (GI), regular agricultural framework cannot not be directly used. The research intents to persuade utilization of customized e-commerce framework for jasmine considering the existing crude system. This will reinforce the socio-economic growth of this community-based enterprise as there will be a well-organized circulation of agricultural products on a larger scale.

Keywords

Udupi jasmine, e-commerce, e-business, community-based enterprise, socio-economic, policy making, e-agriculture, ICT.

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Introduction

Jasmine is one of the oldest flowers grown for their aromatic scent. It is widely used in southern India for various decorative purposes and for personal use. Jasmine is also used in production of perfumes and cosmetics. Although there are more than 50 types of jasmine species grown in India, out of which only three species are used for commercial purposes. Udupi Jasmine belongs to one of these species of Jasminum Sambac–1 species of jasmine (Ashok and Sarma, 2016). Udupi Jasmine has also been accorded with a geographical indication tag in 2008. Majority of the Udupi jasmine is grown in the Shankarapura region of Udupi district of coastal Karnataka, India. Udupi jasmine flower growing community of coastal Karnataka have maintained a community-based enterprise for more than 85 years. Many of the farmers of this region depend directly on cultivation of Udupi jasmine for their livelihood (Krishnamurthy et al., 1995). By the rule of thumb this community-based enterprise has developed a working system of pricing, supply and distribution. Through mutual trust and cooperation, this community has kept poverty away for manny generations. Jasmine cultivation has a significant socio-economic impact on the cultivators. Although the cultivators have other sources of income, jasmine cultivation is the major source of their economy.

E-agriculture is a relatively recent term in the field of agriculture and rural development practices. Food and agriculture organization of the United Nations describes e-agriculture as an emerging field through improved information and communication processes, focuses on the enhancement of agricultural and rural development. E-agriculture to be more specific comprises of the approach, then designing, development based on the design, assessment and application of groundbreaking ways of using information and communication technologies (ICT) in the rural area, with the focus being agriculture.

Using internet to market products and services, buying and selling of goods and services, information exchange, creating and maintaining relationships over internet can be referred to as e-commerce which is one of the aspects of e-agriculture (Fruhling and Digman, 2000). E-commerce is believed to have the potential to increase profitability in agricultural

markets by increasing sales and decreasing search and transactions costs. E-commerce markets tend to attract more customers as they are likely to be more transparent and competitive than physical markets, hence increase in demand (Montealegre et al., 2007). Agricultural e-commerce is to introduce e-strategy to improve the interaction and trading activities between participants in the agricultural sector and changing the configuration and relationships at various stages in linkages of the food supply chain. There has been much evidence that e-commerce offers an important opportunity for cost reduction and demand enhancement (Leroux et al., 2001).

Small stake holders often find it difficult to take advantage of market opportunities in developing countries due to the widespread irregularities of markets such as discontinuity of information on modern technologies and price, disconnection with the established market actors and constrains in credit process (Markelova et al., 2009).

One of the key aspects for any ICT project to succeed is the delivery of information to the key stake holders involved. The important factor in the success of a project depends on the way ICT projects apply, access, deliver and assess the content which in turn increases possibility of farmers using the ICT project. Generally, the critical factors in the success of a project is to understand the information needs of a farmer. Customization and localization of content to the farmers condition effects its relevance. (Glendenning and Ficarelli, 2012).

Local content is generally defined as content that is intended for a specific local audience, as defined by geographic location, language, culture and content that is socially, culturally, economically and politically relevant to a given society (Glendenning and Ficarelli, 2012). Thus, local content is the expression of a community's knowledge. Localization can be improved with the direct involvement of the users by personal interviews that involves question and answers. The sources that provide the content are generally the local experts and establishments who have expert local knowledge.

Manny of the ICT projects are not always relevant to local context and needs, because of a disconnect between the project and its end users (Ballantyne, 2002). Without the necessary knowledge of the working of the existing system and the necessities of framing community, often projects push content to people. In agriculture, information generation needs to be a two-way process, with research at the farm level so that contextually appropriate content can be generated (Chapman and Slaymaker, 2002). With a two way process farmers can generally share their experiences and best agricultural practices which can be incorporated to the program as farmer knowledge base (Silva, 2008). Content can then be contextualized by the ICT project based on the communities information needs. Multiple interactions with the community will insure the trust of the establishment, better understanding of the demands of local communities, hence providing insights to the needs of the community that the ICT platform will serve. Clear understanding of the demands of the communities requires competency in analysis of the needs, which involves the process based on actual dialogues with the members of the community, which then requires the empowerment and organization of the community. Thus, this complication will often hinder the ICT projects from serving the deprived groups within the community. (Chapman and Slaymaker, 2002).

Hence determining the community's needs along with the critical understanding of the existing system proves to be a major success factor for an ICT project. As localization is critical factor for an ICT project to succeed, this framework is designed based on the study conducted and inferences gained from the working of this community-based enterprise.

Introducing e-commerce to market Udupi jasmine has a number of benifits:

- **Providing structure to a fragmented agricultural market.** The Udupi jasmine market is large, dispersed market. E-Commerce may assist in providing answers by assimilating individual actors to improve the structure of the organization. Through the internet many aspects of business can be managed.
- **With a limited investment the e-commerce can improve the market reach.** Irrespective of the geographic location ICT technologies provides with the chance with a little investment in infrastructure to link various actors in the farming chain. By reducing the obstacles of geographic locations of market reach such as time and distance it increases the market reach through online transactions.
- **Price transparency and price stability will improve online.** Online access to product and price information will allow comparison

of products and increase price transparency. Fluctuations in price likely to diminish because of increase in competition. Also, the demand will increase as the accessibility is increased to a larger population and hence stability in price.

- **Accessibility will be key to acceptance.** Adoption of an interment technology depends on the accessibility along with the benefits it offers. Udupi jasmine has got a significant socio-economic impact on the community-based enterprise. The community-based enterprise has an unstructured system. Thus, e-commerce will assist to extend the reach of Udupi jasmine to a larger market.
- **Better information exchange.** Information exchange can help reduce the gap between consumers and cultivators.
- **Formation of an alternative market structure**. It will help in decreasing rural isolation and increasing market transparency.
- **Enhance farming techniques and best practices.** Timely interventions can help improve farming techniques and adopt best practices in agriculture and in policy making.

E-commerce theories in agriculture has different approaches. The term "Business to Business" (B2B) implies similarities or equal partners in trade. By contrast "Business to Consumer" (B2C) suggests a difference between the two parties. The framework attempts to integrate both these business models. The framework focuses on the functions provided by the ecommerce system and does not consider the infrastructure support for e-commerce. Development of the framework also takes inputs from different architectures that will assist this framework in conducting smooth commerce over the internet. The proposed framework intends to assist in improving the socio-economic status of the cultivators. The research gives priority to the existing system so that it can better integrate with the proposed system. The framework is designed exclusively for Udupi jasmine as it will provide a structure to an unstructured system.

Materials and methods

Udupi Jasmine is grown in specific regions of Shirva, Shankarapura, Belle (Moodubelle and Padubelle) of Udupi district, in coastal Karnataka, India. Delivery of information to the key stake holders involved is critical for an e-commerce project. To deliver relevant information to the stake holders understanding of the existing system with respect to the product is important. Usage of Udupi jasmine is very localized and mostly people who are acquainted with it engage in its business. In terms of market, consumers who are familiar and revere the crop are the ones who buy it. Thus, in development of the framework the following aspects are considered.

1. Recognize various actors involved in the system and how each one of them can contribute to the system.
2. Price determination and the variables that influence it.
3. Consumer needs.
4. Discerning some of the existing e-commerce frameworks.

Recognize various actors involved in the system and how each one of them can contribute to the system.

To understand the working of this community-based enterprise, personal interviews were conducted with the various correspondents. The correspondents were jasmine growers, agents and traders. Snowballing technique was used in the selection of candidates. The process of jasmine collection by growers starts early in the morning and is finished by 10 am. Jasmine buds are not directly sold to the consumer, instead they are tied together to a 6-inch chain approximately and then sold. These bundles of tied buds are then collected by agents. Each household is connected to one among 150 agents who operate in the respective area.

Responsibility of the agent is to collect the buds from the household and then arranging them for commercial units comprising of 800 - 805 buds each. Then they are formed into four bundles for which price is fixed by traders each day. As not all households will be able to produce a unit with desired number of buds, the agents form these units with whatever buds they have collected from multiple households. Each agent is connected to multiple households from whom they collect these buds. During the collection process the grower informs the agent of the number of buds they have given, and the agent maintains a record (hard copy) about information of each farmer and price to be given for that day. Growers are paid on weekly basis by the agents for the collected produce.

The agents then supply these commercial units, to a designated trader located in Shankarapura. There are six traders in total to whom all

the agents supply. The traders sell the collected units to wholesalers located outside the region. These units reach wholesalers as far as Mumbai and Dubai. The traders keep track of the units received from agents and appropriate payments are made to them on weekly basis.

Price determination and the variables that influence it

Determination of price per unit is done by the traders. The six traders come together to determine the price for a jasmine unit based on the requirements for that day. Based on the demand from their wholesalers, one of the 6 traders establish a price X for that day. If the price X is not acceptable by the wholesalers of other 5 traders, they decrease their demand. So, the remaining 5 traders are left with additional supply. The price X will be agreed upon by the other 5 traders only if the trader who quoted price X agrees to buy the additional supply. Thus, the traders engage in negotiations on price X and will reach on a consensus in establishing price of jasmine for that day. The wholesalers purchase decision depends on the overall market demand. For a country routed deeply in religious traditions, auspicious days based on religious calendars influences demand. Jasmine cultivation as a major impact on the socio-economic conditions of the growers. It is critical to understand the variations in the price of Udupi jasmine as steps can be taken to stabilize it if variations are evident. The information collected on price will also be useful in generating trends and future price predictions, which will enhance the user experience. To understand the price variations of Udupi jasmine, price per day was collected from the year 2010 to 2016.

Consumer needs

Udupi jasmine is coveted for its exquisite scent. It is a favored flower in religious ceremonies, formal events and for personal use. So, during festive seasons and functions at home the demand shoots up. India is a very traditional country. The people of coastal Karnataka generally keep functions on auspicious days based on religious calendars. Hence auspicious days based on religious calendars too has an adverse effect on demand, hence the price. Consumers who prefer Udupi jasmine for their daily personal use generally buy it from flower markets, but due to the busy life style most of them refrain from going to markets.

Discerning some of the existing e-commerce frameworks

National Agriculture Market (NAM) constitutes a classic example of e-commerce in the realm of agricultural marketing in India. It is a trading portal to create a unified national market for agricultural commodities by networking the existing Agricultural Produce Market Committee (APMC) mandis. NAM works in a B2B setting. APMC related information and services are provided to the user through a single window of NAM. Services such as trade offers to buy and sell, arrivals of commodity and prices, facility to respond to trade offers etc. Online market helps in reducing the information asymmetry and transaction costs, while mandis are used for the flow of materials.

In providing a comparative study of agriculture e-commerce business model between India and China, (Dong, 2016) argues that Indian agricultural e-commerce focuses one solving the poverty of farmers and it primary emphasis is given to reduce the farmer's cost involved in production and purchase. Whereas China's agricultural e-commerce focusses on improving the income of farmers. Thus, focus on improving the farmers income should be a priority in agricultural e-commerce framework as it effects the socio-economic status of a farmer.

While comparing the path of agricultural e-commerce between India and china (Dong, 2016), finds a number of differences in the important factors such as commodity circulation, information flow, capital flow, logistics, personnel flow and credit flow that affect the agricultural e-commerce.

In terms of listing four e-commerce systems functionalities: auctions, storefronts, enterprise portals and e-procurement (Turban et al., 2002) provide some direction for a functional model of e-commerce.

While comparing four architectures of e-commerce systems (Treese and Stewart, 2002) provides explanation of functional characteristics and reviews on each of the four systems. The four architectures compared are:

1. Open Buying on the Internet (OBI) architecture: The OBI group proposed this standard architecture for B2B e-commerce. It comprises functions for the purchasing organization to pick a supplier, surf the supplier's catalog and then an option to place an order. Other functionalities include options for confirming an order by the purchasing organization, authorization of an external payment authority

for electronic payment and fulfillment of an order.

2. Merchant server architecture: This architecture provides functionalities for presentation of product, options to use information on products from an electronic catalog and entry of an order.
3. Open Market commerce architecture: Open Market developed this architecture that has options such as presentation of a product, usage of product information from an electronic catalog, electronic payment, fulfillment of an order, order entry and providing customer service.
4. Secure Electronic Transaction (SET): This architecture focuses on electronic payment function. SET architecture adds an electronic payment functionality to the merchant server model.

Results and discussion

Price analysis of Udupi jasmine

Graph 1 shows the average jasmine price received by the farmers form 2010-16. It is evident from graph 1 that the price is not stable. It is found that the factors effecting the price are festivals, functions, events and weather. Also, the production too plays as a key factor in the variation of jasmine price. Whenever there are festivals and special occasions there is a sharp rise in the price. During the months of October to January the prices remain high since there are several festivals and special occasions during this time. The production of jasmine flower too is moderate during these seasons.

From February to September the prices fluctuate and is generally low since the production is more, but demand is not constant. As there are no major festivals during these seasons there is no sharp increase in demand. Hence during these seasons if the demand can be increased price stability can be maintained. In the coastal region of Karnataka, India women generally decorate their hair with jasmine on daily basis throughout the year. E-commerce will open market to a wider range of audience across geographical locations and provide buying options for customers who use jasmine on daily basis. This will help to boost the demand factor and hence stability in price. Price analysis can also be used for future price predictions which will be valuable for farmers.

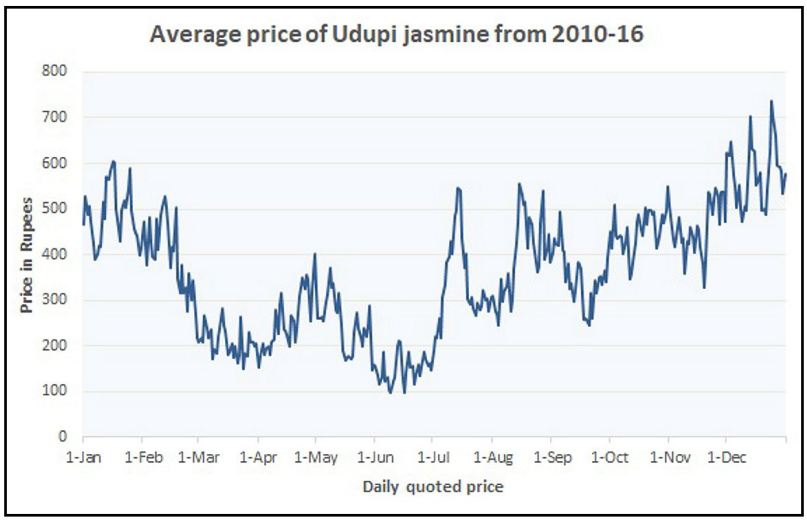
E-commerce Framework to market Udupi jasmine

The proposed e-commerce framework consists of the following interrelated functions:

E-commerce website, B2B Trading Platform, B2C Costumer Platform, Product Information, Electronic shopping cart, Support, Payment Gateway, Stock Management, Supply Chain Management, Information Exchange, Quantity Analyzer, Price Analyzer, SMS module, Mobile application for agents, Database, Data analysis. Interaction between the various functions are shown in Figure 1. Each function is dependent on each other to perform various activities that will assist in performing commerce over the internet.

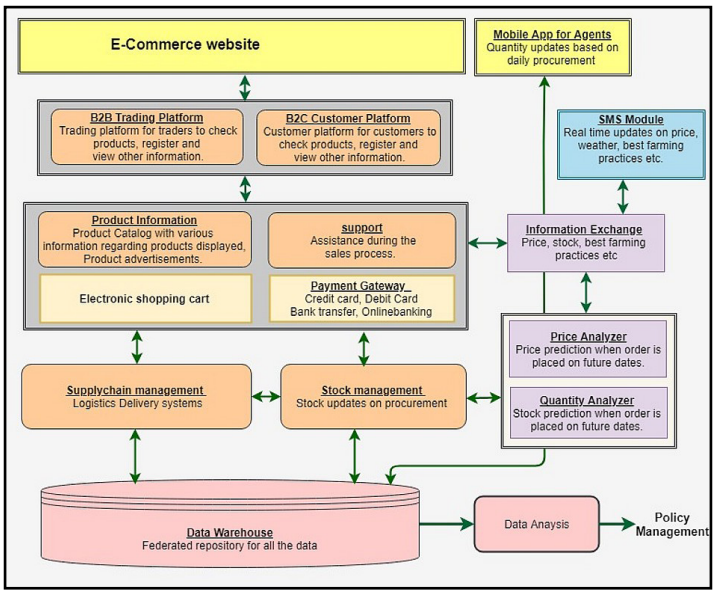
E-commerce website:

Provides an online portal that will facilitate online transactions of goods and services through



Source: own research and processing

Graph 1: Jasmine price variation from the year 2010-16.



Source: own research and processing

Figure 1: E-commerce framework for Udupi Jasmine.

means of the transfer of information and funds over the Internet. Execution of any transactions related to buying and selling can be done online with the help of a website. The website interacts with the other components in the framework to produce the desired results based on customer interaction. Basically, it provides a front end for B2B and B2C transactions between various actors involved.

B2B trading platform:

It provides a platform that will enable traders to conduct businesses. The will help eliminate business complexity and offers buyers numerous possibilities. It also helps in making trade easy without any geographical boundaries. It will provide features such as check products, register, shopping cart, price trends and payment gateway system.

B2C Costumer Platform:

B2C customer platform provides options for customers to buy products. It will provide features such as check products, register, shopping cart, price trends and other information. They will be also provided with a safe and secure payment gateway system to purchase the product once selected.

Product Information:

The product information function provides information about the crop. This function is included as the framework can be extended to other flowers or agricultural products as well. The information can include:

- Crop descriptions.
- Interesting information about the crop that will help in promotion.
- Product views like photographs.

Additional features such as product search, selection of language and user preference customization.

Electronic shopping cart:

Electronic shopping cart provides an interface for users to place items in a "shopping basket" so that the products included can be remembered for a predetermined time. Shopping cart will include features such as quantity and matching links to the items. Once a customer inputs the shipping address, taxes and shipping costs can also be matched from within the shopping cart. It provides important information, which is often transparent to the customer including a cart number to track the order.

Support:

Assistance is provided to the user before and after the product has been received. It aids users with questions or problems related to the purchasing process. This assistance may be needed before, during or after a purchase. Assistance can also be provided during the entry of the product, payment related issues, tracking of order, exchange and return etc.

Payment Gateway:

The payment gateway function provides the user options to pay for the order and thus complete the transaction. Payment options may include debit card, COD, credit card or any other electronic funds transfer method. With the national government starting several money transfer applications, transfer of payments has become much simpler even in rural India. Unified Payments Interface (UPI) can be also integrated for payments.

Stock Management:

Stock management function is useful to keep track of the stock available and the stock to be procured. Also, it keeps track of the changes made as per customer transactions.

Supply Chain Management:

The Supply Chain Management function is used in delivering the product to the customer. From the time order is placed by the costumer till the order is delivered the complete track of the process is taken care by this function. This also helps in updating the stock management function.

Information Exchange:

Information dissemination plays a major role in e-commerce. Information can be on price, products, trends etc. This information will influence the decision making of customers while buying products. This function thus provides various aspects related to information which is a major aspect in e-commerce. Information exchange function will gain inputs from price analyzer and quantity analyzer in providing information to the user such as price trends, availability of stock etc.

Quantity Analyzer:

This function helps in predicting the future stock. This is especially useful for Udupi jasmine as it is difficult to predict future stock. Udupi jasmine production is highly unpredictable. So, this function provides an estimation of future stock based on previous stock data, thus providing valuable information to the user on the availability of the product on a specified date.

Price Analyzer:

This function helps in predicting the future price of crops. Jasmine price is unstable. Jasmine prices vary daily as per production and demand. This function provides approximate future price based on previous information on price. It will also provide trends based on week, months and years. Thus, users will be provided information on the future prices which will enhance user buying experience.

SMS Module:

SMS module is an GSM based module which is intended to help customers and famers alike, who are not tech savvy and places with the lack of internet services. SMS module will provide users with information such as price, price trends etc. SMS module plays an important role in providing information to the grower. Crop price information which is critical for growers can be given via SMS, as they generally call the traders for price on daily basis. Also, timely information can be provided to growers on information on fertilizers, weather and best agricultural practices etc. This helps in providing effective information dissemination.

Mobile application for agents:

Agents play an important role in jasmine enterprise. They not only take care of the logistical part of jasmine collection and packing, they also collect valuable information on farmers and their daily agricultural output. Although data on quantity is taken on daily basis, information is not stored for long time. The existing data is in paper format.

A mobile app can be provided to the agents to automate the existing process. Agents can provide data about details of the grower and then update the daily agricultural outputs of Jasmine growers. For an e-commerce model to work for jasmine there should be multiple sources from where product can be procured. Information on agents and their daily procurement details will help in the efficiency of the e-commerce model. It will help in procuring jasmine based on orders.

At present there is no database on information of Udupi jasmine growers and their agricultural output. The mobile app will assist in maintaining this data as:

- The agents generally have grower information and collect data about quantity on daily basis.
- Most of the agents use smartphones and they have some level of awareness using them.
- An app can be developed to automate the existing process that the agents use. The app will give reports such as sales, money to be given to farmers and quantity of jasmine acquired over a period.
- From the personal interviews it is found that there is a willingness factor among the agents for an app that will assist them in their daily work with respect to Jasmine.

Data warehouse:

Data warehouse will be a federated repository for all the data collected. Data such as user identification and credit data, is stored in the data warehouse database. User preferences and purchasing decisions, price information, trader information, farmer information will also be stored. Data warehouse will also include data collected from the Mobile application for agents and SMS Module. The data acquired by this function would be used for data analysis which will be helpful in marketing research and policy making.

Data analysis:

Data analysis function is one of the most important function as it not only helps in the improvisation of the framework, but it also gives valuable insights to various trends related to farming, trading etc. Using the data received from the data warehouse, data mining techniques can be applied to identify relationships, trends and other useful information. Information received from the analysis can be applied in decision making and marketing. Information can be also used to provide expert view on agricultural practices, e-commerce evolution etc. Data analysis will be beneficial in providing inputs to improve the framework over a period based.

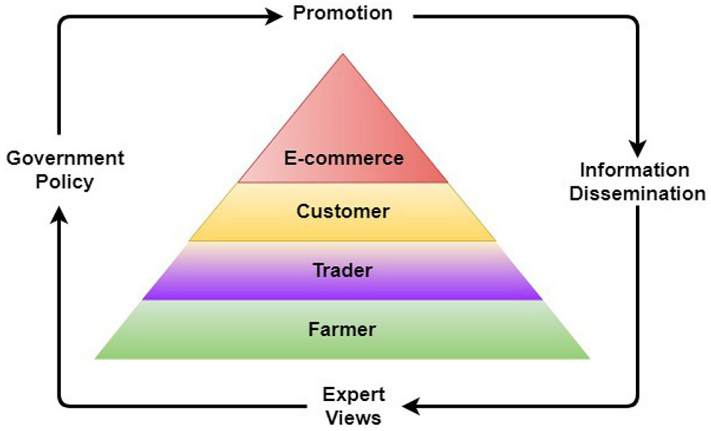
Policy Management:

In India, agriculture is a highly regulated sector with government agencies and corporations exercising a persistent influence over it. Both central and state governments impose these regulatory controls. Information gained from data analysis can be used in government policy making. Policy making is a critical factor for the overall development of the grower. Agricultural support forms an essential part of farmer's income. Agricultural support ensures production and its development. In addition to aid, farmers may also receive structural support. Policy management will also improve agricultural productivity, develop the structure of agriculture and promote good agricultural practices. Based on the data analysis it can provide timely assistance to farmers incase of decrease in agricultural production.

Benefits of the framework

Agriculture, with its allied sectors, is the largest source of livelihoods in India. As per the report of Food and Agriculture Organization of the United Nations, 70 percent of India's rural households still depend primarily on agriculture for their livelihood, with 82 percent of farmers being small and marginal. This is true for the community-based enterprise for Udupi jasmine growers. Therefore, the e-commerce framework will assist in integrating the rural and urban resources which will assist improving the socio-economic conditions of the growers involved in the jasmine production. In this process it will integrate information of both rural and urban market, provide guidance to market agricultural products.

Figure 2 explains the benefits of e-commerce framework. The farmer is given the maximum priority as he sits at the bottom of the pyramid. Farmers will have information about prices, best agriculture practices, government polices etc. E-commerce will integrate traders and consumers to provide an organized market. Traders will be assisted by the trading platform to conduct trade. Finally, the consumers will have a portal that will allow them to buy the product irrespective of their geographical location. As the market reach increases there will be an increase in demand



Source: own research and processing

Figure 2: E-commerce framework for Udupi Jasmine.

which will directly affect the price of the product. Hence the farmer will benefit with the increase in demand. Effective information dissemination will be possible as the sector gets organized. As data will be integrated at all levels through the data warehouse it will allow experts provide inputs in various aspects of the supply chain that will assist in government policy making. Agriculture product promotion is a critical factor for e-agriculture to succeed. On promotion (Kotler and Keller, 2000) says that promotion is the element of market mix that includes all the ways a frim communicates the merits of its products and persuades its target customers to buy it. Hence product promotion will assist the product in reaching to a larger audience.

Conclusion

Marketing of agriculture products through internet has its own challenges due to several factors like shelf life, price, quantity, storage and location. In India there are many crops that are specific to a geographical location and Udupi jasmine is one among them. Existing e-commerce

framework cannot be used to market such crops as it does not suit the required ground conditions. Localization of e-commerce is necessary to market such crops. The framework proposed is localized to market Udupi jasmine and the framework considers several factors that govern the entire jasmine growing community-based enterprise. It provides trading and customer platform to the traders and customers respectively. Farmer and their crop information is collected by a mobile app provided to the agents. By integrating data of the entire system through a data warehouse, information dissemination at all levels can be achieved. Data analysis will help to understand the problems faced by the farmers and timely intervention by the respective authorities can be sought. It will also help in forming effective government policies that will assist in improving the socio-economic status of farmers. Hence the e-commerce framework will improve the market reach, reduce transaction cost, convenience, transparency, efficiency in productivity and organize supply chain. Further this e-commerce framework can be customized has per the need of the crop which are specific to a geographical location.

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Data Protection and Security in SMEs under Enterprise Infrastructure

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Abstract

Information is becoming a highly valued commodity of strategic importance in the period of globalization of trade, cooperation and mutual integration of companies. These facts bring a new perspective and the importance of adequate information security in IS/IT, especially in connection with their electronization and electronic exchange. The protection and security of IS/IT is therefore becoming increasingly important for companies and is one of the key factors for the economic success of SMEs, as well as in agricultural organizations and rural development organizations. Management's interest in IS/IT security and information results not only from a threat to prosperity, but also in the case of the threat to the company's own existence. By analysing the risks, adopting IS/IT security policy, developing safety standards, and implementing security in the life of the company, the security process does not end but comes into a qualitatively new stage. At the moment when the main problems are solved and the environment, at least to a certain extent ready, there is time for important routine activities. This is monitoring, control and audit.

Keywords

Security of IS/IT, SMEs, incidents, risks.

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Introduction

The deployment of information systems and information technology has become a prerequisite for the success of companies in all areas of economic activity today. IS/IT has been one of the decisive factors for the development and competitiveness of economic organizations in all three sectors (Vaněk et al., 2011; Collins et al., 2006). Without information technology, the work with information is not only inefficient nowadays, but also impossible. In addition, our dependence on these systems is increasing every day. However, the rapid development of modern technologies and information systems is also increasing the possibility of abuse (Leede et al., 2005; Smith, 2003; Kumar et al., 2011). There are a variety of security incidents, such as unauthorized data manipulation (deletion, altering, abusive and consequential misuse), stopping the entire organization from collapsing the infected information system, and others. In addition, today's Internet is constantly rotating other unintended threats looking for any possible deficiency in the security of workstations (Boer et al., 2003). According to Kumar et al. (2011) there is an unprotected PC with Windows operating system after being plugged into the Internet attacked on average within twenty minutes, which is a double increase compared to 2005, when it took about forty minutes. According to several authors Leede et al. (2005); Corso et al. (2001); Hosťovecký et al. (2015); Vaněk et al. (2009), the process of achieving and maintaining confidentiality, integrity, availability, accountability, authenticity, reliability of information and IT services must be at an appropriate level in the current conditions. According to Bresnahan et al. (2002); Zairi et al. (1995); Maglio et al. (2009) protection of information during their creation, processing, storage, transmission and disposal through logical, technical, physical and organizational measures that must counter the loss of confidentiality, integrity and availability of these important business values.

According Wielky (2017); Jones et al. (2003) security management is formulated in the organization on the basis of the following

three security policies: the overall security policy of the organization is the set of security principles and regulations that define how to secure the organization as a whole. The IT security organization's overall IT security policy is the managerial view of IT security, it tracks the overall security policy, defines the core strategy, goals, attitudes, roles, responsibilities, and principles related to security-related activities of the IT organization. The overall security policy is the basic information resource for building lower and specific levels of security documentation.

IS security policy has already specifically defined how the overall IT security policy for the particular IS will be adopted and implemented. It contains detailed standards, rules, practices and regulations specifically defining how to manage, protect and distribute sensitive information and other IT resources within the organization and the particular IS (Erumban et al., 2006). The principles of IS security policy elaboration are formulated on the basis of specified requirements in the field of computer security, system security requirements of the given IS in the documents of the overall IT security policy, the results of IS risk analysis, safety requirements stated in laws, regulations, standards, regulations and standards (Šimek et al., 2008). In the literature, the concepts of the overall IT security policy and IS security policy often blend under the unified name of security policy, or system security policy (McAdam, 2006).

According to Leach (2008), it is typical of most companies that meet the goal definition: The goal is to eliminate potential direct and indirect losses due to misuse, damage, destruction, or unavailability of information by creating a comprehensive, cost-optimized and efficiently functioning information security management system.

Three basic rules defining safety objectives in the IS (Jai Arul et al., 2011) are as follows:

- ensuring confidentiality and integrity,
- ensuring the availability of information and information system services,
- ensuring the responsibility of the user of the information system for his / her activity therein.

If the effort is to make the system a chance for success, it is imperative to convince the leadership of the necessity and the usefulness of this step. IS / IT security does not just mean the purchase of HW and SW, this process requires the development of the set of internal directives and regulations that must be respected and strictly observed. As always, in the IS / IT industry, the most common challenge in introducing changes is the attitude of regular users whose thinking needs to change (Manas-Argemi, 2005). Management support is therefore a key prerequisite for project success. It is precisely because of the lack of this support that many security projects, regardless of their quality, will end up with the initial design of the paper or at a different stage of elaboration with the only effect, with the unnecessary means and forces of IS security staff. According to Miller (2012), the implementation of safety measures does not generate any immediate direct profit for the organization - on the contrary, investment in its deployment and maintenance is not negligible. However, in the event of extraordinary events, it becomes invaluable.

The main importance of security policy is prevention. In the long run, it is nowadays a necessary part of the overall security policy of the organization. Security policy protects business investment (hardware & software & know-how). IS/IT security certificates increase corporate credibility - a competitive advantage with today's insignificant meaning. At the same time, the security policy prevents damage to the company's reputation by spelling out data leakage by almost eliminating the possibility of leakage. And in case any leakage has yet occurred, the security policy has precise guidelines on how to maintain it and is the argument against accusations of unreliability. Detailed tracking of the entire system blocks illegal activities before damage occurs, or at least immediately detects weaknesses, making it impossible for data to be repeatedly leaked in the same way. Miller (2012) and Hennyeyová et al. (2010) states that the objective of any risk analysis within an organization is to identify and quantify the risks so that they can decide on their acceptability or decide on the adoption of additional measures to reduce them. The magnitude of the risk is determined on the basis of the likelihood of occurrence of the risk and the magnitude of the impact. IS Risk Analysis being a key activity in the security solution process that must provide answers to the following three basic questions: "What happens when information is not protected?", "How can information security be compromised?", "How likely it will become? ". A typical output of the analysis is the document describing the system description and the results of the analysis, i.e. the level of threats, identified vulnerabilities, the level of existing safeguards and the distribution of the resulting risks.

Materials and methods

The aim of our research was to collect material and verify hypotheses that were determined on the basis of theoretical training and knowledge of the current level of solving problem. The main focus of the research was to address the current security threats in enterprises. The aim of this article is to identify and analyse the causes of current IS / IT security incidents and risk factors and their impact on current businesses in terms of creating and improving security policy and protecting sensitive electronic data. The results of our empirical research can serve to concretely improve the security policies of individual businesses, thus avoiding the security threats that current e-times bring. The issue of security of enterprise information systems is currently being addressed by many reputable authors and is considered to be crucial in terms of business operation and competitiveness. The security policy of organizations and compliance with security standards is essential and a key activity leading to the protection of sensitive corporate data of clients and leads to the overall information security of the business itself.

Based on the theoretical knowledge of domestic and foreign literature and practical experience from our previous publications, we have decided to determine the following hypotheses of our empirical research.

H1: The security of a business information system of a particular organization depends to a large extent on compliance with the established security policy of the organization and the compliance with established safety standards of the enterprise.

H2: The human factor and ignorance of safety standards of technology security management is the biggest threat of loss and aft of data in an enterprise.

The benchmark sample consisted of 36 medium -sized enterprises in Slovak republic. The questionnaire contained a total of up to 25 questions that were specifically targeted to the area of enterprise information system security and the main stakeholders were IS/IT security managers and IS/IT administrators as well. Data collection was conducted through a questionnaire survey, which was composed of the groups that were assigned to individual questions. The questionnaire was constructed from closed questions for better clarity and evaluation. Reliability of the questionnaire was performed using Cronbach's alpha. The variables in the position of static and dynamic parts of the hypothesis were compared by Kuskal-Wallis to use more than two variables.

$$\alpha = (k/(k-1)) * (1 - \Sigma s^2_i / s^2_{sum})$$

k - number of items

s^2_i - variance for k items

s^2_{sum} - variance for the sum of items

Hypothesis was tested by standard statistical methods, hypothesis testing was performed by the Kruskal-Wallis test, which is an extension of the Mann-Whitney U test to use more than two variables. Analyses of the attribute group show that the reliability of the data obtained from the main survey is sufficient (internal consistency of the scale is considered appropriate even if the coefficient is greater than 0,7). The values are given in Table 1.

Range of reliability analysis	Number of items surveyed	Value of Cronbach's alpha
All variable items	15	0.862
Hypothesis H1 variables	7	0.891
Hypothesis H2 variables	8	0.846

Source: own research and processing

Table 1: Overview of the introduction and use of management methods and techniques.

Results and discussion

In empirical research, we mainly focused on whether businesses are interested in the current state of their IS/IT security in the enterprise, and whether businesses are interested in monitoring their security technologies. Practical experience from our survey has produced results that we can generalize as follows. A major challenge is the enforcement of standards and methodologies of IS/IT security from the theoretical to practical level. We can safely say that support for top management in IS/IT security is low, says 81% of respondents. Likewise, 71% of respondents claim that the interest in IS/IT security in an organization is manifested mainly by the security incident itself, and systematic control and updating stagnates. The bottom line, however, is that most of the 91% questioned are aware of security policy and business safety standards, but are aware that employees lack the skills and knowledge they possess. Surprisingly, I'm not willing to find out my current IS/IT security status. Up to 61% of companies are not interested in detecting their current state of information and communications technology security. Part of companies 39%, are interested in finding their actual state of information and communication

technology security. We also note that most businesses 90% are not interested in external IS/ IT security management, consider it unnecessary and expensive, only 10% would consider external security management collaboration with their systems.

Testing of the H1 hypothesis focused on the assumption that the security of the enterprise information system of a particular organization depends to a large extent on compliance with the established security policy of the organization and the compliance with the established business safety standards. Simple statistical validation can be based on the analysis of the averages from the established security policy values and their comparison with the average of the values with the specified attributes. Same trends of variables would suggest that the hypothesis is valid. Conversely, different trends would suggest that we cannot confirm the hypothesis. The results of this simple comparison are shown in Table 2. Based on the test, we can accept the hypothesis H1.

Range of values	Average
100-71	71.12
70-51	63.23
50-21	42.69
20-0	39.32

Source: own research and processing

Table 2: Results of statistical comparison of mean to H1.

Testing the H2 hypothesis focused on the assumption that the human factor and ignorance of the safety standards of the technological security management is the greatest threat of loss and theft of data in the enterprise. The statistical validation may be based on the analysis of the averages from the detected human factor values and the ignorance of the safety standards and their comparison with the average of the mean values with the specified attributes. Based on the test, we can accept the H2 hypothesis. According to the calculated data, the descending order is evident, but the trends show greater differences than in the hypothesis H1. The comparison results are shown in Table 3.

Range of values	Average
100-71	83.05
70-51	61.17
50-21	46.88
20-0	31.45

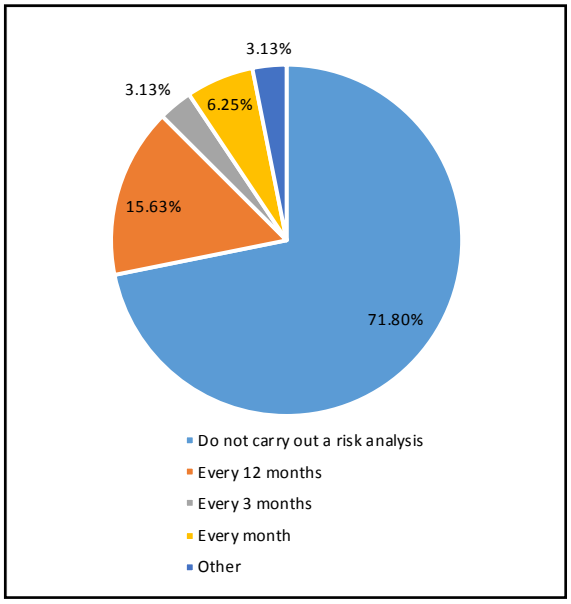
Source: own research and processing

Table 2: Results of statistical comparison of mean to H2.

Our empirical research clearly shows the majority of the 89% questioned that an unambiguous trend in the IT security of information and communication technologies in an enterprise is the application of multi-level and combined IS/IT security protection. The essence of multi-level and combined IS/IT security protection is to deploy more types, types and technological levels of interconnected and cooperative IS/IT security systems. In the absence of identification of the security threat or failure of a certain IS/IT security technology level, another IS/IT security system assumes a different level of detail.

There is no unambiguous solution to eliminate the causes of IS/IT security incidents. In addition, each company is specific in a number of aspects: its field of expertise, staff, technology, IS/IT, etc. It is, however, possible to avoid an adequate combination of process management of IS/IT security and IS/IT security technologies by reducing the risk of security incidents. An important factor in reducing the number of safety incidents is the human factor. Security training and employee training in the sense of the importance of IS/IT security could contribute to the reduction. On the basis of the results obtained, we have confirmed that the human factor affects the security of information and communication technologies at all levels. For users, this is especially the lack of awareness, underestimation of security risks.

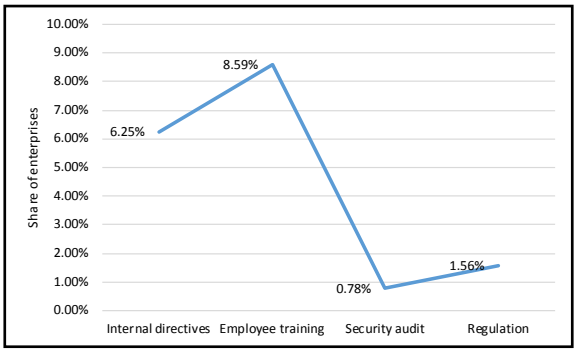
While all subjects provide IS/IT protection, up to 71.88% of these entities do not analyse the potential risks that may be threatening for their IS/IT, as seen in Figure 1.



Source: own research and processing

Figure 1: Performing IS/IT security risk analysis.

We can see the link between the percentage of developed and implemented Security Policy and Security Project documents, because in the preparation of these documents, the subjects would be guided by risk analysis at certain time intervals directly resulting from these documents and audit of IS / IT security. Everything continues, and it is also the case of informing the staff of the subjects about the security and threats to IS/IT, as shown in Figure 2. Only the very lack of security documents causes these low levels of awareness, respectively higher degree of lack of information of employees. However, account must also be taken of the general knowledge of employees and their previous qualifications in this area. Every individual is an ICT user, whether at work or at home. Therefore, it must take care of information security and have minimal knowledge about it if it is just a regular user. An employee should already have this knowledge on the workplace.



Source: own research and processing

Figure 2: Security awareness and threats to ICT.

Conclusion

Information is a highly valued commodity of strategic importance in the period of globalization of trading with a greater degree of cooperation, dynamism and mutual integration of companies. These facts bring a new perspective and importance of adequate information security in IS / IT, especially in connection with their electronization and electronic exchange. The protection and security of IS / IT is therefore becoming increasingly important for companies and is one of the key factors in the company's competitiveness and economic success. The IT security and information is therefore not only a threat to prosperity and competitiveness, but also to the extreme existence of an enterprise. If we compare our empirical research with EY's Global Information Security Survey 2013, we get a very similar match in terms of low-interest companies in the overall security audit once a year, inadequate staff training on IS / IT security. EY's Global Information Security Survey 2013 as well as our unambiguously demonstrates that SMEs have neglected to prevent burglary attacks in the long run and are also not trying to eliminate human factor defects within companies. On farms the situation is similar, data and information are mostly stored on local disks. The computers where the data is stored are on the user's table with any security. Very similar is the situation in companies involved in rural development. Companies have little confidence to outsource corporate security firms and fear the misuse of sensitive corporate data. Despite these reasons, most of the managers interviewed are 81% aware of online-related threats, which we consider to be paradoxical. In spite of the vast amount of IS / IT security issues related to standards, methodologies, security processes, terminology, partial security solutions, IS / IT security manager's profile and status, and a number of documented IS / IT security case studies there are still other and other security threats affecting companies and companies.

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Comparative Advantages of Alternative Crops: A Comparison Study in Ben Tre, Mekong Delta, Vietnam

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Abstract

This study aims to measure the comparative advantages of alternative crops of rice, coconut, and pomelo as the key indicators for crop cultivation choices by using DRC, SCB, and other competitiveness indicators in PAM model with sensitivity analysis. The results indicate that pomelo fruit obtains the strongest competitiveness, coconut has the medium competitiveness, and rice has the weakest competitiveness. Coconut crop is the most stable while rice is the most sensitive to climate and market changes. This may suggest that farmers and policymakers should convert from rice crop into and adopt pomelo and coconut crops for more effective economic and sustainable benefits. However, this conversion should take account of the soil transferring costs and the initial cultivation costs of pomelo and coconut crops. Production indicators and trade indices seem to indicate contradictory rankings of competitiveness. The result, however, is still consistent with the economic theory.

Keywords

Vietnam, agriculture, crop choices, comparative advantage, sensitive analysis.

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Introduction

The agricultural production system is affected by various factors such as dynamic policies, economic resources, market situations, and environmental conditions. This leads to challenges to identify the comprehensive comparative advantage of an agricultural production system and difficulties to make crop choice decisions. Moreover, the conventional economic wisdom advocates that a country should utilize its scarce resources by specializing in agricultural commodities with stronger comparative advantages and creating higher values added and social welfare. Hence, a central part of economic theory is to search for efficient and summary tools to measure the comparative advantages of agricultural commodities, assess the policy impact on social welfare and estimate the future performance of the commodity subject to the potential scenarios.

Agriculture is a key economic sector in Vietnam when it accounts for 12.2% GDP, 17.8% of export, and 41.9% of employment in 2016 (General Statistics Office, 2018). The country has various public policies to enhance the stability and growth of agricultural sector at both production and market levels. The Mekong Delta is the main agricultural production region of Vietnam with strategic sectors such as rice, fruits, vegetables, and aqua-products. These key agricultural products, however, have become less profitable and less competitive due to input cost increases, oversupplies, and environmental food-prints. These issues compel farmers, enterprises, and policymakers to urgently identify and adopt the most profitable, suitable, and sustainable crops in the same arable lands with the similar natural and social conditions based on competitiveness indicators.

Ben Tre province is chosen for this empirical and policy analysis as it represents agricultural characteristics of the Mekong Delta in Vietnam. The province has advantages in agriculture thanks to appropriate natural conditions such as fertile soil and abundant water resource. Ben Tre has diverse agro-ecological characteristics and can be divided into three main ecological zones: fresh, brackish and saline water. Rice and fruit crops are mainly based on freshwater zone while coconut is easily planted on fresh, brackish and saline water condition. Nevertheless, three crops can be alternatively

grown in the same land they are dominant crops of Ben Tre province. Under the impact of climate change, areas affected by brackish and saline water increase while lack of fresh water in dry season reduces rice and fruit production capacity of the province. Under these changes, raising agricultural plan and policy questions are how to change the crop cultivation structure to get a better adaptation to climate change, market variations, and to ensure higher benefits to farmers.

To examine the question, this study aims to measure and compare the comparative advantage of rice, pomelo, and coconut crops in the same arable lands of Ben Tre by using Domestic resource cost (DRC), Social cost-benefit (SCB) models, and other competitiveness indicators in Policy Analysis Matrix (PAM). The sensitive analysis is used to estimate the elements' changes in the comparative advantages of these sectors based on the different assumed scenarios of natural and market conditions. These crops are selected since rice is a key representative of the food sector, pomelo is a significant representative of fruit sector, and coconut is a good representative of the agricultural material sector as an essential input for the coconut processing industry in Vietnam. In addition, the paper analyses the consistency of production indicators and trade indices in measuring the competitiveness. The results should make both academic and practical contributions to policymakers, enterprises, and scientists. First, the study identifies, compares, and estimates the comparative advantages of alternative crops for farming choice and agricultural policy decisions. Second, the result extends the empirical studies of the literature and approach in the case of transition economy as Vietnam. Third, the paper contributes to the economic theory in measuring by, comparing, and defining comparative advantage approaches.

Literature review

There are different frameworks to measure comparative advantage at different levels. Buckley et al. (1988) categorize the measures of competitiveness into three groups: competitive performance, competitive potential, and competitive process for each level of analysis such as country, region, industry, firm and commodity. In the economic literature, there are two approaches for comparative advantage assessment of agriculture. One is the domestic resource cost or the equivalent benefit-cost analysis such as DRC, SCB and other competitiveness indicators in PAM model and the second is international trade approach such as Revealed comparative advantage (RCA) of Balassa (1965), Relative trade advantage (RTA) of Vollrath (1991), and Normalized revealed comparative advantage (NRCA) of Yu et al. (2009) (Cai and Leung, 2009; Latruffe, 2010; Gorton et al., 2013). Latruffe (2010) clarifies the approaches into two groups of trade measures and strategic management measures. Trade measures include real exchange rate and purchasing power parities, revealed comparative advantage, and other export and import indices. Strategic management measures are cost measures, profitability, productivity, and efficiency. Cost measures involve domestic resource costs, social cost-benefit, and agricultural production costs.

DRC is a measure of real opportunity cost in terms of total domestic resources of producing a net marginal unit of foreign exchange (Bruno, 1972). According to Tsakok (1990), the concept of opportunity cost is used to assess comparative advantage and there are four stages to evaluate comparative advantages such as (i) determining the opportunity cost of exchange rate; (ii) calculating the value-added component in foreign and border prices; (iii) computing the cost of the primary production factors or domestic resources used in production; (iv) and comparing the domestic resource cost and net benefits. He explains that the process of comparing the costs with benefits for a production activity is employed as an indicator of efficiency and the most popular framework related to this calculation is domestic resource cost. Gorton et al. (2001) add that DRC is useful to measure social profits when activities producing different outputs are compared for their efficiency and it compares opportunity costs of domestic production with the value added it creates.

Masters and Winter-Nelson (1995) argue that DRC ratio is, however, based on the cost of non-tradable inputs and it understates the competitiveness of activities that use mainly such domestic factors in comparison to those that rely more on tradable inputs. To overcome this shortcoming, these authors propose the social cost-benefit (SCB) ratio with the same data that is a generally superior measure of social profitability.

Policy analysis matrix is proposed and completed by Pearson et al. (1976) and Monke and Pearson (1989) based on DRC approach to address the issues. According to Michalek (1995), PAM obtains several critical advantages as follows: (i) the model is specific enough to account for the most important economic relations between the macro and micro indicators with time and data constraints; (ii) it is appropriate to analyze

the price and production efficiency; (iii) it may assess the impact of policies on the incomes of farmers; (iv) the model can identify the magnitude of the income transfers between producers, consumers and policy's budget; (v) it measures the key coefficients relating to the level of protection and comparative advantage of a sector; and (vi) the results can be properly disaggregated between different types of firms, regions, and products. Despite advantages, as in all quantitative methods, the model has limitations: first, PAM is static model; secondly, perfect substitution between the domestic and foreign tradable commodities is usually and strictly assumed; third, only under certain restrictive behavioral assumptions (such as supply and demand elasticities equal to zero) are estimated income transfers identical to producer and consumer surplus; and fourth, plentiful and non-market data is needed to examine the performance of a given production system. In summary, PAM yields various indicators (i) first to measure the comparative advantage of a sector; (ii) second to assess the impacts of government policies, market failures, and economic performance elements; and (iii) third to assess the dynamics and trends of comparative advantages based on the scenario analysis and time data. It is remarkably useful and meaningful that PAM model can compare both the different production systems for the identical outputs and the various outputs from the same production systems.

Yao (1997a, 1997b) evaluates the costs and benefits of the Thai agricultural diversification policy for three competitive crops of rice, soybeans and mung beans in two provinces by PAM model. The result indicates that rice sector is more competitive than soybeans and mung beans and government policy may cause efficiency reduction. Estudillo et al. (1999) measure the comparative advantage in the rice production in the Philippines for the three decades and find out that the Philippines achieves the comparative advantage in rice production due to new technology in the early period but it lost the comparative advantage by 1990. DRC ratio may be also employed to compare the competitiveness of one country to others as well. Gorton et al. (2001) assess the competitiveness of agricultural productions in Bulgaria and the Czech Republic in comparison with other the EU by DRC ratio and revealed comparative advantage. The study indicates that Czech and Bulgarian cereal producers are competitive at the world and at EU market prices by DRC ratio. However, they do not achieve revealed comparative advantage in trade with the EU because of trade restriction policy. Liefert (2002) assesses Russia's comparative advantages of agricultural output and input productions and indicates that the country has an advantage in agricultural inputs compared with its agricultural outputs and also has an advantage in bulk crops in comparison with meat production.

Mohanty et al. (2003) measure the comparative advantage of Indian cotton production by PAM and show that without the intervention of government, cotton farmers may move away from cotton to crops for higher income. Makosholo and Jooste (2006) assess the comparative economic advantage of irrigated longterm crops such as cherries, peaches, apples, and asparagus and conclude that the sectors have been subsidized by different government's policies, especially the impact of the exchange rate. The authors also indicate that the policies of land and water may have a remarkable influence on crops to reduce poverty. Mane-Kapaj et al. (2010) argue the opposition of comparative advantage to profit. They assess the comparative advantage of olive oil production in Albania and show that the sector is profitable while does not have a comparative advantage. Zheng et al. (2013) state that government's policy may impact on the comparative advantages of agricultural sectors in China at different levels. The intervention enhances comparative advantage in wheat production while not significantly improves the comparative advantages of soybean and corn. Adeoye and Oni (2014) analyze the competitiveness and effects of government policies on plantain production systems in Nigeria. The results indicated that plantain production was privately and socially profitable in all the productions systems.

DRC, SCB, and other economic indicators are, however, static models and they cannot capture the prospective shifts in input and output prices, productivity, and another natural, social and market conditions. The models, therefore, may generate unrealistic results in the dynamic sense and potential biased against public policies (Mane-Kapaj et al., 2010; Yao 1997a). The models, however, may estimate the comparative advantage dynamics in the future based on the assuming scenario or time data as the third function of the model. Sensitivity analysis provides a tool for assessing the impact of changes in assumptions and errors (such as exchange rates, global prices, production yield change due to environmental degradation) in estimating profitability and projecting competitiveness. It can be applied to both private and social estimations (Monke and Pearson,

1998; Gorton et al., 2006). According to Monke and Pearson (1989), there are two ways of sensitive analysis: the first is involved to the calculation of breakeven values for social profitability with other fixed initial values and the second is the elasticity of social profitability with respect to a particular parameter with a change in the parameter of interest by an arbitrary percentage. Scholars, moreover, estimate the comparative advantage indicators based on the different scenarios which are assumed to happen potentially in the future, such as regional and global integrations, market conditions, natural environments, and government policies (Yao, 1997b; Gorton et al., 2006). Morrison and Balcombe (2002), moreover, remark that the traditional sensitivity analyses are relatively involved in bootstrapping technique. Thus, the sensitivity analyses can be performed by testing how estimates change when parameters or variables of interest are varied. In conclusion, though DRC, SCB, and other indicators in PAM model are the basic and traditional models, if well combining with sensitive analysis methods, they can be significantly and academically employed to measure competitiveness and choose the alternative sectors, to compare the comparative advantage between countries, and to analyze the impacts of policy, market, globalization, and environmental changes on the comparative advantage and profitability of agricultural sectors.

Materials and methods

Analytical framework

The basic PAM contains two cost columns, one for tradable inputs and the other for domestic factors. Intermediate inputs (such as fertilizer, pesticide, purchased seed, compound feed, electricity, transportation, and fuel) are grouped into the tradable-input and domestic factor components. This process of disaggregation of intermediate goods or services separates intermediate costs into four categories including (i) tradable inputs, (ii) domestic factors, (iii) transfers (taxes or subsidies), and (iv) non-tradable inputs. The non-tradable inputs themselves must be further disaggregated so that ultimately all component costs are classified as tradable inputs, domestic factors, or transfers (Table 1).

There are various indicators in PAM model to measure comparative advantage, policy and market failure, and social transfer. This study mainly uses the private and social competitiveness indicators of production systems which can be presented as follows (Monke and Pearson, 1989; Beghin and Fang, 2002; Adeoye and Oni, 2014):

Private profitability (PP - D)

This index shows the competitiveness of enterprises or actors in the agricultural production system given available technology, input and output prices, and government policy. The term private refers to observed revenues and costs in showing actual market prices received or paid by farmers, merchants, or processors in the agricultural system. The private profitability of agricultural commodity j can be simply calculated as follows:

$$PP = D = A - (B + C) = P_j^p - \left\{\sum_{i=1}^{k} a_{ji} P_i^p + \sum_{i=k+1}^{n} a_{ji} P_i^p\right\}$$

where, a_{ji} (i = k+1 to n) are the coefficients for domestic resources for product j; a_{ji} (i = 1 to k) are the coefficients for tradable inputs for product j. P_j^p is the private price of product j. P_i^p is the private price of input i. The $D > 0$ indicates that production

	Revenues	Costs		Profits
		Tradable inputs	*Domestic factors*	
Private Prices	*A*	*B*	*C*	*D*
Social Prices	*E*	*F*	*G*	*H*
Divergences	*I*	*J*	*K*	*L*
Market failures	M	N	O	P
Distorting policy	Q	R	S	T
Efficient policy	U	V	W	X

Note: *A* is private revenue, *B* is private tradable input cost, *C* is private domestic factor cost, and *D* is private profit. *E* is social revenue, *F* is social tradable input cost, *G* is social domestic factor cost, and *H* is social profit. *I* is output transfer, *J* is input transfer, *K* is factor transfer, and *L* is net policy transfer (*I, J, K*, and *L* are the differences between social and private elements from market failures, distorting & efficient policies).
Source: Adapted from Monke and Pearson (1989)

Table 1: The accounting structure of policy analysis matrix.

system *j* is profitable and competitive. A higher value of *D* indicates stronger competitiveness of production system *j*.

Social profitability (SP - H)

The social profits measure social efficiency or comparative advantage of a production system as the outputs and inputs are evaluated by the social prices reflecting the scarcity values of resources. The social profit (*H*) of agricultural commodity *j* can be simply computed as follows:

$$SP = H = E - (F + G) = P_j^s - \left\{\sum_{i=1}^{k} a_{ji} P_i^s + \sum_{i=k+1}^{n} a_{ji} P_i^s\right\}$$

where, a_{ji} (i = k+1 to n) are the coefficients for domestic resources for product *j*; a_{ji} (i = 1 to k) are the coefficients for tradable inputs for product *j*. P_j^s is the social price of product *j*. P_i^s is the social price of input *i*. The $H > 0$ indicates that production system j is socially profitable and competitive. A higher value of *H* indicates stronger competitiveness of production system j.

Domestic resource cost (DRC)

This indicator evaluates the relative efficiency of a domestic production by comparing the opportunity cost of the domestic production to the values added it creates. This index is especially useful to compare the relative efficiency among different products from a production system. *DRC* can be measured by the ratio of the domestic resources costs (*G*) to the value added (*E-F*) in social prices (or the net foreign exchange saved by domestically producing the product):

$$DRC = \frac{G}{E - F} = \frac{\sum_{i=k+1}^{n} a_{ji} P_i^s}{P_j^s - \sum_{i=1}^{k} a_{ji} P_i^s}$$

The presentation of the symbols in this formula is similar to the social profitability index. $DRC < 1$ means that production system *j* is relatively social efficient and competitive, and vice versa. A lower value of *DRC* indicates a stronger comparative advantage of production system *j*. To identify the degree of competitiveness, this study classifies DRC values of the competitive sectors into two groups: (i) smaller and equal to 0.5: indicate the strong comparative advantage, and; (ii) greater than 0.5 and smaller than unity: mean the weak comparative advantage.

Social cost-benefit (SCB)

Masters and Winter-Nelson (1995) argue that DRC ratio is, however, based on the cost of non-tradable inputs and it understates the competitiveness of activities that use mainly such domestic factors in comparison to those that rely more on tradable inputs. To overcome this shortcoming, the authors propose the social cost-benefit ratio with the same data as follows:

$$SCB = \frac{F + G}{E} = \frac{\sum_{i=1}^{k} a_{ji} P_i^s + \sum_{i=k+1}^{n} a_{ji} P_i^s}{P_j^s}$$

The domestic production is competitive when *SCB* value is less than the unity as it reveals that total input costs are less than the revenue derived from the good. The opposite is true for the *SCB* greater than the unity and *SCB* of less than 0 does not exist. To identify the degree of competitiveness, this study also classifies *SCB* values of the competitive sectors into two groups: (i) smaller and equal to 0.5: indicate the strong comparative advantage, and; (ii) greater than 0.5 and smaller than unity: mean the weak comparative advantage.

PAM model also provides various indicators measuring the policy protection, market failure, and benefit transferring such as Nominal Protection Coefficient (NPC), Effective Protection Coefficient (EPC), Profitability Coefficient (PC), and Subsidy Ratio to Producers (SRP).

Data and social price description

Data sources and sampling: The data for producing PAM indicators and value chain performance for the agricultural crops are productivities, input quantities, input market prices, output market prices. Moreover, the data on transportation cost, processing cost, storage cost, port cost, subsidies, tariffs, exchange rate, and others are needed to derive social prices. The primary data are collected directly in the fieldworks by structured and semi-structured questionnaires for all actors in the value chains including 430 farmers, 50 middle traders, 20 trading and processing companies, 20 wholesales and export companies, and 50 retailers in pomelo, coconut, and rice value chains in Ben Tre province. The secondary data is collected from different resources such as WB, FAO, Vietnam‘s GSO, Vietnam‘s Customs, Vietnam‘s State Bank, and other reports and news articles.

Real exchange rate estimation: The real exchange rate is a key ratio to transfer the private revenue into social revenue. According to Bui et al. (2017), Vietnam real exchange rate has been significantly overvalued recently, most notably due to Vietnam’s relatively high inflation rate. Mai (2007), based on IMF data, shows that the real exchange rate is relatively higher than the nominal official exchange rate over time. The IMF (2016) and Darvas (2012)

indicate that the real effective exchange rate of Vietnam increases over time in comparison with the index in 2010. This study uses the data of consumer price indices (CPI) of Vietnam and the USA from FAOSTAT and the data of the official exchange rate from WB to estimate the real exchange rate with the reference of Mai (2007), IMF (2016), and Bui et al. (2017). The result shows that, in 2016, the ratio of Vietnam's CPI to the USA's CPI is 1.36. The official exchange rate of Vietnam in 2016 is 21,935 VND per USD[1]. As the result, Vietnam's real exchange rate is 29,815 VND per USD. This means that Vietnam undervalues the exchange rate or overvalues the local currency of VND.

Tradable inputs and domestic factors: Following Yao (1997b), this study separates the tradable input cost into detail tradable inputs and domestic factors with the principals: (i) the service and logistic cost are relatively higher in Vietnam than Thailand; (ii) the local goods and service cost (such as electricity, water, and seed) are also divided into detail domestic factors and tradable inputs; and (iii) the proportions of tradable inputs and domestic factors of various crops are different and dependent on the origin and characteristics of the inputs. Specifically, though seed (purchased), chemical pesticide, chemical fertilizer, and fuel are the tradable inputs, they consist of various domestic costs such as port charge, unloading, transporting, warehouse, and markup and the domestic products obtain significant market shares. Electricity, water, and contracted services are domestic factors they, however, employ some tradable goods such as pipe, pump, wire, machines, and equipment. Pomelo and coconut need to have the initial investments and the farmers have no income in the period. The cost, therefore, will be accounted as the depreciation for the harvesting period. The initial investment costs also include both tradable inputs and domestic factors.

Social prices for outputs and tradable inputs: The social prices for output and tradable inputs are, in general, measured as border prices (export/ import parity prices) and adjusted to the farm level (Gorton et al, 2000). Based on the approach of Yao (1997b), the social input cost will be calculated from the private input cost which includes the private tradable input cost and the private domestic factors. The private tradable input cost is transferred to the social tradable input cost by excluding divergence (tax) and multiplying with the real exchange rate. The social domestic factors are equal to the private domestic factors. The private input price (or cost) data is collected and calculated at the farm gate from farmers, retailers, and public information.

Social prices for the agricultural outputs in this research (rice, coconut, and pomelo) will be computed as export parity prices (F.O.B) and adjusted to the farm gate level since rice, coconut, and pomelo are all export agricultural products of Vietnam. The adjustment of prices from border to farm gate takes account of port and handling charges, transport, storage, packaging, production, primary processing, and markup. The material coconut nut is mainly processed and divided into coconut fiber, coconut peat, coconut cell coal, desiccated coconut, and coconut jelly with various production processes and technology. Thus, the parity price of coconut nut will be aggregated from the parity prices of these various coconut products and materials based on the primary processing coefficients. The paddy rice and bran are processed from paddy grain with milling and polishing as processing. Thus, the parity price of paddy grain will be aggregated from the parity prices of these various paddy grain products and materials (paddy rice and bran) based on the primary processing coefficients. Moreover, the farm gate parity price of export rice type of IR50404 will be transferred into the farm gate parity price of rice type of OC10 produced in Ben Tre based on the price rate of IR50404 and OC10 paddy grain and paddy rice in the local market. The pomelo is fresh fruit and is not processed into other products with polishing and cleaning as processing. The social price for the outputs is transferred from the private price by excluding divergence (tax) and multiplying with the real exchange rate.

Land opportunity cost: The practitioners usually calculate the land opportunity cost by the sum of market rent and state land charge. According to Yao (1997b), a more precise way to compute the land opportunity cost for a crop is the best net return to the land (per hectare) of the strongest competitive crops. The net profits of rice, coconut, and pomelo will be compared. The net return of the most profitable crop will be adopted as the land opportunity cost for other crops and the net return of the second best profitable crop is the land opportunity cost for the first one. This way, however, does not take account of land transforming cost to cultivate a new crop (changing an old crop to other new crops).

Labor opportunity cost: The social cost of labor is based on the formula of Yao (1997b). It is simply

[1] This official exchange rate is used to transfer the currency unit from VND to USD.

calculated as the weighted average of the peak-season and off-peak season wage rates. However, the private prices, the weights, and the high and low seasons of the labors in the sectors of rice, coconut, and pomelo are relatively different. In the peak -season of rice cultivation, the weight is 50% and the wage is USD 11.40 (VND 250 thousand). The weight is 70% and the wage is USD 9.12 (VND 200 thousand) in the peak-season of coconut and pomelo. The authors assume that the wage is USD 3.19 (VND 70 thousand) in the off-season for all sectors.

Sensitivity analysis

In this study, the authors measure the sensitivity of the comparative advantage indicators by three scenarios: (i) Climate change: The drought and salinity intrusion in the Mekong River Delta of Vietnam in 2016, this problem makes rice yield decrease by 14%, pomelo yield decrease by 5% while it causes the 1% increase of coconut yield in comparison with 2015 (calculating based on the data of Ben Tre Statistics Office, 2017); (ii) Water and land charges: The government takes the full charges of water and land (without subsidy); (iii) Parameters changes: The parameters of the comparative advantage elements such as output prices, inputs prices, and the real effective exchange rate are assumed to change in the scope of ±5, ±10, ±15 and ±20%.

Result and discussion

Comparative advantages of the alternative crops

Table 2 summarizes the comparative advantages of the alternative crops of rice, coconut, and pomelo in Ben Tre province, the Mekong Delta, Vietnam. The results show that, in general, these agricultural production systems obtain positive profits and comparative advantages by both DRC, SCB, and other ratios. The possible explanation for these strong comparative advantages is that these crops mainly utilize the domestic resources such as environment and labor. In addition, with the favorable environmental conditions and cheap labor cost, these agricultural production systems get relatively good profits. It is, in overall, remarkable that SCB ratios of rice, coconut, and pomelo are higher than DRC ratios (or showing less comparative advantage) but the competitiveness rankings of these alternative crops are not changed. This means that the tradable and domestic input employments of the agricultural production systems are not significantly different.

Pomelo achieves the strongest comparative advantage with DRC ratio of 0.13 and SCB ratio of 0.15. The crop creates the highest private profitability with the value of USD 16,844 (VND 369,464,491) per hectare and the highest social profitability with the value of USD 25,495 (VND 559,225,182) per hectare. The main reason is that Ben Tre has the best suitable natural conditions to cultivate pomelo, especially Da Xanh cultivar. The product of Da Xanh pomelo becomes recently preferred and specialty with the limited supply and famous brand name. In addition, consumers are willing to pay higher prices for the product, especially for offering gifts or worshiping God and the ancestors. Besides, change of diet preference of urban consumers from staple food to fruits also leads to a higher demand for this special fruit.

Coconut crop obtains the strong competitiveness with DRC ratio of 0.38 and SCB ratio of 0.42. Coconut crop is less profitable than pomelo crop with the private profitability of USD 1,484 (VND 32,555,867) per hectare and the social profitability of USD 3,415 (VND 74,915,361) per hectare. The coconut is less lucrative and has the lower output value in comparison with pomelo. Notably, the coconut has an additional comparative advantage due to generating a coconut processing cluster in Ben Tre with various processed products such as coconut milk, virgin coconut oil, desiccated coconut, coir nets and coconut fiber, coconut peat, and coconut shell coal for both domestic and export market. The production sector becomes the key industry in Ben Tre with the significant contributions of exports, employment, incomes, and taxes. An advantage of coconut is to be able to adapt to diverse cultivation conditions. Coconut tree can stand on all saline, brackish and freshwater environment and bad soil and requires minimum additional agro-chemicals and labor.

Rice crop has the weak comparative advantage with DRC ratio of 0.63 and SCB ratio of 0.71 (Table 2). The crop, however, gets relatively low profit with the private value of USD 146 (VND 3,196,934) per hectare and the social value of USD 964 (VND 21,147,271) per hectare due to low selling price in the world market. In general, despite its popularity, rice brings low output value in comparison with other crops. The agricultural production in Ben Tre province, in general, has been significantly affected by the climate changes such as the sea level increase and lack of fresh water provided from the Mekong River upstream. This reason even makes the rice production becomes less competitive in comparison with pomelo

No.	Indicators	Unit	Rice	Coconut	Pomelo
1	Private profitability (PP)	USD	146	1,484	16,844
2	Social profitability (SP)	USD	964	3,415	25,495
3	Domestic resource cost (DRC)		0.63	0.38	0.13
4	Social cost-benefit (SCB)		0.71	0.42	0.15

Source: own calculation based on the primary data (2017)

Table 2: The comparative advantage indicators of rice, coconut, and pomelo in Ben Tre.

and coconut crops. Although being less competitive than pomelo and coconut, Vietnam's rice sector may obtain still the stronger comparative advantage in comparison with rice productions in other countries such as Philippines (Estudillo et al., 1999), Thailand (Yao, 1997a), Indonesia (Mantau et al., 2014), and Spain (Martinez et al., 2008).

The research also shows that the social profits of these crops are higher than their private profits. The results are relatively different from those of studies in other countries (Zheng et al., 2013; Amirteimoori and Chizari, 2008; Gorton et al., 2006; Gorton and Davidova, 2001). This result indicates that a part of the benefit of the private sector is transferred to the social sector. The calculations of NPC, EPC, PC, and SRP indicators also imply the similar results. The possible explanation is that though the water, land, and environmental charges are free for farmers Vietnam's government takes significant charges from other input and output business activities such as fertiliser, pesticide, transportation, logistics, energy, and others.

Sensitive analysis of the comparative advantage indicators

Climate changes: The Mekong River Delta in 2016 encounters the problem of the drought and salinity intrusion due to the sea level rise and the reduction of the Mekong River water flow. The problem results in the changes of production yields and make the comparative advantages of these crops change. The estimating result shows that rice does not has the private profit and competitiveness with the decrease in production yields by 14% with the negative PP value of USD 184 (VND 4,027,585). The crop still obtains the social comparative advantage with DRC value of 0.77 and SCB value of 0.82. Though pomelo bears the 5% reduction in yield its comparative advantage indicators is still stable. The potential explanation is that pomelo has a relatively strong competitiveness with high private and social profits. Therefore, the 5% reduction in production yield may not impact on these indicators. The 1% increase of coconut production yield is relatively small and may not affect on the private and social profits of the crop. The comparative advantage indicators of pomelo and coconut are almost unchanged (Table 3).

Water and land charges: In general, water and land charges (or taxes) are important parts of inputs costs of agricultural production systems. Vietnam's farmers used to pay for the charges before. The water and land charges are currently supported by the government recently while the society generally still bears these costs. The study assumes that rice, coconut, and pomelo farmers pay for the charges and calculates the comparative advantage indicators of these crops. The results present that the rice private producer gets a loss or negative profit if they have to pay for water and land charges. The private profitability of coconut and pomelo sectors slightly decrease. The comparative advantage indicators of rice, coconut, and pomelo are almost unchanged.

The parameters of output prices: Coconut and pomelo production systems still obtain the comparative advantages by all indicators when the output prices of coconut and pomelo products decrease by 20%. On the other hand, rice crop is not profitable for a private producer at a declining level of 10% while it is still profitable for society at a declining level of 20%. In general, the comparative advantage of the rice crop is relatively sensitive to the changes in rice export price. Whereas, the comparative advantages of coconut and pomelo crops are definitely stable under the changes in their export prices in the assuming scope.

The parameters of fertilizer prices: The comparative advantage indicators of rice, coconut, and pomelo are still higher than the neutral points under the scenario of changing the fertilizer prices in the assuming scope. In overall, the changes in the fertilizer prices have small impacts on the competitiveness of rice, coconut, and pomelo.

The parameters of real effective exchange rates: The changes of the real effective exchange rates,

No.	Indicators	Unit	Rice	Coconut	Pomelo
1	Private profitability (PP)	USD	-184	1,519	15,803
2	Social profitability (SP)	USD	506	3,475	23,991
3	Domestic resource cost (DRC)		0.77	0.38	0.13
4	Social cost-benefit (SCB)		0.82	0.42	0.16

Source: own calculation based on the primary data (2017)

Table 3: The sensitivity analysis of comparative advantages by the climate change.

in principle, should affect on the social comparative advantage indicators only. The result shows that the changes of this variable in the assuming scope do not make these agricultural production systems to be uncompetitive.

In summary, rice production system is probably the weakest comparative advantage one and also the most sensitive to climate change, fluctuation of market prices and policy. Pomelo production system has the strongest comparative advantage and relatively stable to the changes in market and policy conditions. It is, however, potential to be relatively affected by climate change. Coconut has a comparative advantage and definitely stable production system to the changes in climate and other market and policy conditions. Pomelo results in the greatest private and social profits while coconut can generate a potential coconut processing cluster with stable private and social profits. The results suggest that under climate change and lack of fresh water, pomelo and coconut are likely appropriate alternative crops to rice when they have the better adoptive capacity, especially for coconut, and ensure comparative advantages. If diversity of agricultural commodities is considered, the direct comparison might be difficult, for instant, rice and/or coconut land can be converted for brackish water aquaculture. In this case, changes in agro-ecological characteristics cannot be reserved and lead to difficulty in the valorization of loss or gain in changes of environment and land use models. It may be suggested that farmers and policymakers should convert from rice crop into pomelo and coconut crops for more effective economic and sustainable benefits. However, this conversion should take account of the soil transferring costs and the initial cultivation costs of pomelo and coconut crops. Because pomelo and coconut require arable lands with furrow drains and mounds. It takes about four to five years to harvest pomelo and coconut with many cost and investment while there is no income in this period for farmers from the trees.

Consistency of different approaches in measuring agricultural competitiveness

In addition, this study measure trade competitiveness of these sectors by using RCA, RTA, and NRCA (following Hoang et al., 2017a, b) to understand the consistency of different approaches in measuring agricultural comparative advantage. PAM indicators indicate that pomelo is the strongest competitive, coconut is the medium competitive, and rice the weakest competitive while the trade indices show the different results that rice the strongest competitive, coconut is the medium competitive, and pomelo is uncompetitive (Table 4). These results seem to be contrasting to the economic literature which considers PAM indicators as the determinants of the trade performance competitiveness. In other words, the sectors with strong production comparative advantages will obtain stronger export competitiveness on the world markets, and vice versa. The potential explanation for this theoretical and practical issue is as follows.

It is the matter of the definitions of the competitiveness of a nation and a sector. A country can be defined as to have a comparative advantage in a sector if the country can produce the product with higher productivity, lower cost, and lower price finally and obtain higher relative market shares on the world markets. The product of a country with a comparatively lower price in the global market will achieve higher relative market shares in comparison with other countries and commodities. In this case, higher relative market shares (or comparative advantage) and lower price are synonymous. On the other hand, the competitiveness can be also defined as the ability of a nation, a sector, and a company to generate, while being and remaining exposed to international competition, relatively high and rising income and factor employment levels on a sustainable basis. In this definition, the competitiveness is synonymous with or positively related to higher profit and income for farmers. In order to have higher profit and income, farmers and producers should obtain higher prices, higher productivity,

	RCA	RTA	NRCA	DRC	SCB
Rice	5.88	6.25	0.86	0.63	0.71
Coconut	1.56	1.60	0.02	0.38	0.42
Pomelo	0.23	-0.09	-0.01	0.13	0.15

Source: own calculation based on the data of ITC and the primary data (2017)

Table 4: Comparing the competitiveness of different agricultural sectors by various indices.

and lower costs. As the result, the higher prices will lead to the stronger competitiveness of a nation under the constant conditions in this context.

In this empirical study, rice obtains the strongest trade competitiveness while it has the weakest production comparative advantage. The product is a main production system of Vietnam with large cropland areas and export shares in total exports. Rice price is dependent on the world rice price and relatively low. Moreover, Vietnam's rice production system employs the traditional technology with small-scale farms, low-skilled workers, and increasing input costs of fertilizers and pesticides. On the other hand, pomelo has the comparative disadvantage in export measured by the trade performance indices while it obtains the relatively strong competitiveness in production measured by PAM indicators. Da Xanh pomelo is a specialty product of Ben Tre with outstanding characteristics and quality which are preferred and highly evaluated by the local consumers and they are willing to pay a high price. It is, however, difficult to export the fruit to the world markets with a high price and local special characteristics. Coconut is a sustainable crop production system as it provides material input for the processing industry and can be cultivated in a harsh condition. In summary, it depends on the research objectives to define and measure competitiveness by trade (or market), economic (production), social, and environmental indicators or/and perspectives.

Conclusion

The study aims to investigate the competitiveness of these alternative crops under similar agro-ecological conditions and the contexts of climate and market changes. The results, in general, indicate that pomelo achieves the strongest comparative advantage with DRC of 0.13 and SCB of 0.15, coconut obtains the medium comparative advantage with DRC of 0.38 and SCB of 0.42, while rice has the weakest comparative advantage with DRC of 0.63 and SCB of 0.71. The sensitivity analysis of the comparative advantages show that: First, for the case of the drought and salinity intrusion in 2016, rice becomes non-profitable at the market price while the sector is still competitive at the social price. Meanwhile, the comparative advantage indicators of coconut and pomelo seem to be insignificantly changed. Second, if rice, coconut, and pomelo producers have to pay the water and land charges rice producer will get lost while the ones growing coconut and pomelo still obtain good profits. Nevertheless, the payments of the water and land charges to the government do not impact on the comparative advantage indicators. Finally, the different scenarios of sensitive analysis confirm that rice output price decreases make the producers get lost at the point of 10%. Nevertheless, all other comparative advantage indicators are relatively stable in the nature or in the interval [0,1] in the assuming scopes. In general, coconut crop is the most stable while rice is the most sensitive to the changes of climate and market conditions. This may suggest that farmers and policymakers may consider converting from rice crop into and adopting pomelo and coconut crops for more effective economic and sustainable benefits. However, this conversion should take account of the soil transferring costs and the initial cultivation costs of pomelo and coconut crops.

In spite of some limitations, DRC, SCB, and other competitiveness indicators in PAM model are useful analytic tools in detecting comparative advantages and dynamics of comparative advantages under environmental and market changes. They are appropriate to support farmers, agribusiness enterprises, and policymakers in decision-making process. However, to effectively use this approach, it is essential to combine with sensitive analsysis, collect accurate data of all stakeholders from the upstream to the downstream of value chains which are not available in Vietnam's secondary database. In addition, conversion of market prices to shadow prices must be carefully taken into accounts under real social economic situations.

The comparison analysis result between production and trade approaches indicates that production indicators and trade indices explain different rankings of competitiveness of the sectors under study. This result, however, is still consistent

with the economic literature. This is the matter of competitiveness definitions and research objectives. The production indicators focus on the unit profitability and income while the trade indices tress on the relative market share and power.

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Data Pre-processing for Agricultural Simulations

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Abstract

The process of agricultural simulation using APSIM requires input meteorological data to be prepared in a specific format and the simulation setting file to be ready before the simulation processing starts. Because of possible time savings when conducting large number of simulations at once, it is preferable to create all the input and settings files for all the simulations beforehand and process the simulations in batches as large as possible. This article specifically deals with the data acquisition, transformation and preparation process. It also outlines initial testing and computing time estimations and discusses scheduling, parallel processing and other possible simulation optimization methods..

Keywords

APSIM, big data, data processing, yield optimization, software automation, parallel processing.

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Introduction

With increasing processing capabilities, it is becoming possible to tackle larger research endeavours. In the area of scenario simulations, this increase in hardware power allows for broader assignments in terms of variable combination. Historically, the total amount of simulations was severely limited and required either very narrow specification of simulation parameters or usage of techniques that lowered the processing requirement at the cost of less accurate results, such as downscaling (Hewitson and Crane, 1996). Nowadays, higher hardware power can be utilized to calculate more simulations extending the limits of the usual variable spectrum. However, the multi-linear nature of growth of number of simulations based on number of options for each variable still limits the simulation process in general, so some restrictions need to be upheld regardless.

One example of simulation software that was originally designed for small scale field simulations on a single computer but has seen a resurgence as a large scale (even on a global scale) tool for simulation of agricultural production is the Agricultural Production Systems sIMulator (APSIM). This software provides important insight into challenges regarding food security, climate change adaptation and carbon trading (Holzworth et.al., 2014).

By using supporting software tools for automation and scheduling it is possible to tackle large number of simulations in APSIM by splitting the computation onto multiple machines utilizing parallel processing as shown by (Zhao, et.al., 2013). Even though hardware and software scales differently during processing (Kambadur, et.al., 2013), with a proper setup and data pre-processing it is possible to make up for the increased number of simulations. Apart from increasing the range for variables, increasing the resolution of the grid will also affect the number of simulations required, however as pointed out by (Mass, et. al., 2002) when it comes to weather forecasts, reducing the grid size beyond certain limit no longer significantly improves the quality of results.

Another issue is also the period of input weather data. Due to changes in global climate, only short-term predictions are possible (Aurbacher, et.al.,

2013), so it might be necessary to recalculate simulations on a periodical basis with newest possible data sets, in order to maintain high level of usability of results. This however introduces additional layer of scaling, so in order to ensure up-to-date knowledge based on the simulation results, measures must be taken to reduce the processing requirements of each individual set of simulations (Skoogh, et al., 2010).

The requirements for data storage also scale based on the number of simulations. However, there are possibilities to cut down the storage requirements by extracting required results during the processing from output files that have been already calculated and deleting them. But considering the processing of simulations is the most time-consuming part of the research process, deleting finished output files may be ill-advised, since they are the most "expensive" to create. Therefore, a better solution would be to search for additional storage capacities. Luckily, thanks to the rise of IoT (Internet of Things) as a source of data (Stoces et.al., 2018), most research entities have bolstered their storage hardware in recent years.

Overall, the issue of large-scale simulations, their processing requirements and optimization in general is very current topic. Many researchers are looking for solutions in various areas, whether it be utilizing cloud-based capacities (Szufel, et al., 2017), exploiting existing hardware to its maximum potential (Fujimoto, 2016) or looking for new frameworks altogether (Kirby, et.al., 2018).

Materials and methods

In order to simulate agricultural production two input files are required for APSIM. Firstly, there is the .met file which contains historical meteorological data for a given field / grid square. The required parameters are daily rates of solar radiation (radn), minimum daily temperature (tmin), maximum daily temperature (tmax) and precipitation rate (rain). Apart from these daily values the .met file must also contain pre-calculated values for annual ambient average temperature (tav) and annual amplitude in mean monthly temperature (amp).

The second input file is the .apsim file that contains settings for the simulation (irrigation rates, sowing window, sowing density, fertilization etc.) as well as data related to the given grid square (such as soil properties, characteristics for given plant genotype and so on).

The meteorological data we use are from Goddard Institute for Space Studies (GISS), which is part of National Aeronautics and Space Administration (NASA). The AgMERRA Climate Forcing Datasets (https://data.giss.nasa.gov/impacts/agmipcf/agmerra/) are free to download in an .nc4 format. The datasets are split into files per year (from 1980 to 2010) and per variable. Therefore, some pre-processing will be required to transform the data, since APSIM is expecting the data split into files per grid square containing a table with all the values for all the variables and for all the years.

The .apsim files are just .xml files using the markup language to capture all the input variables for each given simulation. These files have to be prepared based on real agricultural conditions in given area. For the purposes of multi-variable simulation, each single simulation has to be reproduced so that every possible combination of variables was represented. Considering the large-scale nature due to the high number of grid squares as well as high number of variable combinations, it is unfeasible to do this task manually.

To complete the pre-processing, both the .met and .apsim file for all the simulations must be ready. The next task is to optimize the simulation computations themselves outside of the APSIM software. Possible solutions include parallel processing, utilization of cloud based resource structure, optimizations regarding scheduling and use of additional hardware resources during their downtime. We plan to publish a separate follow-up article regarding this process at a later date.

Results and discussion

The required data conversion from .nc4 files downloaded from the NASA into .met files required by the APSIM software was achieved using a MATLAB script. The calculation of (tav) and (amp) variables can be done within MATLAB as well or using R script. However, we found that the easiest way is to first convert to .xls, do the calculation in MS Excel and then convert to .prn file, which has the same required structure as the .met, and simply change the extension.

In order to create the settings for all the simulations we have written a program using C# language that loads a single .apsim file with one simulation in it and returns an .apsim file with all the possible variations of that simulation, with all the combinations of chosen variables. In our case, it was 12600 simulations per each grid square. This batch size proved to be too high for the APSIM software, so we had to adjust the program to create

several smaller files (see below). The choice to use C# was arbitrary based on experience of the programmers in our team. Any other programming language (python, java etc.) can be chosen and will work just as fine to write a similar program / script.

Our simulations used single soil settings for all the grid squares. In cases where different soil settings are required the preprocessing depends on the form and availability of data in a given country. This will provide additional layer of preprocessing, however as shown by (Kim, et.al., 2018), this step can be also automated by writing an application specific to the soil database that will fetch the data in bulk.

Overall, the pre-processing of data did not provide any challenges in terms of software / hardware requirements; even with high number of simulations (hundreds of millions) the computation time is in the range of several minutes. The majority of input in this stage was therefore programmer labour time needed to write the scripts and programs.

The simulation processing itself will be done using the command line version of APSIM. The software has a graphical user interface (GUI) provided (see Figure 1), but it does not include any functionality that would be helpful setting up computation of large number of simulations. It is designed merely as a tool to better visualize the contents of the .apsim files and to edit values when dealing with small number of simulations at a time. The computation time of both variants (command line and GUI) is similar, but the former provides easier options for automation and scheduling using third-party tools.

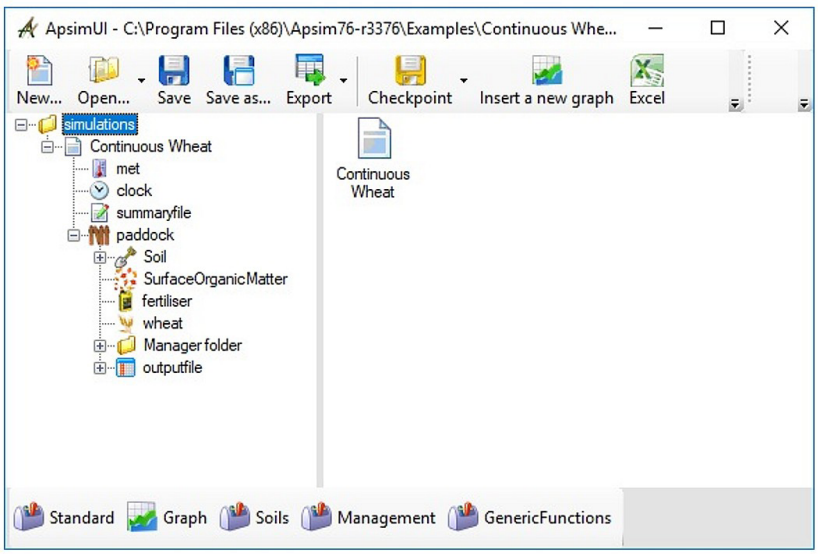
We conducted preliminary testing runs for some of the simulations on several different machines in order to estimate the overall time requirements. What we found was that the processing time doesn't scale perfectly with the amount of simulations in a single batch. Possibly due to some overhead requirements (initialization, clean-up etc.) the efficiency of simulations processed per minute goes up with the batch size (see Table 1 for approximate results).

Number of simulations	Approx. time (minutes)	Simulations per minute
100	2.5	40.0
500	11.5	43.5
1000	22.0	45.5
2000	40.0	50.0
2500	48.0	52.1

Source: own processing

Table 1: Preliminary processing efficiency for different batch sizes.

Based on these results it became clear that in order to optimize the processing, the batch size should be as large as possible. However, the APSIM software cannot handle all the simulations at once. There seem to be a limit on maximum batch size that is influenced by used hardware. Some of the stronger machines we used for testing were able to handle between 2000 and 3000 simulations at once, whereas regular desktop computers



Source: own processing

Figure 1: APSIM User Interface.

with mid-range hardware installed were not able to go over 1000 simulations in a single batch. This limit seems to be influenced by available memory capacity, but strangely during the simulation processing itself, the limiting factor was processor, not memory. This would imply that the memory capacity is mostly relevant during the initialization. We plan to conduct further testing using wider variety of hardware to reach more definite conclusion in this matter.

At this moment, the best way to optimize processing seems to be determining optimal batch size for each machine that will be involved in the computation process and use third-party scheduling software to run the simulations on every machine separately when its resources are free for use. With the way our C# program to generate simulation works at this point, that would mean creating a stockpile of simulations of varying batch sizes for each machine. Due to uneven workload of machines however, this may prove problematic, since each computer will drain its simulation stockpile at different rate. A solution to this issue might be adjusting the simulation generation so that it does not work as a static application, but rather an ongoing server application. That way the schedulers that handle processing could request batches of input files when necessary.

Conclusion

The requirements for data pre-processing when working with APSIM scale with the amount of simulations due to the lack of in-built option for variable simulations. However, this can be handled reasonably efficiently using features of MATLAB for weather data processing combined with self-written scripts to generate simulation files for all possible combinations of variables. There is little to no room for improvement or time saving when handling these necessary tasks. But when utilizing parallel processing it becomes possible to reduce computing time via optimizing the batch size for each individual machine. Having the option to select variable batch size within the simulation generation script therefore proved very advantageous.

But overall, we must conclude that the age of APSIM software really shows, especially with regards to lack of features / packages that could help with large scale research by removing or at least reducing the required pre-processing requirements. This issue is only amplified by the fact that personnel who use APSIM often do not possess enough IT knowledge and training, especially when it is required to operate additional third-party software. Similar findings regarding lack of IT expertise we pointed out by (Reinmuth and Dabbert, 2017) for instance. Some of these issues will be hopefully handled in the APSIM Next Generation as outlined by (Holzworth et. al., 2018).

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What Is Relationship between Profits and Dividends in Agricultural Legal Entities?

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Abstract

The paper assesses the development of profits in the selected legal entities of agricultural primary production in the Slovak Republic as well as the progress in taxation of profit distribution in the form of dividends including mutual correlations in 2009-2014. Mean values of profit or loss are noted for the diverse development of examined variables. The development of mean values of dividends from the net profit is achieved a slight increase in the selected years. The dividends generated in the analysed periods were not taxable because according to the Slovak tax law dividends were not subject to tax. The results of testing of differences significance in profit or loss values in the reviewed commercial companies and cooperatives determined that the statistically significant differences existed in the particular years. In case of dividends no statistically significant differences were found. The statistically significant correlations between profit and dividends were reported by means of nonparametric correlation analysis except for the profit generated in the year 2009 and dividends in the year 2010.

Keywords

Profit, shareholder, profit distribution, dividends, agricultural legal entity, income tax, withholding tax.

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Introduction

Profit after income tax which a legal entity achieved in a prior accounting period is obliged to be settled within the subsequent accounting period. The shareholder´s/cooperative member´s right for profit share belongs to his basic rights and results from the ownership share in a legal entity´s share capital. If Articles of Association do not determine the manner and amount to be paid as a profit share, it is applied that the profit is divided in accordance with their shares of unpaid contribution. The legal entity can allocate profit shares only from the net profit (i) decreased by shares in the reserve fund, (ii) increased by retained earnings and funds created from profit. In general, if a legal entity does not disclose the profit it cannot allocate shares in profit to a shareholder in the form of dividends. Despite that fact the allocation of dividends is not a legal right; it is the subject to a collective approval of statutory body deciding about the profit distribution between shareholders/members of cooperative.

The accounting result (profit or loss) is an important financial indicator expressing the effectiveness and efficiency of business activities mainly in connection to the contributed capital. It is the basic information source and the measurement of financial profitability of contributed capital to the respective accounting period (Baštincová, 2007). The Act on Accounting (2018) defines the profit or loss as the monetary final result of the company's activities achieved during the accounting period. Pursuant the accounting legislation of the Slovak Republic profit or loss is calculated in the appropriated structure in the income statement included in the individual financial statements. The individual financial statements provide basic information source to a company management but as well as to the external users of information (Košovská and Váryová, 2015). According to Hornungová and Milichovský (2016), the income statement representing the influence of managerial operational decisions on the economic results of the company,

has been used to study company performance (in this case the information whether the company generates profit or loss). Tumpach et al. (2014) states there are different groups of external users of business information for the financial statements whose needs are more often in the mutual contradiction. As a result, data about the business transactions, events and conditions need to be presented in the form of general purpose financial statements. The issue of accounting information provided by the company financial reporting is treated by Saxunová (2014). By means of the specific function and the importance of agriculture within the national economy this sector is the subject of government regulations which deforms a market and market prices as these are the input for accounting systems of agricultural companies and significantly influence the accounting result of agricultural companies and the assessment of their economic performance (Dvořáková, 2012). Hanová et al. (2015) compared economic position of the Slovak Republic with the EU countries by using the selected socio-economic indicators. The participation in profit (loss) belongs to criteria according to which the legal form is opted. The selection of a business legal form belongs to long-term effective decisions and it presents the factor substantially influencing the financial politics of a business (Sivák et al., 2015). The legislation stipulates mainly the manner of payments, respectively shares in profits in relation to the profit distribution (Commercial Code, 2018). Profit distribution and loss settlement is decided by the General Meeting of a company, generally when the financial statements are approved. Particular profit distribution depends on the balances of equity, internal directives of an accounting entity and presents in the Articles of Incorporation or Articles of Association, on the amount of profit or loss and other circumstances (Šteker and Otrusinová, 2013). In many countries the corporate profit is subject by two level of tax, corporate level of income tax and investor level tax when the corporate net profit is distributed as dividends. The mechanism of dividend payments differentiates according to individual countries (Kráľovič and Vlachynský, 2002). The issue of profit distribution policy is a topic often discussed by many authors in various jurisdictions such as Široký and Valentová (2013), Sander et al. (2014), Matuszewska-Pierzynka (2015), Mei and Wei (2015), Toder and Viard (2016). The investors shift the profit to low tax jurisdictions and the concern grows due to increasing international tax rate differentials (Martini et al., 2012).

The aim of the paper is to assess development and mutual relationship between profit and its distribution in the form of dividends as well as to consider the legal treatment of dividends taxation in the selected legal entities of agricultural primary production in the Slovak Republic (hereinafter referred to as "SR" or the "Slovak Republic") by means of testing of differences significance and correlations of reviewed variables in the analysed period of the years 2009-2014.

Materials and methods

Data source for the assessed legal entities is presented by the Information Letters of the Ministry of Agriculture and Rural Development of the Slovak Republic (hereinafter referred to as "MARD SR"). These are the data from individual financial statements of agricultural legal entities (limited liability companies, joint stock companies and agricultural cooperatives).

The taxation of profit and its distribution in the form of dividends within the territory of the Slovak Republic is considered in accordance with the provisions of the Act no. 595/2003 Coll. on Income Tax as amended (further referred as "Income Tax Act") as well as from the international perspective, in particular, the provisions of the Council Directive 2011/96/EU of 30 November 2011 on the common system of taxation applicable in the case of parent companies and subsidiaries of different member states (further referred as "EU Parent Subsidiary Directive" or "Directive") is also taken into account.

The significant differences and correlations in values of dependent variables are examined, namely *Profit* and *Dividends* for the years 2009-2014. The selected descriptive characteristics are calculated for the assessed variables – the point and interval mean estimate, the standard error of mean estimate and the standard deviation.

The analysis of variance and repeated measures (ANOVA Repeated Measures) is the most suitable analysis for the testing of differences significance of dependent variables.

The analysis model of variance with repeated measures without division to groups:

$$Y_{ij} = \mu + \alpha_j + \beta_i + \lambda_{ij} + e_{ij},$$

Where μ is an average of dependent variable, α_j is effect of j repeated measure, β_i is effect of i object, λ_{ij} is an interaction between the repeated measure j

and the object *i*.

We are interested in one zero hypothesis:

$H0_A$: $\mu_1 = ... = \mu_I$ (averages of repeated measures are the same).

The restricted condition of using the significance tests is the condition of sphericity of the covariance matrix – the equality of variance and covariance in the covariance matrix for repeated measures. Mauchley Sphericity Test is used for the verification of the covariance matrix sphericity – the assumption of using the analysis of variance for repeated measures with more than two levels. If the condition of covariance matrix sphericity is not met, the amount of the first level error is increasing. In such cases the degrees of freedom of used F-test are adjusted by means of Greenhouse/Geisser and Huynh/Feldt Adjustments. In order to determine the statistically significant differences at the level of intragroup factor Year the multiple comparison is used, namely Tukey HSD Test. The null hypothesis assumes that in the profit or loss there are no statistically significant differences between the assessed years. The null hypothesis assumes that there are no statistically significant differences in paid dividends from profit between the assessed years. It means that the variables *Profit* and *Dividends* are not dependent on the intragroup factor *Year*.

The nonparametric correlation – Spearman Rank Order Correlations is used for the assessment of correlation significance between selected variables during the analysed years due to the deviations from the normality. The null hypothesis states that examined variables are independent (Munk, 2011).

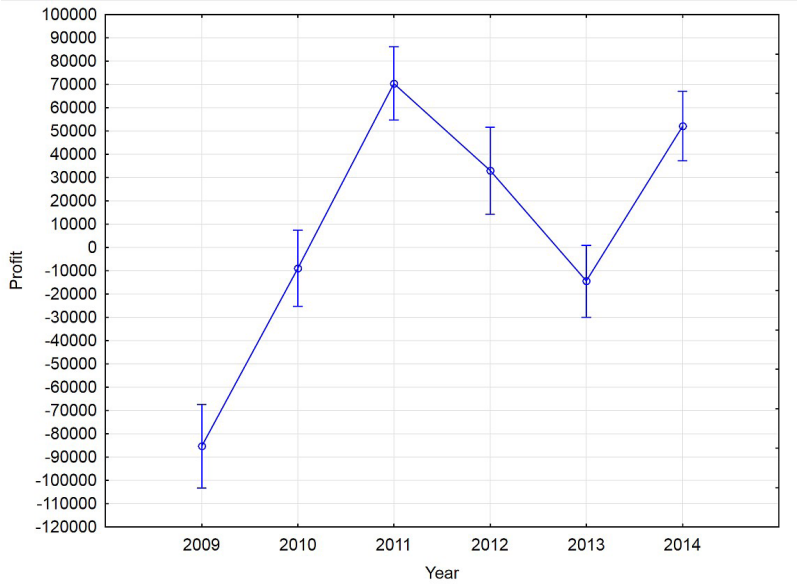
MS Access, MS Excel and the system STATISTICA are used for the data processing from database and the analysis of relations between selected variables.

Results and discussions

In general, profit presents generated result in the accounting period which positively influences the equity of a legal entity. Profit or loss disclosed by a legal entity achieved for a current accounting period shall be settled till the end of the following accounting period. Based on the decision of the statutory body of a commercial company or cooperative the profit part can be allocated in the dividends in the favour of shareholders/cooperative members who participate in the equity of a legal entity.

The calculation of selected descriptive characteristics and 95% interval of mean reliability presents the results for the analysed variables of the selected legal entities of agricultural primary production in the Slovak Republic in the years 2009-2014.

Results from accounting of legal entities figured the differentiated development in the analysed years (Figure 1) based on the achieved values of the development of mean level of profit or loss in the selected agricultural legal entities. In the year 2013 the interval mean estimate of profit or loss was at the level -29890.5 EUR till 1014.2 EUR.



Source: Own calculation based on data from the Information Letters of the MARD SR

Figure 1: Means plot for variables Profit 2009-2014.

For comparison in the year 2012 the mean amount of profit was at the level 32970.2 EUR and in the year 2014 at the level 52165.0 EUR. The highest average level of profit was recorded in the year 2011, on the contrary the highest average value of loss was in the year 2009.

The significance of differences at the level of factor Year was tested in connection with the presented results of selected descriptive characteristics of examined variables.

Based on the results of Mauchley Sphericity Test (W = 0.582; *Chi-square* = 532.706; df = 14; p = 0.0000) the assumption of using the analysis of variance for repeated measures was breached in case of the variable *Profit*.

Because of the sphericity assumption breach the adjusted tests of significance Adjusted Univariate Tests for Repeated Measure (Table 1) were used for the testing of differences. In case of the dependent variable profit the null hypothesis was set which at the level of factor Year assumes that there are no statistically significant differences between the analysed years in the obtained profit or loss. The hypothesis was rejected with 99.9% reliability.

If the null hypothesis was rejected which states that there are no statistically significant differences between the analysed years, Tukey HSD Test (Table 2) is applied, on the basis of which there are statistically significant differences in the individual years of the recognized profit after tax for the period.

Based on the multiple comparison we identified three homogeneous groups (2013, 2010), (2012, 2014), (2014, 2011), it means that in such cases the statistically significant differences were not demonstrated between the analysed years.

As regards the obtained results of selected descriptive characteristics it can be stated that in the reviewed period of years 2009-2014 the slightly increasing trend was determined in the mean amount of dividends in the selected agricultural legal entities in the Slovak Republic (Figure 2) while the development of such a variable influence mainly the recognized accounting result obtained in the prior accounting period. The most significant increase in dividends was achieved in the year 2013 when the highest mean amount of dividends from profit distribution recognized in the accounting period 2012 was disclosed at the level 117319.6 EUR. In the year 2014, the interval mean estimate of dividends was at level 83361.3 EUR till 132530.6 EUR.

As well as in the case of profit, the validity assumption was breached even for the dependent variable which was the level of dividends based on the results of the Mauchley Sphericity Test (W = 0.129; *Chi-square* = 1.092.001; df = 14; p = 0.0000).

Adjusted Univariate Tests for Repeated Measure (Table 3) were used for the testing of differences significance. The null hypothesis was set also for the assessed variable dividends which assumes that there are no statistically significant differences between the amounts of dividends from profit between the reported years.

At the level of factor *Year* no statistically significant difference is determined in the variable *Dividends*

	G-G Epsilon	G-G df1	G-G df2	G-G p	H-F Epsilon	H-F df1	H-F df2	H-F p
Year	0.817	4.084	4027.256	0	0.821	4.104	4046.101	0

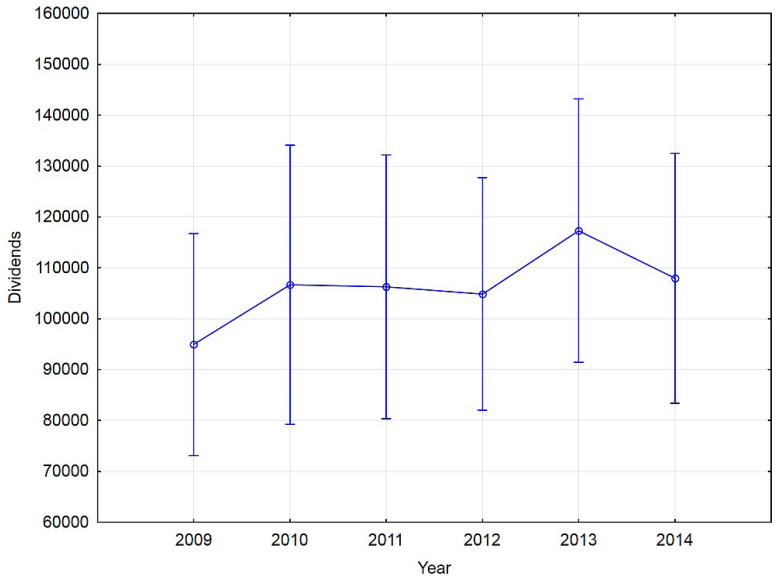
Source: Own calculation based on data from the Information Letters of the MARD SR

Table 1: Adjusted Univariate Tests for variables Profit 2009-2014.

Profit	Mean	1	2	3	4
2009	-85268.4				****
2013	-14438.2	****			
2010	-8916.5	****			
2012	32970.2		****		
2014	52165.0		****	****	
2011	70466.4			****	

Source: Own calculation based on data from the Information Letters of the MARD SR

Table 2: Multiple comparison for variables Profit 2009-2014.



Source: Own calculation based on data from the Information Letters of the MARD SR

Figure 2: Means plot for variables Dividends 2009-2014.

	G-G Epsilon	G-G df1	G-G df2	G-G p	H-F Epsilon	H-F df1	H-F df2	H-F p
Year	0.535	2.674	1433.527	0.2445	0.538	2.689	1441.393	0.2444

Source: Own calculation based on data from the Information Letters of the MARD SR

Table 3: Adjusted Univariate Tests for variables Dividends 2009-2014.

	Valid N	Spearman R	t(N-2)	p
Dividends 2010 & Profit 2009	854	0.066	1.924	0.0547

Source: Own calculation based on data from the Information Letters of the MARD SR

Table 4: Nonparametric correlations for variables Profit 2009 and Dividends 2010.

	Valid N	Spearman R	t(N-2)	p
Dividends 2014 & Profit 2013	826	0.104	3.012	0.0027

Source: Own calculation based on data from the Information Letters of the MARD SR

Table 5: Nonparametric correlations for variables Profit 20013 and Dividends 2014.

($p > 0.05$) and the null hypothesis is rejected. It means that there were no statistically significant differences in paid dividends between the particular years.

In connection with the before mentioned facts the nonparametric correlation analysis, specifically Spearman Rank Order Correlations, was used for the determination of significance level of correlations between the selected variables.

The statistically significant correlation between profit and dividends was determined within the analysed variables in the assessed commercial companies and cooperatives in the years 2009-2014, except for the profit recognized in the year 2009 and the dividends in the year 2010 (Table 4), the statistically insignificant trivial correlation was determined between the variables ($p > 0.05$).

In the following analysed years the small statistically significant correlation was determined between the variables profit in the year 2010 and subsequently the dividends in the year 2011 ($p = 0.0017$), the profit in the year 2011 and the dividends in the year 2012 ($p = 0.0037$), the profit in the year 2012 and the dividends in the year 2013 ($p = 0.0000$), as well as the profit in the year 2013 and the dividends in the year 2014 (Table 5).

The net profit after income tax for the accounting period influences not only the subject of selected business activities but as well as the legal form of entrepreneurship. The most frequently

represented forms of legal entities of agricultural primary production in the Slovak Republic present limited liability companies, joint stock companies and cooperatives. Above mentioned issues are approved by Adamišin and Kotulič (2013) as commercial companies and agricultural cooperatives have a dominant position from legal entities and also have higher equity (Tóth et al., 2014).

Agricultural companies are influenced by the biological character of production, seasonality but as well as currently valid system of subsidies payments (Serenčéš et al., 2014). Biological nature of primary agricultural production significantly impact on the economic performance of legal entities (Gyurián and Kútna, 2015). According to Tóth et al. (2016) climate and weather related risks have a strong effect on agricultural production. Risk and return are negatively related and investors are comparing the risk with a profitability. With the entry of the Slovak Republic into the European Union (hereinafter referred to as "EU") companies can apply for assistance in the form of subsidies, grants or other assistance in the form of contributions from the funds of the SR or the EU. Despite the supports of SR or EU, companies need to reassess their economic activities and use of selected methods appropriately and prevent possible financial bankruptcy (Fiľarská, 2017). The entrance of the SR in the EU meant for the Slovak agricultural legal entities the possibility to adopt the financial compensations and the reduction of losses occurred by the influence of external effects under certain assumptions. The success of performed business activities is also the comparison of recognized profit or loss of legal entities with the achieved profit or loss of other companies in the agricultural primary production in the Slovak Republic. In the year 2009 despite of rising subsidies from the EU the unfavourable profit or loss of agricultural legal entities was caused mainly by low prices of agricultural produce (Report on agriculture and food sector in the Slovak Republic for the year 2009). In the year 2010 the profit or loss was influenced by various factors, except for the subsidies politics specifically direct payments, the faster increase in realization prices of agricultural produce as well as the input prices to agriculture and the flood impacts during the year caused the produce breakdown (Report on agriculture and food sector in the Slovak Republic for the year 2010). In the year 2013 the differences persisted in the profit or loss between companies in the various climatic conditions and in the legal forms. The subsidies were provided in accordance with the same criteria and conditions for both legal forms (Report on agriculture and food sector in the Slovak Republic for the year 2013).

Above mentioned statements are approved by the achieved results of selected descriptive characteristics regarding the development of profit or loss in the analysed commercial companies and cooperatives (Figure 1). In the years 2009, 2010 and 2013 the agriculture in the Slovak Republic as a whole obtained the negative accounting result (loss). On the contrary, in the years 2011, 2012 and 2014 the profit has been generated in the selected legal entities. The profit for a particular financial year after corporate income tax presents the net profit which can be allocated in the form of dividends between shareholders/ members of cooperative based on the decision of statutory body.

The profit of the Slovak legal entities is included in the general tax base. Corporate income tax in the SR is levied on all taxable income which is subject to standard corporate income tax rate. Income is computed as taxable revenues reduced by eligible costs incurred to generate, assure or maintain taxable income, subject to additional tax adjustments. From the international perspective, corporate income tax has been characterized in recent years by a gradual decrease of the nominal tax rate and the countries of the EU are no exception (Delgado et al., 2014). The corporate income tax has developed also in the Slovak Republic. Since 1993 the Slovak corporate income tax rate has fallen from 45% to 21%. In comparison with the countries of Visegrad group, the corporate income tax burden is the highest in the Slovak Republic. Within the period of last 17 years, the most significantly reduced the corporate income tax rate in the Czech Republic, by 12 percentage points, i.e. the current corporate income tax rate amounts 19%. The lowest corporate income tax rate presents Hungary in the amount of 9% (Taxation Trends in the European Union, 2018 Edition).

From the results of the selected descriptive characteristics it can be further stated that in the analysed period of the years 2009-2014 the slight increase of average value of dividends was determined in the agricultural commercial companies (Figure 2). This issue relates to the principle of a particular direct taxation. Pursuant to this principle the income shall not be the subject to income tax which has already been taxed. Before stated principle is the part of adopted tax reform approved in the Conception of tax reform in the years 2004-2006 and subsequently in the tax law (Act on Income Tax, 2017).

In the Slovak Republic, the dividends paid out of profit earned in the analysed periods 2009-2014 were exempt from taxation, unless they were distributed out of profits earned prior to 1 January 2004. In this respect, it should be noted that, according to the amendment of the Income Tax Act, effective from 1 January 2017, dividends are subject to withholding tax (Act on Income Tax, 2018).

In particular, dividends are subject to tax if paid to individuals and, in specific cases, to companies for tax periods starting after 1 January 2017. Dividends paid to individual shareholders/ members of cooperatives or tax non-residents from contractual countries by Slovak legal entities are subject to withholding tax at a rate of 7%, if the applicable double tax avoidance treaty does not determine otherwise. A withholding tax of 35% applies to dividends paid by Slovak entities to all tax residents from non-treaty countries (i.e. countries with which the Slovak Republic has not concluded a double tax avoidance treaty or a treaty on the exchange of tax information), including individuals and legal entities. The withholding tax shall be remitted to the tax authorities by the person paying the dividends within 15 days of the following month for the previous calendar month. The Slovak legal entity paying the dividends is obliged to report the withholding tax to the respective tax authorities. The same approach applies to dividends received by Slovak tax residents from foreign sources due to its shares in a foreign company from profit generated after 1 January 2017. In such case, those are included in the separate tax base and taxed at a rate of 7%, or 35% in the case of receipt of dividends from non-contractual countries.

The EU Parent Subsidiary Directive is incorporated into the Slovak tax legislation and therefore need to be taken into consideration in respect of profit distribution. The Directive eliminates double taxation of profits distributed by a company resident in one EU member state to a parent company resident in another member state, affects the levying of withholding tax on dividends at domestic or tax treaty rates. The EU Parent Subsidiary Directive is mandatory for all EU member states, due to the fact that double non taxation is one of the key EU areas for urgent and coordinated action, it forms part of an on-going effort to improving the paper functioning of the internal market, by closing tax loopholes generated by exploiting the differences in national tax systems (Explanatory memorandum of the proposal for a Council Directive amending Directive 2011/96/EU on the common system of taxation applicable in the case of parent companies and subsidiaries of different Member States).

Should conditions stated in the EU Parent Subsidiary Directive are not met, the respective bilateral double tax avoidance treaty, as the important toll for elimination of double taxation of dividends, need to be considered. Currently, the Slovak Republic has an extensive array of double tax treaties, which normally reduced the withholding tax on dividends. The Double Tax Avoidance Treaty concluded with the Czech Republic reduces the withholding tax on dividends to 5% or 15%. The reduced rate of 5% is applicable to legal entities directly holding a minimum stake of 25%. The same rates on dividends are applied under the Double Tax Avoidance Treaty concluded with Hungary. The Double Tax Avoidance Treaty concluded between the Slovak Republic and Poland reduces the withholding tax on dividends in the amount of 0% or 5%, while 0% is applicable to legal entities directly holding a minimum stake of 10% for a period of at least of 24 months as at the date of payment.

Based on the achieved results, statistically significant correlation was determined between profit and dividends in the assessed commercial companies and cooperatives within the reviewed variables. Whereas the right to the payment of particular dividends does not arise directly with the fact that a legal entity has obtained the profit in a financial year but it arises with the decision of a legal entity´s statutory body about the distribution of profit between shareholders/members of cooperative.

Conclusion

The following conclusions are formulated based on the assessment of achieved profit or loss and paid out dividends as well as the assessment of their mutual correlations in the reviewed legal entities of agricultural primary production in the Slovak Republic in the analysed years 2009-2014. Based on selected descriptive characteristics the development of mean levels of profit or loss determined a differentiated progress in the particular period 2009-2014. On the contrary the mean value of dividends slightly increased in the analysed years. The facts related to the development of profit or loss in the agriculture are approved as well as by reports on agriculture and food sector in the Slovak Republic for the assessed years. The testing of differences significance in values of selected dependent

variables (Profit and Dividends) which were treated on the base of independent variable at the level of factor Year resulted in the fact that between the analysed years there were determined the statistically significant differences in the achieved accounting results which were dependent on the reported years in which the assessment was conducted. The profit or loss in the commercial legal entity of agricultural primary production is affected by specific circumstances, namely climatic conditions, seasonality and adopted subsidies of non-investment character which cause the recognition of diverse levels of obtained profit or loss in the respective years. The statistically significant differences were not determined between the amounts of paid dividends between the analysed years, i.e. the dividends were not dependent on the concrete years. Before stated is approved by the fact that if a shareholder/member of cooperative does not decide on the distribution of net profit, it is not paid and is accumulated in the equity of a legal entity in the form of retained earnings. The statistically significant correlation between profit and dividends was recognized in the analysed years based on the determination of correlation significance between the reviewed variables in the selected commercial companies and cooperatives. The amount of dividends paid from profit depends on the decision of statutory body of a commercial company or cooperative as well as the amount of profit recognized in the prior accounting period. Pursuant to the concluded analysis it can be stated that if a legal entity does not recognize the profit, the share in profit in the form of dividends cannot be paid to shareholder/member of cooperative. The statutory body of a legal entity is obliged to decide about the dividends allocation. In the Slovak Republic, dividends were not taxable, unless they were distributed out of profits earned prior to 1 January 2004. Dividends distributed out of profits generated after 2017 and paid to resident individuals or tax non-residents from contractual countries by Slovak legal entities are subject to tax at a rate of 7% or 35%. The foreign investors within the EU countries can benefit from the provisions of the EU Parent Subsidiary Directive which allows exempt dividends and other profit distribution paid by subsidiary companies to their parent companies from withholding taxes and eliminates double taxation. The additional tool for elimination of double taxation of dividends presents bilateral double tax treaties which the Slovak Republic has concluded. The provisions of double tax treaties in many cases also reduce withholding tax rate applicable on dividends in accordance with the national law.

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Sensitivity Analysis in Research of Construction of Agricultural Buildings Focused on Poultry Farming

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Abstract

Both heat comfort and energy saving represent important parameters of agriculture buildings environment. Selecting material composition for perimeter walls (in course of both new building construction and reconstruction of existing ones) can aid to eliminate heat load of interior environment. Non-stationary processes taking place in building constructions in connection with building interaction with exterior environment and installed ventilating and heating systems are affected by a number of factors that can be well modelled by help of simulation methods and verified by experimental measuring. This work deals with analysing building construction from viewpoint of material used materials and changing their different physical parameters in order to achieve an optimal perimeter construction composition for agriculture building with regard to poultry farms.

Keywords

Economical operation, sensitivity analysis, system analysis, system model, poultry farming, economy of agricultural engineering, heating energy economy, temperature time characteristics, building temperature interaction.

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Introduction

The primary aim of the work is economical optimization employed during a project phase of poultry house construction designing and, at the same time, creating a designer´s support tool for decision making concerning selection of proper building materials (and construction configuration) focused on future costs associated with heating and, thus, with costs spent to heating energy. In fact, an unsuitable construction design may cause completely wasteful operation related to excess costs and depreciation of business plans. The following method provides designers with ability to select both material optimum types and sizes ensuring future economical operation of the realized poultry house.

In association with development of animal farming, importance of heating energy economy and, concurrently, ambient temperature well-being constantly increases. For that reason, constructors should place appropriate emphasis on non-stationary processes in the area of building temperature interaction with outer environment as well as with installed heating and ventilation systems (Veverka et al., 1992). Building objects of poultry farms have to provide protection against excessive heat losses in cold macroclimatic conditions and, concurrently, to avoid excessive heat penetrating during hot time periods (Chloupek, 2012). Often unresolved aspects of thermal and insulating properties of perimeter constructions of poultry barn envelope or inappropriately designed or improperly used ventilation systems causing heat losses represent a part of the lacks of existing poultry farm buildings. Heat losses caused by penetrating through building construction are wholly useless and should be as more as possibly eliminated. Under optimum conditions, computation macro- and microclimatic values for thermal and insulating properties of walls and ceilings of poultry barns should eliminate water condensation on inner surface of the constructions. Especially during cold timer periods, negative heat balance of poultry barn spaces intended for breeding of young birds not having fully developed thermoregulation must be compensated by additional heating (Výmola et al., 1995).

By help of a mathematic model of a poultry farm building construction, it is possible to simulate and study heat behaviour of each structural element in response to time changes caused by both outdoor temperature and indoor heating system. This method is applicable for indoor non-stationary heat processes analysis as well as for computer-controlled heating optimization (Cooke and DeBaerdemaeker, 1975).

This method was first time introduced by Professor Jiří Pánek, the former dean of the Faculty of Civil Engineering at CTU in Prague and, afterwards, it was enhanced by Professor Petr Moos and Associate professor Dalibor Vytlačil, both of them of the same institute. Later, senior lecturer Vít Malinovský (1993) worked up a method and carried out its application on particular building constructions together with a comparative analysis of the obtained results. At the Department of Building Equipment at CTU, the team led by Professor Miroslav Jokl developed the special application ANATH for analysis and synthesis intended for calculating heat responses at different building structural configurations.

Materials and Methods

Climate inside a poultry house comprises a set of environmental factors influencing wellbeing and health of a poultry flock. Particularly younger birds are sensitive to the inner climate consisting of five main factors reliant to building construction aspects: temperature, relative humidity, air composition, air speed and movement, and light. The first four of them are directly related to the interior temperature conditions. That is why, designers have to pay strong attention to a constructional side of planned objects of poultry houses – well done project radically affect success rate of future poultry breeding.

The most important factor for breeding birds is so called micro-climate i.e. the temperature closely encircling animals. Since interior temperature (without considering air circulation) can be characterized as a function of inner height – when the lowest values occur at a floor level and the highest at a ceiling – location of animals plays an significant part in creating environmental comfort. Taking this fact into consideration, satisfactory heat & costs saving can be achieved. Use of breeding rings may be given as an example. Layers keep their body temperature approximately constant within the range of 41 °C and 42.3 °C. Ideal ambient temperature for both layers (and broilers) lies between 20 °C and 24 °C and, with decreasing temperature, they require more feed to be able to maintain body temperature. Contrarily, higher temperatures cause worsening of egg weight as well as shell quality. A table of recommended temperatures for layers and broilers follow (Hulzebosch, 2005):

1st day	1st	2nd	3rd	4th
	week of decrease			
32-34 °C	30 °C	26 °C	22 °C	20 °C

Source: Hulzebosch, J. (2005)

Table1: Recommended temperatures for layers and broilers.

For the purpose of practical demonstration, a common and simple type of a poultry house object was selected. The paper comprises problems of the 3D model construction based on a real poultry house (on Figures 1a and 1b), mathematic theory of sensitivity analysis including calculation methods of temperature interior responses on exterior temperature values and, in the Results section, simulating of temperature courses for three different types of perimeter wall construction.

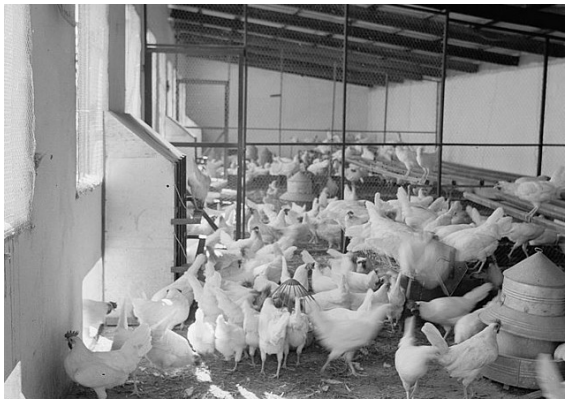

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Figure 1a: Typical poultry house object used for mathematic model.

For describing problems of heat transfer sensitivity for parameters of building constructions, a simplified 3D-model of a poultry farm shown on Figures 1a and 1b was considered. This poultry farm represents a single-space building object of single-layer perimeter wall very appropriate as an initial base for a particular system model scheme creation. Also a glass-walled part is taken into the consideration for temperature changes calculation (Moos, Vytlačil 1991).

This 3D-model is used for creating a particular scheme of a thermal circuit – handled as an electric circuit – representing a construction part of the poultry farm building object (Sonderegger, 1977).

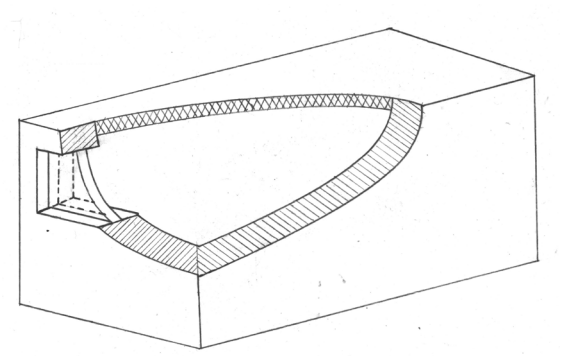

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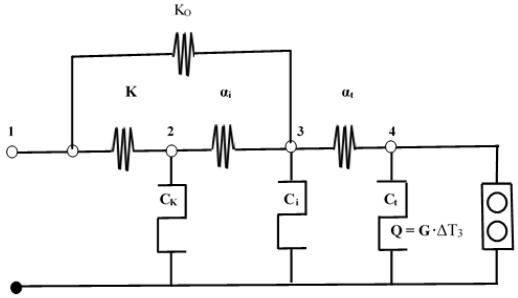
Figure 1b: Object scheme for system model creation.

Further, the thermal circuit considered as the building object system macromodel shown on Figure 2 based on the object scheme is used for entering input parameters for calculation carried on by ANATH application (Moos, Vytlačil 1991, Malinovský 1993). Numbers at the macromodel nods on Figure 2 represent selected temperature nods: $T_o = T_1$ on outer surface of perimeter wall, T_2 on inner surface of perimeter wall, $T_3 = T_i$ in interior, and T_4 on heating body (Jokl, 1989).



Source: Malinovský, V. (1989)

Figure 2: Particular scheme of examined system model.

1, 2, 3, 4 thermal circuit (system macromodel nods;

K heating transfer coefficient (wall) [K.W^{-1}];

K_0 heating transfer coefficient (glass-walled part) [K.W^{-1}];

C_K heat capacity of perimeter wall [W.h.K^{-1}];

C_i heat capacity of interior [W.h.K^{-1}];

C_t heat capacity of heating system [W.h.K^{-1}];

Q regulation factor [W.K^{-1}];

α_i heat transfer from perimeter wall to interior [K.W^{-1}];

α_t heat transfer from heating system to interior [K.W^{-1}].

For simplicity, individual parameters are modelled by help of elements with concentrated parameters (Malinovský, 2018). Temperatures changes within the adjacent areas of stabilized state can be determined through a system of differential equations that could be – after Laplace transform – represented in matrix form:

$$\begin{bmatrix} Q_1 \\ Q_2 \\ Q_3 \\ Q_4 \end{bmatrix} = \begin{bmatrix} K+K_0 & -K & \propto_i & 0 \\ -K & K+\propto_i + p\cdot C_K & -\propto_i & 0 \\ -K_0 & -\propto_i & \propto_i + K_0 + \propto_i + p\cdot C_i & -\propto_i \end{bmatrix} \cdot \begin{bmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \end{bmatrix} \quad (1)$$

An image of Laplace transform of temperature change within the interior (T_i) initiated by change of outer temperature (T_o) can be determined in the following form:

$$T_3 = \frac{\Delta_{13}}{\Delta_{11}} \cdot T_1 = F(p, x_1, x_2 \dots x_n) \cdot T_1 \quad (2)$$

p Laplace operator

x_i heat properties of construction and heating system ($K_{(x)}$, $C_{(x)}$, Q …)

Natural heat transfer is a typical process continuously changing in time. During the process, also transfer parameters show changes and some interesting relations among their values occur (Wachowicz, 2016). Amount by which the heat transfer is sensitive for changing individual partial parameters is very worth of detail research (Pöttgen et al., 2016). Therefore, a definition of heat transfer sensitivity was introduced. If linear approximation in the area of parameter x nominal value is carried out – as shown on Figure 3 – sensitivity of function *F(p,x)* to parameter *x* can be determined as derivation (2).

$$S_x^F(p,x) = \left.\frac{dF(p,x)}{dx}\right|_{x=x_q} \quad (3)$$

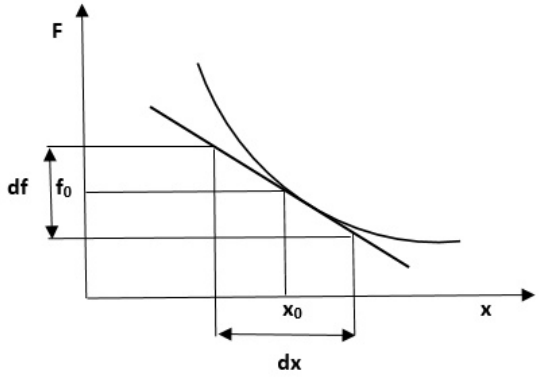


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Figure 3: Linear approximation in parameter value area

Also, so called relative sensitivity can be used:

$$S_{r\,x}^F(p,x) = \frac{dF(p,x)}{dx} \cdot \frac{x_0}{F_0} \quad (4)$$

where x_0 and F_0 represent nominal values. Function $F(p,x)$ can be determined after calculating algebraic complements in equation (2) as:

$$F(p,x) = \frac{N(p,x)}{D(p,x)} \tag{5}$$

where $N(p,x)$ and $D(p,x)$ are polynomials with variable p and changing parameter x.

Actually, relative sensitivity (4) represents a sensitivity function because variables p and x figure within. After substituting nominal values $p = j\omega_0$, $x = x_0$ numeral data figuring sensitivities are obtained.

Calculating sensitivities cane be carried out by the following equation:

$$S_{r_{x_i}}^{F}(p,x_i) = x_i\left(\frac{N'}{N} - \frac{D'}{D}\right) \tag{6}$$

which enables to avoid more complexed deriving function ratio (Moos, Vytlačil 1991).

At analysing heat damping, amplitude of heat divergences distributed through constructions and time offsets (phase offsets) of heat excitements at passing through construction are of special importance. Heat inertia of individual building constructions can be determined by dimensionless quantity heat damping v which is equal to a ratio of amplitude of exterior air temperature variation A_e to amplitude of interior surface temperature A_{is} (Figure 4) :

$$v = \frac{A_e}{A_{is}} \tag{7}$$

Periodically changing temperature of exterior air causes periodical temperature change on interior construction surface (provided temperature of interior air is constant) as shown on Figure 3 (Sangi et al., 2016). During the process time offset of temperature amplitudes called phase offset Ψ can be observed as shown on Figure 5.

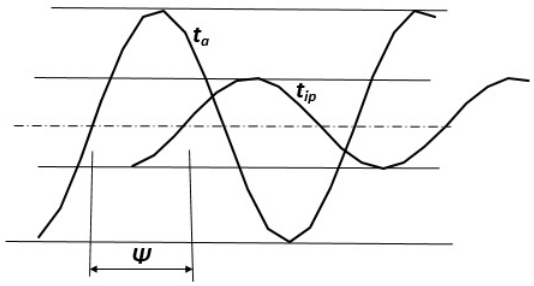

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Figure 5: Temperature amplitudes time offset.

By use of Fourier transform – or Fast Fourier transform; FFT (Bracewell, 1999) – time progress of temperature change can be decomposed to a set of harmonic components characterized by appropriate phase amplitude (Svoboda, 2012). At calculating sensitivities of amplitudes and phases to changes of parameters, derivations of both module and phase functions derived from system function $F(j\omega,x)$ need not be calculated individually but in bulk thank to the fact that a real part of the sensitivity function (4) after substituting $p = j\omega$ directly represents sensitivity of temperature amplitude an imaginary part represents sensitivity of phase delay to change of parameter x. It can be determined as:

$$S_{r_{x_i}}^{F}(j\omega) = Re\cdot S_{r_{x_i}}^{F} + j\cdot Im\cdot S_{r_{x_i}}^{F} = \frac{d|F(j\omega,x_i)|}{dx_i}\cdot\frac{x_i}{|F(j\omega,x_i)|} + j\cdot\frac{d\{argF(j\omega,x_i)\}}{dx_i} \tag{8}$$

Graphs of the functions:

$$Re\cdot S_{r_{x_i}}^{F} \quad \text{and} \quad Im\cdot S_{r_{x_i}}^{F} \tag{9, 10}$$

represent sensitivity characteristics.

A differential characterizing heat transfer:

$$\Delta F = \sum_{i=1}^{n} S_{x_i}^{F}\cdot\Delta x_i \tag{11}$$

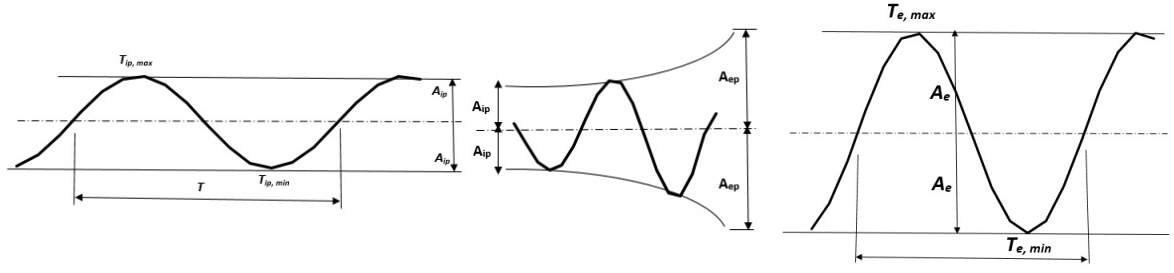

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Figure 4: Heat damping characteristics.

represents tolerance of system function $F(x_i)$, while relative tolerance is defined as:

$$\frac{\Delta F}{F} = \sum_{i=1}^{n} S_{r\,x_i}^{F} \cdot \frac{\Delta x_i}{x_i} \qquad (12)$$

Resulting signs of partial tolerances can be different and effects of changes may be compensated to a certain extent (Dong et al., 2015). The worst scenario occurs when all partial tolerances of the same signs are added. It can be defined by the equation:

$$\frac{\Delta F}{F} = \sum_{i=1}^{n} \sqrt{\left(S_{r\,x_i}^{F} \cdot \frac{\Delta x_i}{x_i}\right)^2} \qquad (13)$$

Analysis of the worst case of tolerances effects is of great significance because it enables to avoid undesirable impacts of production spread of building constructions parameters (Evola and Marletta, 2013).

While formulas of system function tolerances (12, 13) describe current effect of tolerances of all considered parameter so called sensitivity matrix enable transparent arrangement of partial tolerances and represents an useful tool for considering dominant construction parameters from the viewpoint of both temperature amplitudes and time (phase) offsets (Moos, Vytlačil 1991). A sensitivity matrix is defined as:

$$\begin{bmatrix} IF! \\ \varphi \end{bmatrix} = \begin{bmatrix} S_{11}, S_{12}, \dots, S_{14} \\ S_{21}, S_{22}, \dots, S_{24} \end{bmatrix} \cdot \begin{bmatrix} x_1^* \\ x_2^* \\ \cdot \\ x_4^* \end{bmatrix} \qquad (14)$$

Values S_i represent sensitivity amplitudes and phases of heat transfer while x^*_{2i} represent values of native tolerances.

Results and discussion

The theory was verified on an example of a poultry farm represented by a simplified system macromodel shown on Figure 1 transformed into heat circuit scheme shown on Figure 2 (Moziraji at al., 2014). Calculations were carried out for all elements in the macromodel for three categories of perimeter walls of different material composition (Table 2, 3) by means of ANATH application (Rochla, 1983). The following values were entered into the calculating process.

Result values are graphically shown on Figure 6 in the form of the histogram of temperature changes transfer for three construction types containing both amplitude (real part) and phase (imaginary part) properties.

Primarily, the interior heat capacity and window heat conductivity are significant for both types of sensitivities while perimeter wall heat capacity and conductivity affect the values to a lesser degree (Zajicek and Kic, 2014). The perimeter wall heat conductivity is a dominant one from the point of stationary heat transfer. Other elements are of no consequence. The graphs also show shifting sensitivities among the construction elements at change of a sole value (Malinovský, 1989).

Analyses of the graphs originated as outputs of ANATH show interesting effects of varying sensitivities at inputting different nominal values of the constructions parameters. The real and imaginary parts of transfer sensitivities of temperature changes from exterior environment are represented by separate curves – sensitivities are depicted on vertical axes while heat capacities, heat resistances, and regulation factors are depicted on horizontal axes as shown on Figures 7a-h (Moos, Vytlačil 1991).

No	Category	Material	Thickness [m]
1	light	chipboard, mineral felt, wood-fibre (Sololit)	0.11
2	medium	brickwork	0.6
3	heavy	stone wall	1.2

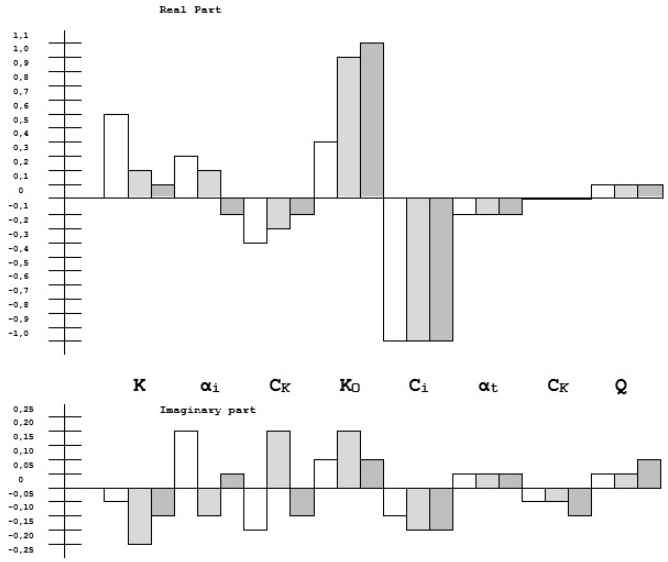
Source: Malinovský, V. (1989)

Table 2: Types of perimeter walls.

No	C_K [W×h×K^{-1}]	K [K×W^{-1}]	α_i [K×W^{-1}]	K_0 [K×W^{-1}]	C_i [W×h×K^{-1}]	α_t [K×W^{-1}]	C_t [W×h×K^{-1}]	Q [W×K^{-1}]
1	202	11	84.5	4.2	2000	20	100	100
2	2210							
3	6350							

Note: K – heating transfer coefficient (wall); K_0 – heating transfer coefficient (glass-walled part); C_K – heat capacity of perimeter wall; C_i – heat capacity of interior; C_t – heat capacity of heating system; Q – regulation factor; α_i – heat transfer from perimeter wall to interior; αt – heat transfer from heating system to interior.
Source: Malinovský, V. (1989)

Table 3: Input values for calculation.



Note: Constructions: light (white), medium (light grey), and heavy (dark grey); K – heating transfer coefficient (wall); K_0 – heating transfer coefficient (glass-walled part); C_K – heat capacity of perimeter wall; C_i – heat capacity of interior; C_t – heat capacity of heating system; Q – regulation factor; α_i – heat transfer from perimeter wall to interior; αt – heat transfer from heating system to interior.
Source: Autor´s own research and processing

Figure 6: Histogram of transfer sensitivities.

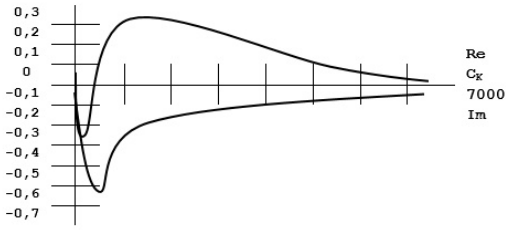


Figure 7a: C_K – heat capacity of perimeter wall.

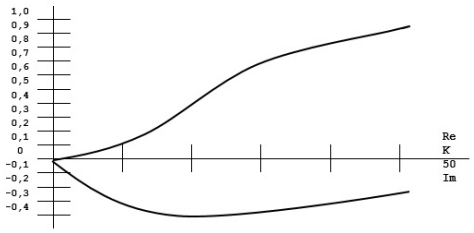


Figure 7b: K – heating transfer coefficient (wall)

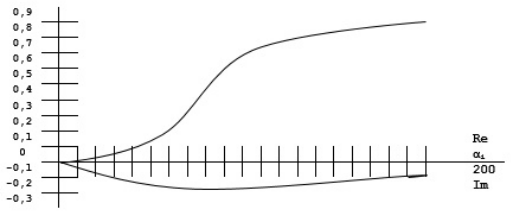


Figure 7c: α_i – heat transfer from perimeter wall to interior

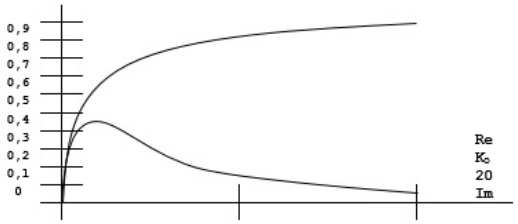


Figure 7d: K_0 – heating transfer coefficient (glass-walled part).

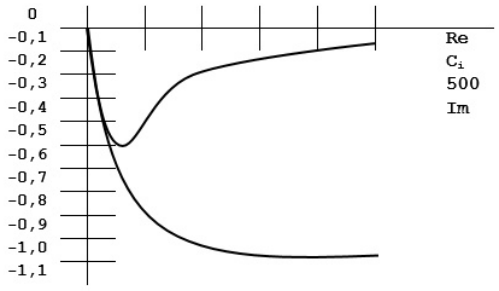


Figure 7e: C_i – heat capacity of interior

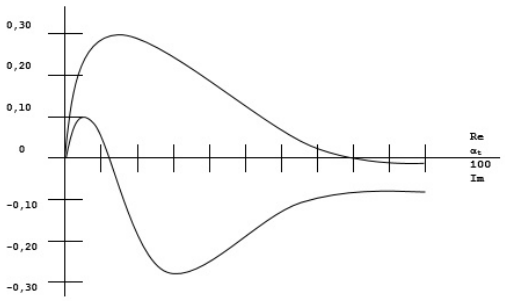


Figure 7f: α_t – heat transfer from heating system to interior

Source: authors´ own processing in ANATH

Figure 7a-h: Transfer sensitivities of temperature changes (to be continued).

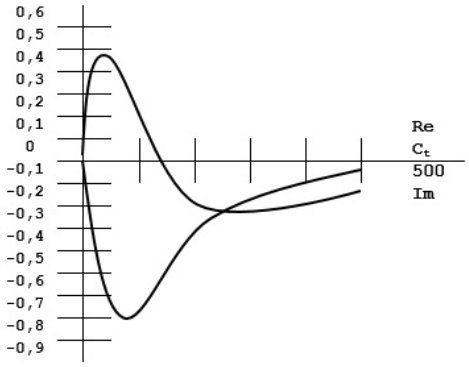


Figure 7g: C_t – heat capacity of heating system

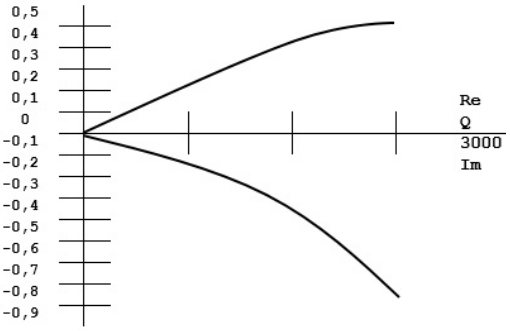


Figure 7h: Q – regulation factor

Source: authors´ own processing in ANATH

Figure 7a-h: Transfer sensitivities of temperature changes (continuation).

Discussion

According to (12), these values were used for determining a new course of the temperature T corresponding with a changed conductivity value K. The original and new course are shown on Figure 8a. Further, comparison of the course with the values determined by the analysis were carried out by ANATH application for both the original and changed wall conductivity value. Results are shown on Figure 8b and a newly obtained course of both the methods does not differs more than 3% which represents a very good concordance of results obtained by the sensitivity method and analysis (Mehta and Woods, 1981). Together with a larger change of the element value, inaccuracy increases because the F function course is nonlinear (Moos, Vytlačil 1991).

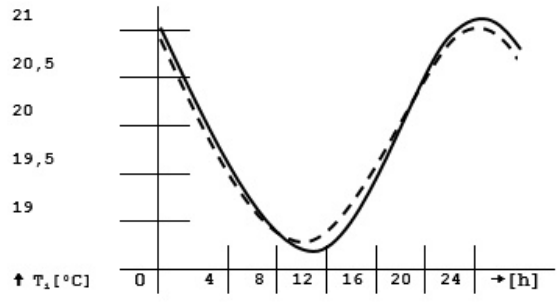


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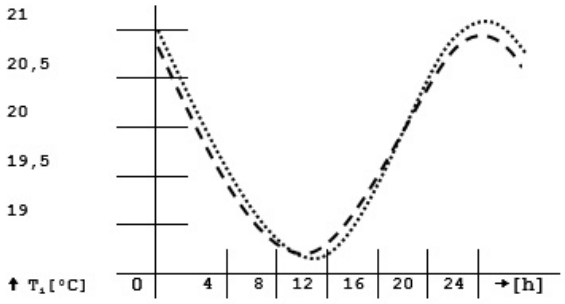
Figure 8a: Temperature courses depending on heating transfer coefficient change.



Source: authors´ own processing in ANATH

Figure 8b: Temperature courses obtained by measurement and calculation.

At the particular nod of the construction system macromodel, sensitivity analysis enables to obtain a change of temperature course (Hoffman and Feldman, 1981). The analysis need not be repeated, results can be determined from sensitivity values of amplitude range ReSr (Real sensitivity) and phase sensitivity delay ImSr (Imaginary sensitivity) (Lloyd et al., 1978). Verification of the method was carried out by calculating the interior temperature change at increased heat conductivity value of the perimeter construction (wall) by 10%. The ANATH application calculated both the values $ReSr$ = 0.634 and $ImSr$ = –0.062 for a particular nominal value and generated graphs of sensitivities depending on a nominal value of a selected element.

Conclusion

The used sensitivity methods is effective for determining resulting course of temperature at frequent changing value of only or more construction elements. In some cases the sensitivity method can be applied even instead of synthesis including searching for element values for requested amplitude and time offset, however, it is important to remember the theory of linear sensitivities outputs quality results for lesser changes of perimeter elements values only. In case of greater changes, it should be used progressive sensitivities calculating according to a way of changing nominal values or, alternatively, the method of non-linear sensitivities considered as very significant one for building constructions.

Mutual sensitivity rate among individual elements is changing according to a kind of an used model. At finding sensitivities for a transfer function set for a circuit characterizing temperature change in interior at change of heat flow from a heating system – at constant exterior temperature –, sensitivities distribution is other than in a case of an unheated interior and the element characterizing the heat system represent the most significant ones. The carried out analysis by help pf ANATH application also checked out the theorem of sensitivity invariant declaring that a sum of sensitivities is constant – indeed, if a sensitivity for a certain element increases a sensitivity for another elements decreases. All the new finfing can be fruitfully used at projecting and designing or reconstructing building objects intended for poultry farming.

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Creation, Storage and Presentation of Information Content – Semantics, Sharing, Presentation, and Archiving

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Abstract

People are getting more and more used to consume a digital, online content. Many outlets switched to online publication or at least increased their online presence. Besides, online publication is not the only domain of publishing houses. Many different organisations and companies - including those from area of agriculture and rural development - provide online content in form of articles. Importance of semantic web is growing constantly. Together with metadata descriptions, it is necessary for all the current search engines, smart assistants and AI technologies. Public standards and open source software can significantly speed up development and reduce costs when it comes to the Internet and World Wide Web. The paper provides overview of an updated methodology for creation, storage and presentation of online information content in World Wide Web environment. The latest research was focused mainly on presentation and semantics. The whole research process is established as well as the final formulation of the methodology.

Keywords

WWW, semantics, semantic web, metadata, information content, CMS, HTML, WYSIWYG, Web 4.0.

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Introduction

The paper builds on the previous work published by (Masner et al., 2018). The paper provides an updated version of the methodology for Creation, Storage and Presentation of Information Content, newly referred as WICM (Web Information Content Management). The paper provides overview of the research design and all the methods used.

We have seen a significant departure from classical printed media such as newspapers, magazines, and even books for more than twenty years. People are getting more and more used to consume a digital (online) content. In order to stay relevant in light of these changes, many outlets switched to online publication or at least increased their online presence (Das et al., 2009). Besides, online publication is not the only domain of publishing houses. Many different organisations and companies provide online content in form of articles. Establishing and managing websites and portals have become easier as of late. Due to the progressive development of internet and web technologies, especially Content Management Systems (CMS), even users without knowledge of the desired technologies such as HTML, CSS, and JavaScript can manage the online content nowadays (Brown, 2014).

Current information content should focus not only on the appearance of the result shown in a browser but also to be accessible for humans as well as for machines (Minin et al., 2015). The content is also commonly viewed on variety of devices, especially smartphones and tablets (Šimek et al., 2014). The structuring of content then helps to display it more responsively. Besides, structuring and metadata are essential in open data publication (Stočes et. al, 2018).

As (Rudman and Bruwe, 2016) stated: “Web 3.0 entails an integrated Web experience where the machine will be able to understand and catalogue data in a manner similar to humans.” So, Web 3.0 is usually considered by authors as semantic web. Furthermore, there are talks about “Web 4.0”. There is not a unified definition of the term yet. Some authors define it as a symbiotic web with interactions between humans and machines (Aghaei, 2012; Choudhury, 2014), many stated that there will be an important role of IoT technologies (Nath and Iswary, 2016;

Srirama, 2017), and some mention the important role of Big Data technologies (Peinl, 2016). Taking everything into account, until there is a real artificial intelligence which understands human language, the semantics on the web is crucial. Semantics is necessary for all the current smart assistants such as Google Home, Amazon Echo, Siri (Sweney, 2016).

Open source software and open source CMSs in particular are highly exploited in the field of online publication. Not only in areas such as agricultural sector, rural development, government and local government and non-profit sector, the open source software is very popular. It is a logical way of saving expenses for own development (Šimek, et. al., 2017).

Use of WYSIWYG (What You See Is What You Get) editors for content creation and update is very widespread. These editors strive to work like conventional desktop text editors such as Microsoft Word. Many users use the Word application to create documents for printing. Nevertheless, WWW environment is different and has many specifics. Therefore, the output is not always as intended and seen in the editor. The WYSIWYG editors are not able to simulate different devices and responsiveness. Moreover, as (Khalili et al., 2012; Khalili and Auer, 2015) state, there is lack of support of semantics. On the other side, advanced ways of content creation, such as composing from separate, simpler and more independent blocks using some kind of blocks are becoming more widespread (Nikolíc and Šilc, 2016), (Czerniak, 2015).

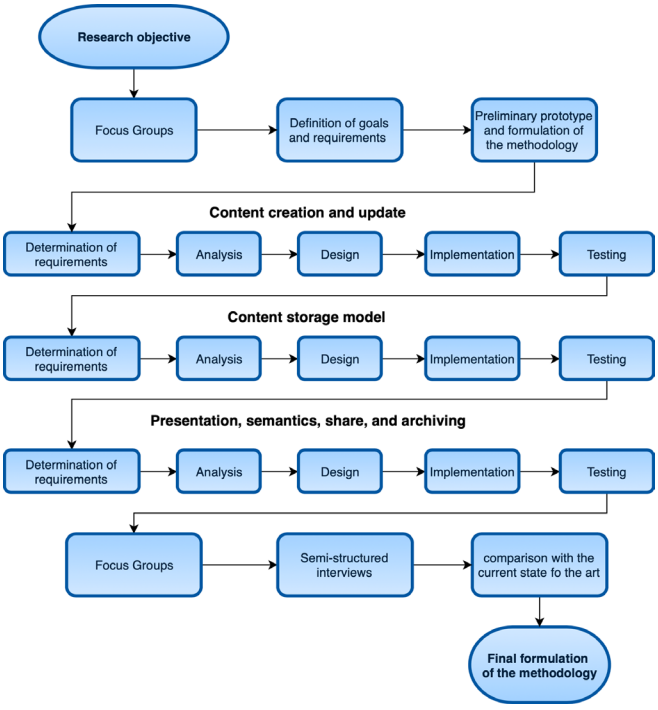
Current trend in web development leans towards small applications modules, reusable components and microservices. As (Sahay, 2003) shows, the standardisation simplifies software development and enables utilisation of widely used libraries, modules and frameworks based on open source code. Using open source software components has therefore a positive influence on development speed (Merilinna and Matinlassi, 2006).

The main objective of the proposed WICM methodology is to bring standardisation to creation, storage and presentation of the information content in WWW environment. The methodology was divided into 3 main modules. Each module deals with different area of interest. The modules are as follows:

- Creation and update
- Storage model
- Presentation, semantics, share and archiving

Materials and methods

The whole research process utilizes several methods as shown in Figure 1. The methodology development was based on prototyping approach



Source: own processing

Figure 1: Research process design.

according to (Bally et al., 1977). It has been divided into three main stages according to the three defined modules. First of all, we developed a preliminary software prototype. After that, the Focus Group session was held. The prototype was shown to the participants. The session was mainly dedicated to a collection of users' needs. After that, the detailed objectives and requirements for the methodology has been defined. The previous paper dealt mostly with the Content creation and update and the Content storage model modules.

The objectives and requirements for the methodology have been updated, based on the preliminary and follow-up research. According to the modules, they are as follows:

- Creation and update
  - Users without knowledge of internet technologies should be able to create and update the content
  - The process of creation and update should not allow to make inconsistent output (in terms of HTML code)
  - Data input should be user friendly without any need for training
  - Users should be able to see the result of the inserted content
- Storage model
  - There is a need for general model of storage without regards to database technology
  - The structure should respect other modules
- Presentation, semantics, share and archiving
  - The stored content should not contain any CSS code
  - The structure of the stored content should be transformable for use in various devices such as tablets and smartphones
  - There should be a way to define presentation rules, especially HTML structure
  - The stored content should be resistant to redesigns
  - The methodology should follow semantics rules
  - The storage model should allow metadata enrichment
- The methodology should follow best practices for SEO
- There should be standardised data format and structure for content transfer, share, exchange and backup

Within the third stage, an analysis of semantic web, metadata description, and data exchange formats has been conducted. In WWW environment, there are basically two formats used to store and exchange data – XML and JSON. As (Sandrih et al., 2017) stated, both formats are very commonly used and are exchangeable and inter-transformable. Many authors point out that JSON format is faster in processing and less data-intensive, especially for use with mobile devices (Jorstad et al., 2008; Nurseitov et al., 2009; Lin et al., 2012). JSON is therefore appropriate exchange format to be used within web services and by server-side APIs in communication with mobile applications. To facilitate portability of the content, an exchange format based on the storage structure needs to be defined.

After the third stage, the Focus Groups method was used again. The same group of participants as previously was involved. The developed prototype was introduced and discussed. The session was mainly focused on the user-related part of the proposed methodology. The prototype is shown in Figure 2 and Figure 3.

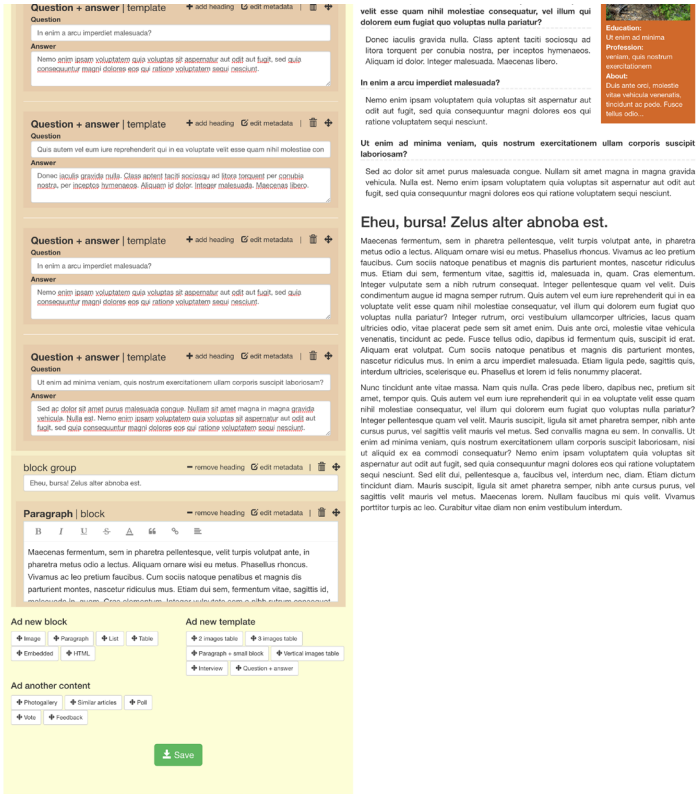
The methodology and its components were discussed with several web professionals and developers. Semi-structured interviews were conducted. The interviews were focused on the other side of the methodology – storage model, technological presentation in browsers and aspects related to developers and administrators. Guide for the semi-structured interviews included following questions:

- Can you evaluate the use of content structuring for content creators?
- How do you evaluate the storage model? Does it contain all the necessary fields?
- Can the proposed standardisation help speed-up the development process?
- How are you using metadata description? Is the proposed method beneficial?
- Have you carried out any migration between CMSs?
- Can you evaluate the proposed methodology and its contribution?

The methodology was finally defined using a form similar to the current web standards and specifications. IETF recommendation RFC2119

Source: own processing

Figure 2: The application prototype part 1.



Source: own processing

Figure 3: The application prototype part 2.

as defined by Bradner (1997) is used in the text to signify the requirements. The words MUST, MUST NOT, SHOULD, SHOULD NOT, and MAY are used in the same manner.

Results and discussion

The methodology was updated according to the results of the latest research. The Creation and update, and Storage model modules were modified to comply with the needs for semantics. Additional modifications have been made according to the findings obtained during the Focus Group session and interviews.

For example, during the Focus Group session, users mentioned a need for offline mode for editing. The structuring of the content can be difficult at first sight. On the other side, use of templates can make it much more comfortable. To many users, adding the metadata descriptions was unclear and they did not see much sense in it. The following discussion lead to the recommendation, that the metadata enrichment should be automated as much as possible. The final application should also guide the author when adding it.

During the interviews, professionals and developers suggested, that there a broader discussion across involved companies and open source community should follow. There can be some requirements regarding the attributes in the storage model. Additionally, the professionals mentioned the problematic metadata section which requires users' activity. Another suggestion was for a future development. The model can be transformed to be more compatible with most used databases, such as MySQL, MongoDB, or Elasticsearch.

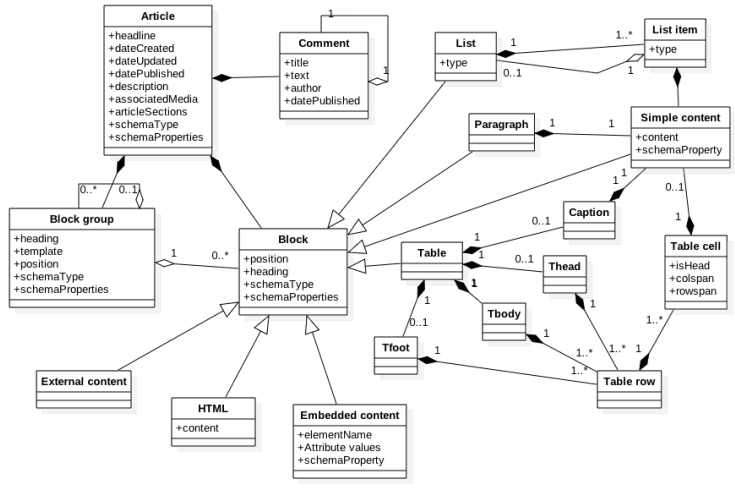
Formulation of the methodology

Creation and updating of the content

1. The content MUST be composed of independent blocks.
2. The blocks SHOULD NOT have any fixed position. Users SHOULD be able to easily change order of the blocks.
3. The preview of the result MUST be separated from the editor.
4. The preview SHOULD be shown to users in real-time.
5. The content MUST consist of several basic blocks which MUST respect the Storage model. The blocks are according to classes: Paragraph, List, Table, Embedded content, HTML (pure HTML).
6. The application SHOULD be able to create groups from abovementioned blocks to support more complicated content.
7. The content MAY be enriched by connecting external media, which can be specific for the implementing application.
8. The final application SHOULD provide an interface to define templates of the content.
9. The templates MAY set fixed position for blocks or groups (and create exception from the rule 2)
10. The templates and the editor SHOULD lead authors to properly add metadata descriptions

Content storage

1. The content MUST be stored according to the UML Domain model as shown in Figure 4.



Source: own processing

Figure 4: Class diagram domain model of the storage model.

Description of the classes is mentioned in Figure 4.

Presentation, semantics, share and archiving

1. Each item of the Block class MUST be enclosed in its appropriate HTML5 element. Blocks HTML and External content MAY be enclosed in div element.
2. Each block of the Block group class MUST consist of Block or Block group items. Composition is defined by the template.
3. Each instance of the Article class MUST be composed from Block and/or Block group items. Order is defined by the position attribute. The content is enclosed in Article element.
4. The structure inside article MUST respect semantic rules.
5. The content MUST respect the following structure at its minimum:
    a. <header>
        i. <h1>
        ii. <time>
        iii. <p>
    b. <section>
    c. <footer>
4. The final HTML result SHOULD be added by metadata description using one of the RDFa, JSON-LD, or Microdata format in connection with the most used vocabularies (i.e. Schema.org).
5. The defined templates MUST contain links to Blocks or Block groups using braces syntax – {Block_name}.
6. The template MAY contain HTML elements.
7. The implementing application MUST provide an exchange format in JSON, using the Schema defined http://kit.pef.czu.cz/JSONschemas/wicm.json
8. The application SHOULD use the format defined in the rule 9 to data exchange between server and client side.
9. Future versions of methodology and applications MUST be backward compatible with any older versions.

Conclusion

The proposed methodology has been divided into three main modules. The first module deals with content creation and updating. It consists of several recommendations and requirements for the future applications, implementing the methodology. WYSIWYG editors are likely to be supplanted in the near future. To ease the authoring of the information content as well as enable its easier structuring, creation by composition from separate blocks presents itself as the logical next step. The core of the proposed methodology is content composition. The latest research has added the needs for semantics. The storage model has been enriched by necessary metadata description fields.

The Presentation, semantics, share and archiving module has been formulated. The need for use of semantics has been clarified. The necessary semantic HTML template structure has been defined. The module consists of a set of recommendations and requirements. Additionally, the exchange format for data export, transfer, share, and archiving has been defined. It uses JSON data format, complemented with JSON Schema definition.

The proposed methodology has many contributions. The structured composition of content can help authors produce superior and consistent content. The content can be more unified across the website as the environment would lead the user to do so. Additionally, the structuring natively leads the authors to produce responsive content which can be easily transformed for usage within applications for mobile devices.

The standardisation can help to develop general purpose libraries. The libraries can speed up further development of applications and content management systems. The export format can help to transfer the content between applications, upgrade, or in a transition to new application system. The use of general libraries and open source software is highly exploited within the areas of agriculture, reginal and rural development. Therefore, the methodology contribution in this area is significant

Final consumers (readers of the content) can profit thanks to superior presentation of the content. The content can be also easily accessible through search engines and content aggregators thanks to better semantics.

Finally, all the mentioned contributions can lead to cost reduction for companies and organisations. Faster development saves the cost of programmers. Easier and more effective content creation and update can avoid hiring additional employees. More accessible content can bring more customers and income.

The methodology has been named as Web Information Content Management (WICM). For the future, the methodology will need to engage interest groups such as browser makers, content management systems producers, and other companies and organisations. A broader discussion and consensus are necessary to spread and finalize the methodology.

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Contract Farming and Profitability: Evidence from Rice Crop in the Central Mekong Delta, Vietnam

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Abstract

This study aims at investigating profitability of rice contract farming in Vietnam's Mekong delta. We used data from a farm-household survey comprising of 70 contract and 96 noncontract respondents, and apply the Student's t-test and ordinary least square regression model for data analysis. We found that farmers with larger rice plantations are unlikely to engage in contract farming, and that market outlets and output price for contract growers tend to be ensured compared with noncontract ones. The findings reveal that contract farming has a significantly positive impact on rice-farming profitability in terms of average return and average rate of return on variable cost when controlling for observable characteristics of household and farm. The results suggest that contract farming may enable rice farmers to raise their rice income as well as household income. The policy implication may be that contract farming may not be feasible for all rice farmers and rice business firms.

Keywords

Contract farming, return, average rate of return, rice, Mekong delta.

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Introduction

Contract farming (CF) is considered an institutional measure to assure the quantity and quality of raw materials for exporters, processors, distributors, and supermarkets (Reardon et al., 2009; Swinnen and Maertens, 2007). In addition, CF can solve major constraints for smallholder farmers such as access to inputs, financial problems, technical capacity, information and price, and market outlets at harvest (Barrett et al., 2012; Miyata et al., 2009; Swinnen and Maertens, 2007). Many studies show that contract farming improve largely farm productivity and households income or welfare such as those by Girma and Gardebroek (2015), Naryananan, (2014), Dedehouanou et al. (2013), Cahyadi and Waibel (2013), Bellemare (2012), Maertens and Swinnen (2009), Miyata et al. (2009), Minten et al. (2009), and Bolwig et al. (2009). However, few studies have estimated the effect of CF on profitability (Hu, 2013). In addition, most CF studies have examined high-value products including industrial crops, horticulture, poultry, and dairy, but rarely staple foods (Maertens and Velde, 2017; Minot, 1986).

Contract farming used for agriculture and in particular for the rice sector has been encouraged and promoted by the Vietnamese government with attempts to improving farm-market efficiency and farmers' income since its policy decision No. 80/2002/QD-TTg in 2002, which was amended by decision No. 62/2013/QD-TTg (2013). This policy provides incentives and support to those who engage in a contract scheme. Accordingly, farmers who participate in rice CF can take bank loans at a low interest rate and receive priority access to extension services. Meanwhile, the company that conducts rice CF also gains some benefits (e.g., preferential loans from commercial banks, priority approval of rice-export by the Vietnamese Ministry of Trade and Industry, and allocation of rice-export assigned by the Vietnam Food Association). Nevertheless, the uptake of CF in the rice sector is still limited in the Vietnamese Mekong delta (Nhan and Yutaka, 2017), which supplies annually more than 50% of Vietnam's total rice production and 90% of its rice exports. Vietnam recently has become the world's third-largest rice exporter with 18% of international market share (FAO, 2016).

Growing concern is also reflected in studies on CF conducted in Vietnam, such as those by Oanh et al. (2016), Wang et al. (2014), Saenger et al. (2013), and Tuan (2012); however, these authors mainly focused on industrial and vegetable crops and the dairy sector. Consequently, there is little evidence of any previous study on CF in the rice sector carried out in Vietnam, except for the study by Nhan and Yutaka (2017) that explored the constraints to the enforcement of rice CF in the Mekong delta and another study by Nhan et al. (2013) which examined the potential of contract farming on rice growers' income. At present, it is hard to find any existing study related to estimating impact of CF on profitability in rice farming although it has been strongly promoted for use in the delta since the 2000s (Can, 2014). Hence, we attempt to examine the profitability of rice cultivation with contract farming and to contribute significantly to rice production through CF in this region.

The remainder of this paper is organized as follows: the following section describes the farm household survey and data analysis methods used in this study. In Section 3, we present and discuss the results by focusing on a description of the CF scheme, socioeconomic characteristics for contract and noncontract farmers, and the profitability of rice crop with and without the contract scheme, and in the last section we summarize the findings and recommend policy implications.

Materials and methods

This study used primary data gathered from a household survey conducted in September 2017 in Can Tho city of the central Mekong delta where there are several companies specializing in rice processing and export. Data collection was focused on Co Do district, known as the largest rice-producing region of Can Tho city in terms of area and production, where CF is conducted by business firms and rice production is the most prevalent among other districts.

A structured questionnaire was used to collect household demographics, farm characteristics, assets, rice production and sales, production costs, inputs supply, income sources, and contractual details. The questionnaire was pre-tested to adjust the questions before conducting the household interviews. The practice of rice CF is still uncommon and a large number of rice growers in the study area do not engage in the contract scheme. Hence, the total sample numbered 166 rice growers, of which 96 farmers who had never participated in CF, while the remaining farmers who had participated. Interviewees were selected randomly. Noncontract and contract farmers were identified from lists provided by the commune people's committee and from lists provided by contract firms, respectively. Noticeably, both groups of respondents reside and practice rice farming under the same geographic setting, which ensures that their natural conditions, traffic infrastructure, and cultural status are homogeneous. We also interviewed the two contract companies to gather information on their rice business.

A simple cost-return analysis was used to estimate the profitability of rice cultivation in the current study. The profitability was focused on not only estimating return and average rate of return on investment but also calculating variable cost and output price. We used the Student's t-test to test the mean differences for the two groups. Yet, the t-test does not allow controlling for other external factors that may substantially influence the outcomes. We thus employed Ordinary Least Square (OLS) regression models to estimate the different outcomes related to profitability performance such as average variable cost, selling price, mean return and average rate of return as functions of household and farm characteristics, and a dummy variable presenting participation in a CF scheme. The effect of participation in CF can be measured by the coefficients of variables for contract farming in the OLS regression model (Imbens, 2004; Wooldridge, 2002). This regression approach was applied in earlier studies by Maertens and Velde (2017), Krause and Machek (2018), Wang et al. (2014) and Miyata et al. (2009). The linear regression models can be written as follows:

$$Y_i = \varphi_i + \alpha C_i + \beta X_i + \varepsilon_i$$

Where Y_i denotes the outcome variables as mentioned above. C_i is a dummy variable for participation in contract farming. X_i is a vector of continuous variables (age, education of household head, farming experience, household size, rice planted area) and dummy variables (social participation, owning boat, owning storage, sale after harvest and use of RTV variety). By including these observable factors, we can control for the observable differences between the two groups, which may influence the dependent variables (Maertens and Velde, 2017; Krause and Machek, 2018; Miyata et al., 2009). However, unobservable factors such as industrious and skillful characteristics of sampled farmers, which may influence the outcomes were not considered in the current study.

Results and discussion

1. Description of rice CF schemes

As shown in Table 1, we shortly describe the major characteristics of the two contract companies operating in the area of the study. The investigation showed that the companies' sales are mostly in the export market and their procurement is mostly from contract farmers. With regard to contracting process, the company generally first approaches the local authority for its potential contracting locations. Second, after identifying the location with support from the local authority, the company holds an orientation meeting for rice farmers who wish to participate in the contract scheme. After the meeting, the farmers make decision whether to participate in CF or not. More importantly, the company accepts all farmers registering, even if their rice plantation is small. Lastly, the company and individual farmers sign a written contract prior to rice cultivation that commits the company to buy the entire output and transport it to the company's facilities. The contract specifies the rice variety, area planted, anticipated output volume, output quality, price mechanism and agrochemical use. The company provides the seed variety to all their contract farmers, but it may not provide pesticide and fertilizer.

The results in Table 1 showed that about 11% of contract farmers receive fertilizer and pesticide from the company. It also delivers technical training to the contract growers and offers market price plus a premium. For contract farmers, they also commit to selling their output to the company as well as following all contract terms agreed.

2. Socioeconomic characteristics for contract and noncontract farmers

The results of the Student's t-test for mean comparison of household and farm characteristics for contract and noncontract farmers are presented in Table 2. These results suggest that contract households are likely to have better human capital than noncontract ones. Indeed, contract households had more experience in rice farming and a larger household size compared with noncontract ones (significant at 0.05). The educational level of the heads of contract households seemed to be higher than those of noncontract ones, but the difference was not significant. However, it was observed that the head of contract households tended to be older than that of noncontract ones (significant at 0.05).

Farm scale in the sample was somewhat large, with a mean of 2.264 ha per household compared with the average farm size in the Mekong delta (1.4 ha), and the farm size for both groups appeared similar. However, noncontract farmers tended to hold slightly larger rice plantations compared with contract farmers (significant at 0.1). Evidence from the investigation suggested that the share of contract and noncontract farmers owning agricultural assets (storage, tractor, and combine harvester) was relatively small (less than 5%). However, more than 50% of farmers in the study area owned a boat with a small loading capacity (transportation is mainly by river in the delta) and these farmers reported that their boat was mostly used for transporting farming inputs due to the underdeveloped road system that makes

Variables	A enterprise	B enterprise
Product	Rice	Rice
Procurement (%)		
Contract farmers	100	80
Spot market		20
Sales (%)		
Export market	70	70
Domestic market	30	30
+ Other export companies	24	12
+ Wholesalers and retailers	6	18
Share of farmers receiving inputs (%)		
+ Seed	100	100
+ Fertilizer and pesticides	0	11.4
Determination of price	Market price plus premium	Market price plus premium
Year of starting contract with farmers	2013	2012

Source: Authors' estimates from the survey

Table 1: Characteristics of contracting companies.

Variable	All sample (n=166)	Noncontract farmers (n=96)	Contract farmers (n=70)	Mean difference
Age of head (years)	50.12	48.44	52.43	3.991**
Farming experience of head (years)	25.25	23.69	27.40	3.713**
Education of head (years of schooling)	6.34	6.06	6.71	0.652
Household size (persons)	4.59	4.39	4.87	0.486**
Farm size (ha)	2.26	2.43	2.04	-0.381
Rice planted area (ha)	2.19	2.39	1.91	-0.475*
Owning boat (yes=1, otherwise=0)	0.58	0.58	0.57	-0.012
Owning storage (yes=1, otherwise=0)	0.04	0.06	0.01	-0.048
Owning tractor (yes=1, otherwise=0)	0.04	0.05	0.03	-0.024
Owning combine harvester (yes=1, otherwise=0)	0.01	0.01	0.01	0.004
Share of rice income (%)	90.36	91.78	88.5	-3.281
Social participation (yes=1, otherwise=0)	0.23	0.18	0.30	0.123*
Distance to nearest dryers (km)	2.01	2.06	1.93	-0.128

Note: * and ** denote significances at 0.1 and 0.05 levels, respectively
Source: Authors' estimates from the survey

Table 2: Household and farm characteristics for contract and non-contract rice farmer.

farms inaccessible by truck. The average distance to the nearest drying facilities among the surveyed households was 2 km. This distance did not differ as they reside under the same geographic setting. The possible implication of these results is that physical capital for contract and noncontract farmers is seemingly similar.

The major source of income for both contract and noncontract growers is from rice production, which generates approximately 90% of their total income. This implies that the financial source for surveyed households is likely to depend on their rice-farming performance. Participation in farmer-based organizations (e.g., an agricultural cooperative, cooperative group, or extension club) may play an important role in enhancing farmers' social capital and providing more opportunities for farmers to access extension services and expand their public relations. The share of sampled farmers engaging in such organizations was relatively low; however, contract farmers participated in these organizations at a higher rate than noncontract ones, which implies that farmers who are members of farmer-based organizations are more likely to engage in CF schemes than other farmers.

3. Rice-farming profitability with and without a contract scheme

The results of a t-test mean comparison for outcome indicators between contract and noncontract farming models are presented in Table 3. We did not include the fixed costs of crop sprayers, tractors, harvesters, and land since they are long-term assets applicable to other farming activities and few farmers own a tractor and harvester. Hence, we mainly used variable costs to calculate costs and return.

The average variable cost for contract farmers was 3.8% lower than that for noncontract ones (significant at 0.1). Accordingly, the costs of irrigation and postharvest (e.g., drying and transport costs) for the contract group were likely to be lower as compared with the other group. Yet the share of irrigation and postharvest costs was relatively small, accounting for 2.6% and 0.5% of the total cost, respectively. A possible explanation for the differences in these costs is that some noncontract farmers dried and stored their output after harvest, whereas the output of most contract farmers was collected by the contract company right after harvested. As discussed earlier, contract farmers seem to have better human capital and smaller rice plantations, which may result in better water management. However, other variable cost items for contract and noncontract farmers did not differ tremendously. Specifically, the costs of soil preparation and rice seed appeared to be, on average, 5.4% and 10.3% of total cost, respectively, and the costs for pesticides and fertilizers were displayed as the highest and the second largest shares, constituting 30% and 25% of the total cost structure, respectively. In addition, harvest cost accounted for 12% of total cost (hiring a combine harvester instead of a manual harvest as these machines are widely used in the Mekong delta). The total labor costs for both farming methods appeared similar,

Variable	All sample (n=166)	Noncontract farmers (n=96)	Contract farmers (n=70)	Mean difference
(1) Average variable costs (VNDa/kg)	2,479	2,519	2,423	-95.49*
Land preparation cost	136	134	140	5.97
Seed cost	256	259	251	-7.56
Pesticides cost	743	756	723	-33.57
Fertilizers cost	628	635	620	-14.74
Combine harvester hired cost	284	284	285	1.37
Hired labor cost	202	209	193	-16.50
Family labor cost	153	154	152	-1.93
Irrigation cost	65	69	60	-9.32*
Postharvest cost	12	20	0	-20.03***
(2) Unit selling price (VND/kg)	5,220	5,202	5,244	42.02
(3) Unit return (VND/kg) (2) – (1)	2,733	2,683	2,821	137.70*
(4) Average rate of return (3)/(1)	1.14	1.09	1.22	0.13**

Note: *, ** and *** denote significances at 0.1, 0.05 and 0.01 levels, respectively
a1 USD is taken as 22,500 VND
Source: Authors' estimates from the survey.

Table 3: Profitability of rice farming with and without a contract scheme.

attributing an average 14.3% of total variable cost.

As a second outcome, the output price received by contract and noncontract farmers did not differ even though the contract companies committed to offering an average of 200 VND/kg higher than the normal market price. The explanation for this may be that some noncontract growers selling their paddy a number of days after harvest might prompt an increase in price by around 1,212 VND/kg, equivalent to 24% of average selling price (Table 4).

The third outcome is that the average unit return achieved by contract farmers was 5.1% higher than for noncontract ones (significant at 0.1). The possible reason for this is that the average variable cost for contract farmers was significantly smaller than other group.

The last outcome indicator – average rate of return or return on variable cost investment value for contract and noncontract farming models – was 1.22 and 1.09, respectively, which suggests that contract farmers tended to obtain approximately 12% greater return than noncontract farmers (significant at 0.05). This result implies that the contract and noncontract farming models are able to generate a return of 1.22 million VND and 1.09 million VND, respectively, for every 1 million VND invested in a rice crop, suggesting that rice production through a contract scheme is more likely to be profitable on variable costs in the study area.

4. Estimated effect of contract farming on profitability of rice cultivation

As earlier discussion, some remarkable differences exist in observable covariates, including rice plantation size and human capital indicators, across the samples. It was assumed that these characteristics might have an implicit impact on the profitability of both contract and noncontract growers. Therefore, these variables and a CF variable (dummy) should be simultaneously included in the regression model to estimate the effect of a contract scheme on rice-farming profitability. We found that CF had no impact on the average variable cost (Table 4), whereas previous studies indicated that contract farming results in an increase of inputs costs (Maertens and Velde, 2017; Miyata et al., 2009). This result is also not in line with the above t-test analysis. However, the regression results showed that participation in a contract scheme had a dramatically positive effect on the output-selling price. The coefficient on the contract variable suggests that CF raises the selling price by 160 VND/kg, equivalent to 3% of output price (significant at 0.01), while the t-test result showed no significant difference. The possible reason for this may be that the quality of output produced by contract farmers under the supervision of the company could be better than other farmers did. This result is in line with the findings

of Maertens and Velde (2017), Girma and Gardebroek (2015), and Miyata et al. (2009). Similar to t-test results, we found that participation in CF greatly increases mean return and average rate of return on variable costs, significant at 0.05 and 0.1, respectively. The implication of the results from the regression may be that CF has a positive effect on profitability of rice growers in the study area. This finding is also consistent with earlier studies by Mishra, et al. (2018), Hu (2013) and Bolwig et al. (2009).

Table 4 also reports the full regression results for different outcome indicators including average variable cost, selling price, average return and average rate of return. We now explain briefly the major factors affecting these dependent variables. First, the households with older heads obtained a lower selling price but the size of this effect was relatively small. Second, it found that households with heads having higher education result in a small decrease in production cost, since farmers with higher education seem to have better management in their rice cultivation. As a result, this factor sharply raised mean return and average rate of return. Third, farmers with longer experience in rice farming were likely to gain higher profitability. Fourth, larger rice plantation remarkably increased the output-selling price, likely so because of the fact that farmers who sell a larger output volume receive a higher price because purchasers can reduce transportation cost for collecting paddy at many small individual farms. This variable also led to obtaining slightly larger return. Fifth, membership in farmer-based organizations could lead to a slight decrease in variable cost, which results in higher profitability because farmers who are members of the farmer organization were likely to have better access to extension services resulting in better management for their crop (Dang, 2017). Sixth, boat ownership might cause the largest decrease in total cost, which may be associated with to a large reduction in transporting cost for inputs. As a result, this factor contributes to a large increase in profitability. Seventh, storage ownership could result in an increase in selling price; likely explained by the higher quality of output. Eighth, selling output after harvest might lead to a remarkable increase in total cost but this factor also greatly increases the selling price, making a greater unit return. This likely relates to storage cost and small supply of rice in the market after peak harvest period. Finally, using RTV variety could make to a positive significant impact on selling price owing to the higher quality of RVT variety (fragrant rice variety).

Explanatory variables	Dependent variables (Coefficient)			
	Average variable cost	Selling price	Mean return	Average rate of return
Contract farming (dummy)	-10.624	160.450***	171.069**	0.140*
Age of head (years)	-0.759	-4.256**	-3.498	-0.002
Education of head (years of schooling)	-19.045**	3.721	22.767**	0.019**
Farming experience of head (years)	-4.878	3.176	8.054*	0.006*
Household size (persons)	7.514	-2.198	-9.712	-0.011
Rice planted area (ha)	-8.623	25.213***	33.836*	0.021
Social participation (dummy)	-103.368*	52.718	156.087**	0.128**
Owning boat (dummy)	-189.592***	-40.074	149.518**	0.160***
Owning storage (dummy)	-109.383	224.200***	333.584*	0.161
Selling after harvest (dummy)	630.747***	1,212.000***	580.857***	-0.081
Applying RTV variety (dummy)	131.114	287.240***	156.123	-0.016
Constant	2,834.000***	5,112.120***	2,278.000***	0.804***
F-value	5.672	54.330	7.978	3.768
Probability value > F	0.000	0.000	0.000	0.000
Adjusted R^2	0.240	0.780	0.320	0.160
Number of observation	166	166	166	166

Note: *, ** and *** denote significances at 0.1, 0.05 and 0.01 levels, respectively
Source: Authors' estimates from the survey

Table 4: Full OLS regression results of estimated effect of contract farming.

Conclusion

The study investigates the major differences between contract and noncontract rice growers for various characteristics. Contract farming households were found to have better human and social capital, but they were likely to own remarkably less rice land area than noncontract ones. The outlet and price of output for the contract group are more likely to be ensured compared with the noncontract one. Interestingly, some noncontract farmers who sold their output some days after harvest could receive a remarkably higher price. As the main objective of the study, that is to estimate profitability of rice cultivation under a contract scheme, it found that CF had a significantly positive impact on the profitability of rice crop in terms of return and average rate of return. This suggests that the contract scheme may increase both rice and household incomes for rice growers since the sampled households' income is mainly derived from rice cultivation. Although CF may be highly effective for increasing small-farm income, it is only applicable in certain circumstances (Miyata et al., 2009). Expanding CF in the rice sector is likely an effective measure to reach the Vietnamese government's target for improving market efficiency (farmgate price) and rice growers' income.

As in earlier studies and based on the results from this study, it is convinced that contract farming is more likely to be of benefit to small farmers and favor oriented-export commodities. The findings of the current study imply that contract farming is potentially sustainable and generally applicable to stable crops and rice sector particularly but several previous studies indicate that successful contract-farming schemes with such crops are not common (Maertens and Velde, 2017).

The possible policy implication from the study is that CF may not be feasible for all rice farmers and business firms. As a result of the fact that some firms cannot provide certain inputs (e.g., seed, agrochemicals) and technical guidance to their contract farmers owing to their limited human and financial resources. Some farmers, particularly large-scale farmers, are likely not to engage in a contract scheme because they may have more outlet choices that can sometimes enable them to achieve a higher selling price.

As the first study on estimating the impact of contract farming on rice-farming profitability in Vietnam's Mekong delta, our estimation method by OLS regression analysis still has some shortcommings such as unobserved characteristics of farm and household and bias selection that were not addressed in this study. Hence, there should be further examination on unobservable characteristics by other econometric approaches. Furthermore, investigation with larger sample sizes in different locations and with various types of contracts should be carried out..

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Fish Output and Food Security under Risk Management Strategies among Women Aquaculture Farmers in Ondo State, Nigeria

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Abstract

This study examined the impact of risk management strategies' adoption on fish output and food security among women aquaculture farmers in Ondo State, Nigeria. Multistage sampling procedure was used to select 90 respondents. Endogenous switching regression model and recursive bivariate probit model were employed to carry out the impact analysis. The empirical findings revealed that farmer's age, household size, education, non-farm income, pond system, quantity of feed, credit constraint, and risk attitude significantly influenced risk management strategies' adoption. Moreover, adoption of risk management strategies increased fish output and reduced food insecurity among women aquaculture farmers. In conclusion, adoption of risk management strategies is capable of enhancing fish output and reducing food insecurity. Therefore, development agents should encourage women aquaculture farmers to adopt risk management strategies in order to have increased fish output and reduced food insecurity which can help in bridging fish supply-demand gap and reducing their level of vulnerability.

Keywords

Risk management, women, aquaculture farmers, fish, food security.

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Introduction

Hecht (2006) stated that the contributions of aquaculture to livelihoods, national economic development and food security in Africa are very important. There is total or partial dependence of between 660 and 820 million people on fisheries, aquaculture and related industries as a source of income (HLPE, 2014). There is no any other food producing sector that grows faster than aquaculture and capture fisheries production in response to global demand will be augmented by aquaculture if the growth is sustained (Bostock et al. 2010). However, it faces series of risks higher than the crops considering its complexity in terms of species, environments and systems (Forum for Agricultural Risk Management Development (FARMD) 2017). This is supported by Ahsan and Roth (2010) who explained that aquaculture, like any other agri-businesses, is a risky business with production risk as one of the types of risk associated with it.

Records of Federal Department of Fisheries (FDF) and Food and Agriculture Organisation (FAO) revealed that Nigeria was recording self-sufficiency ratio of 98.8% in 1983 and later reduced to 40% and 19.2% in 2005 and 2014 respectively with average of about 49% per annually (Oladimeji, 2017). FAO (2013) indicated that Nigeria has been importing over US$400 million fish annually because fish demand in Nigeria has not been met.

Biotic and abiotic processes that cannot be totally understood affect agricultural production. There may be little that can be done to control the processes even if there is a reasonable understanding of such processes (Hurley, 2010). Ogundari and Akinbogun (2010) stated that since some inputs have increasing or decreasing effect on level of production risk, Tveterås (1999) therefore, emphasized that consideration should be given to production risk in inputs in the empirical analysis of productivity change. This is important since majority of the key risks in agriculture have close relations with or direct consequences on food security (FAO, 2016).

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy

life (World Food Summit, 1996). Food security is a great concern in Nigeria going by its position in the food security index as the 2017 *Global Food Security Index* ranked Nigeria 92nd out of 113 countries (The Economist Group, 2017). Garcia and Rosenberg (2010) stated that fisheries can contribute to food security directly and indirectly. It is directly in the sense that fisheries can serve as a source of essential nutrients and indirectly as a source of income to buy food. Managing risk is an important aspect of reducing food insecurity, protecting livelihoods and opening up investment opportunities and income growth since it is clear that risk is an unavoidable part of economic and social activities in agriculture (Kassie et al., 2015). Risk management methods provide means to address increasing complexity for successful agriculture management (such as fisheries management) by systematically identifying and coping with risk (Sethi, 2010). It involves choosing among alternatives to reduce the effects of risks (Harwood et al., 1999).

There are various studies on how the use of inputs and technologies affect production risk in agriculture (such as Ogundari and Akinbogun, 2010). Also, there is a long established literature on risk management strategies used by aquaculture farmers. With these in the literature, there is little or no information about how risk management strategies affect fish output and food security especially among women aquaculture farmers being the most vulnerable group. Moreover, studies on how combinations of risk management strategies impact fish output and food security among women aquaculture farmers are still lacking in the literature. In order to increase fish output in the presence of risk, multiple risk management strategies are employed by the farmers as compliments. Hence, this study examined the impact of risk management strategies' adoption on fish output and food security among women aquaculture farmers in Ondo State, Nigeria.

This paper contributes to the body of knowledge in the following ways. This study has considered the importance of synergetic effects of risk management strategies combinations in the attainment of increased fish output and food security. Second, the impact of risk management strategies' adoption on fish output and food security among women aquaculture farmers being the most vulnerable is examined. Lastly, in order to simultaneously estimate the determinants and impact of risk management strategies adoption, while accounting for both observable and unobservable factors in an efficient manner, endogenous switching regression model approach (Lokshin and Sajaia, 2004) was used for output being a continuous outcome. In the case of food security being a binary outcome, a recursive bivariate probit model was used (Joshi et al., 2015). Risk management strategies considered in this study are financial liquidity reservation (savings), membership of professional association (such as Cooperative societies) and following required standard in the establishment of fish farm. Any farmer who did not practice any of the three risk management strategies is regarded as non-adopter, while any farmer who practiced one or more of the risk management strategies is termed adopter.

Materials and methods

Study area

The study was carried out in Ondo State, Southwest Nigeria. The State lies between longitudes 4° 30[11] and 6[11] East of the Greenwich Meridian, 5° 45[11] and 8° 15[11] North of the Equator. The State has a land area of about 14,793 square kilometers (km^2) (Ondo State Government, 2016) and its population is about 3,460,877 (National Bureau of Statistics (NBS), 2011). Some of the inhabitants of the State are fish farmers while most of them cultivate food crops such as cocoyam, sweet potato, tomato, maize, pepper, plantain and cash crops such as cocoa and timber are cultivated in the state (Oseni, 2010).

Data collection and sampling procedure

Primary data were collected through administration of well-structured questionnaire and interview schedule on the selected respondents. Multistage sampling procedure was used to select the respondents. In the first stage, simple random sampling technique was used to select 9 Local Government Areas in the State. In the second stage, five (5) communities were purposively selected considering the level of urbanization from each of the selected Local Government Areas. In the third stage, two (2) women aquaculture farmers were selected using snow ball sampling technique from each of the selected communities. In all, a total of 90 respondents were selected for the study.

Data analytical procedure

Descriptive Statistics, Endogenous Switching Regression Model and Recursive Bivariate Probit Model were used for the analysis of data. Out of 90 copies of questionnaire administered, 87 copies were used for the analysis. The remaining

3 were not used due to insufficient data provided. Household expenditure on food has been widely used by various researchers (such as FAO, 2003; Adepoju and Adejare, 2013) in estimating food security line for rural households. It is on this basis that two-third of the mean per capita monthly food expenditure of all the households was used to estimate the food security line. Household is said to be food secure if its per capita monthly food expenditure is equal to or above the two-third mean-per capita monthly food expenditure, while food insecure household is the one with per-capita monthly food expenditure of less than two-third mean-per capita monthly food expenditure. In this study, 1 is assigned to household that is food insecure, while the household that is food secure is assigned 0.

Household impact evaluation and selection bias

It is assumed that women fish farmers are risk neutral, evaluate benefits associated with adoption and non-adoption of risk management strategies, denoted by S_{iA} and S_{iN} respectively. Another assumption is that only the adoption status is known to the researcher, while the household net benefits and other preferences are known to the women fish farmer only. Unobserved net benefits of the fish farmer i is denoted by $S_i^* = S_{iA} - S_{iN}$. The basic relationship used here is that net benefit from risk management strategies' adoption is expressed with respect to a vector of household explanatory variables (X_i) in a latent variable framework. The relationship is expressed as follows;

$$S_i^* = X_i'\alpha + \varepsilon_i, S_i = 1[S_i^* > 0], \quad (1)$$

where S_i is a dichotomous variable with 1 = farmers who did not adopt and 0 = who adopted, X represents all observable factors that influence adoption of risk management strategies, α is a vector of parameters to be estimated, ε is the error term with mean zero, and variance σ_ε^2 which captures measurement errors and unobserved factors.

Given that the primary aim of this study is to analyse the impact of risk management strategies' adoption on fish output and food security among women aquaculture farmers, a framework that captures the farmers' choice of adoption is applied. The relationship being considered in examining the effect of risk management strategies' adoption on farmers' fish output and food security assumes that vector of outcome variables is a linear function of a vector of explanatory variables (X_i) and risk management strategies' adoption which is a dichotomous variable (S_i). The relationship can be expressed as follows;

$$Y_i = K_i'\beta + S_i + \mu_i \quad (2)$$

where variable Y_i is a vector of outcome variables, K_i is a vector of farm and household characteristics, S_i is the adoption status, μ_i is a random error term while β and γ are vector of parameters to be estimated.

According to Abdulai (2016), selection bias ensues if error terms of the outcome equation, (μ) and choice equation (ε) are influenced by unobservable factors. Therefore, correlation of the error terms of the outcome and choice equations will come into play and ordinary least square will give biased estimates. As explained by Asfaw et al. (2012) the selection bias problem is addressed by randomly allocating individuals into treatment and control groups in a randomized control trial set up.

However, this case is not the same in a non-randomized experimental set up like adoption of risk management strategies which is not random and selection bias may come up. Authors such as Nkala et al, (2011) have employed Propensity Score-Matching (PSM) Approach in impact evaluation of technology on household welfare when there is self-selection. Nevertheless, Abdulai (2016) has stated that PSM approach has its own major drawback of only accounting for the observable factors. In order to simultaneously estimate the determinants and impact of adoption as well as account for observable and unobservable factors in an efficient manner, an Endogenous Switching Regression (ESR) model approach which was developed by Lokshin and Sajaia (2004) is used. It is worthy of note that ESR is suitable for expected outcome that is continuous in nature such as fish output but impact evaluation of adoption on food security, which is a dichotomous outcome variable needs a different specification. Seemingly unrelated regression approach cannot be used since adoption and food security status are dichotomous dependent variables. Therefore, Recursive Bivariate Probit (RBP) model is used to estimate the adoption and impact of risk management strategies on food security status because it accounts for endogeneity and selection bias.

Empirical specifications

Endogenous Switching Regression (ESR) model

In the process of modeling the impact of risk

management strategies' adoption on the fish output using ESR framework, a two-stage estimation procedure is simultaneously estimated. In the first stage, the adoption decision in equation (1) is estimated in order to determine the factors that influence adoption. The second stage involves the estimation of relationship between the outcome variables and a set of explanatory variables specified for two regimes of adopters and non-adopters of risk management strategies. The specifications for the two regimes are as follows;

Regime 1(Adopters): $Y_{iA} = K_{iA}\beta + \mu_{iA}$ if $S_i = 0$ (3a)

Regime 2 (Non-adopters): if $S_i = 1$ (3b)

where Y_{iA} and Y_{iN} are outcome variables for adopters and non-adopters, respectively; K is a vector of household and farm-level characteristics; β is a vector of parameters to be estimated and μ is the error term. The structure of the ESR model allows for an overlap of X in Equation (1) and K of Equations (3a) and (3b). However, it is important that at least one variable does not appear in K for the purpose of identification. Therefore, this implies that the same set of variables are used to estimate selection and outcome equation but with additional one variable in the former. Awareness about risk management strategies is used as a valid instrument as it is expected to influence adoption decision and not the outcome. Only observable factors are accounted for in equations 3a and 3b by variables in K. But it is possible for ESR model to address the selection bias problem owing to unobservable factors within the structure of omitted variable problem. As explained by Heckman (1979), the selectivity terms used in the selection equation which represent λ_A and λ_N for adopters and non-adopters, respectively, covariance terms σ_{AN} and $\sigma_{A\varepsilon}$ are included in equation 3a and 3b which resulted to equation 4a and 4b below;

$$Y_{iA} = K_{iA}\beta + \sigma_{A\varepsilon}\lambda_A + \varphi_{iA} \quad \text{if } S_i = 0 \tag{4a}$$

$$YiN = K_{iN}\beta + \sigma_{N\varepsilon}\lambda_N + \varphi_{iN} \quad \text{if } S_i = 1 \tag{4b}$$

where the selectivity terms λ_A and λ_N correct for selection bias from unobservable factors and φ_{iA} and are the error terms with conditional zero means. Maximum likelihood approach was used in this study as proposed by Lokshin and Sajaia (2004) and used by Abdulai (2016). The ESR model is used to examine the impact of adopting risk management strategies on fish output by comparing the expected fish output of farmers who adopt with expected outcomes of the counterfactual hypothetical cases that adopters did not adopt. The expected values of the outcome Y on adoption and non-adoption can be expressed as follows;

$$E(Y_{iA}|S = 1) = K'\beta_{iA} - \sigma_{A\varepsilon}\lambda_A \tag{5a}$$

$$E(Y_{iN}|S = 1) = K'\beta_{iN} - \sigma_{N\varepsilon}\lambda_A \tag{5b}$$

According to Lokshin and Sajaia (2004), average treatment effect on the treated (ATT) is a change in the outcome due to adoption, which is expressed as follows in equation 6 as the difference in the expected outcomes from equations 5a and 5b.

$$ATT = E(YiA|S = 1) - E(Y_{iN}|S = 1) \tag{6a}$$

$$ATT = K(\beta iA - \beta iN) + \lambda A(\sigma A\varepsilon - \sigma N\varepsilon) \tag{6b}$$

where σ represents the covariance of the error terms and λ the inverse mills ratios or selectivity term.

Recursive Bivariate Probit (PBP) model

Awotide et al. (2013); Kuntashula et al. (2014) have used Heckman two-stage selection method to evaluate impact of a dichotomous variable on a dichotomous outcome. The method was used to account for observed and unobserved heterogeneity between adopters and non-adopters. However, Lokshin and Sajaia (2004) argued that heteroskedastic residuals are generated by two-stage approach, which cannot be used to obtain consistent standard errors without cumbersome adjustments. Therefore, this study employs RBP model to jointly estimate adoption of risk management strategies and its impact on dichotomous variable (such as food security) in order to overcome the shortcoming as used by (Amare et al., 2012 and Abdulai, 2016). The selection equation described in equation 1 is equally needed in RBP model so as to take care of possibly endogenous binary variable and outcome equation described in equation 2. The model is expressed as follows;

$$S_h^* = X_h'\theta + \varepsilon_h, \quad S_i = 1[S_i^* > 0] \tag{7}$$

$$Y_h = K_h' + S_h'\omega + \mu_h \tag{8}$$

where variable S_h^* is the latent adoption outcome of the farming household; X_h includes all factors influencing risk management strategies' adoption decision, such as household and farm-level characteristics; Y_h represents food security status for household; K_h is a vector of household and farm-level characteristics (e.g., age, education); S_h indicates farmers' adoption status; μ_h and ε_h are random error terms which are assumed to follow a bivariate distribution; θ and ϕ, and ω are

parameters to be estimated. Following Marra and Radice (2011), the assumption that the error terms follow a bivariate distribution is expressed as follows;

$$\left(\begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix}\right) \quad (9)$$

where ρ represents correlation coefficient among unobserved explanatory variables in both equations.

For the purpose of identification as it is in ESR model, it is vital to make sure that the exclusion restriction on the exogenous variables hold, that is X_h and K_h must be different by the minimum of a variable (Maddala, 1983). The bivariate normal cumulative distribution function is specified in equation 10 and if ρ is significant, it indicates that correlation of disturbance terms exists.

$$Я(X_k, K_k, \rho) = \frac{e^{-1/2\left(X_h^2 + K_h^2 - 2\rho X_h K_h\right)/(1-\rho^2)}}{2\pi(1-\rho^2)^{1/2}} \quad (10)$$

The nonlinear conditional expectation expressed in equation 11 is meant to estimate the marginal effects, while the average treatment effect on the treated (ATT) is estimated using equation 12.

$$E[s_h|Y_h, K_h] = \frac{Я(\emptyset X_h, (2Y_h - 1)\emptyset K_h, (2Y - 1)\rho)}{Я[(2Y_h - 1)\emptyset K_h]} \quad (11)$$

$$ATT = E(Y_{hA}|S = 1) - E(Y_{hN}|S = 1) \quad (12)$$

where Y_{hA} is the expected probability of food security status from adoption, and is the expected probability of food security outcome in the counterfactual case.

Credit constraint and adoption decision may be jointly determined and this is capable of causing potential endogeneity problems in Endogenous Switching Regression Model and Recursive Bivariate Probit Model estimation. There may be bias estimates if such potential endogeneity problems are not accounted for. In view of this, the endogeneity issue is accounted for using two-stage procedure of Blundell and Smith (1989) since the dependent variable is dichotomous. The first stage involved the specification of potentially endogenous variable (credit constraint) as a function of all other independent variables including a set of instruments as in equation 13.

$$Pr[V_i = 1] = \aleph' G_i + \tau' T_i + e \quad (13)$$

where V_i is a vector of the potential endogenous variables, G_i is a vector of independent variables, while T_i is a vector of instruments that are correlated with the given endogenous variable, but uncorrelated with the error terms in equation 13. A variable that influences credit constraint but does not influence the outcome variables was included in equation 13 for identification purpose. Possession of collateral which influences credit constraint but not the outcome variable was used as an instrument in the credit constraint specification. However, the second stage involved the inclusion of the values of credit constraint as well as their corresponding residuals from equation 13 in ESR model. Therefore, consistent estimation of the parameters in the presence of potential endogenous variable in T_i is possible. A simple t-test for the significance of the coefficient vector is a test for the exogeneity of these variables (Wooldridge, 2010).

Results and discussion

Summary of statistics

Table 1 presents the variable names, descriptive statistics of adopters and non-adopters. The t-test values indicating the differences between women fish farmers who adopted risk management strategies and those who did not adopt suggest that there are statistically significant differences between the two groups with respect to some household and farm level characteristics. For instance, women fish farmers who adopted risk management strategies obtained 1,420.3 kg of fish output, while those who did not adopt the risk management strategies realized 1,278.1 kg of fish output. Also, there is a significant difference between the age of adopters and non-adopters with 52.03years and 40.57 years respectively. Furthermore, adopters spent about 16.53 years in school, while non-adopters spent about 10.52 years in school. Moreover, adopters and non-adopters differ significantly in household size, quantity of feed used, non-farm income, credit constraint, awareness about risk management strategies and risk attitude. About 49% of women fish farmers who adopted risk management strategies were food insecure, while 76% of those who did not adopt were food insecure. The reported differences for fish output and food security status in Table 1 could be interpreted as impacts, but this may not be absolutely correct since some other confounding factors are not taken into consideration. In view of this, this study gave serious consideration to other confounding factors in the analysis.

Variable	Variable description	Adopters	Non-adopters	Difference
Age	Age of the respondents in years	52.03	40.57	11.46**
Household size	Household size of the respondents	4.13	6.16	-2.03*
Experience	Experience of the respondents in years	6.34	5.50	0.84
Marital status	Marital Status of the respondents	0.21	0.23	-0.02
Educational level	Number of years spent in school	16.53	10.52	6.01**
Non-farm income	Income from non-farm activities in Naira	89,000.00	64,000.00	25,000.00***
Fish output	Quantity of fish harvested in kg	1420.30	1278.10	142.2.20***
Labour cost	Cost of labour used in Naira	54,561.97	53,613.07	948.9
Pond system	1 if farmer uses earthen pond and 0 otherwise	0.52	0.76	-0.24
Food security	Percentage of household who are food insecure	0.49	0.73	-0.24***
Credit constraint	1 if the household is credit constrained and 0 otherwise	0.43	0.84	-0.41**
Quantity of feed	Quantity of feed used in kg	2,371.20	2,103.32	267.88***
Risk attitude	1 if the farmer is risk seeking and 0 otherwise	0.97	0.51	0.46**
Awareness	1 if the farmer is aware of risk management strategies, 0 otherwise	0.85	0.32	0.53**
Number of observations		34	34	

Note: *, ** and *** represent significance at 10%, 5% and 1% levels respectively
Source: own processing

Table 1: Variable names, descriptions and descriptive statistics of adopters and non- adopters.

Relevant test results in the estimation strategy

As shown in Tables 2 and 3, there are some relevant test results that have to be discussed before moving to the discussion of empirical estimates in this study. To start with, the estimates of credit constraint residual obtained from the first stage estimates of equation 13 are not statistically significant in the specifications used. This indicates that the coefficients of credit constraint variable have been consistently estimated (Wooldridge, 2010). Also, the likelihood ratio tests for joint independence of the equations in endogenous switching regression model and recursive bivariate probit regression model specifications revealed that the equations are dependent. The implication of this is that the models should not be estimated separately because they are not jointly independent. Another result indicates that there was an occurrence of selection bias in adoption since correlation coefficient (ρ) in the specifications are significant. Therefore, it can be said that the use of endogenous switching regression (ESR) model and recursive bivariate probit model which account for both observable and unobservable factors are appropriate for this study (Lokshin and Sajaia, 2004).

The correlation coefficients ρ_1 and ρ_2 are both statistically significant. Since ρ_1 is positive and ρ_2 is negative, it implies that non-adopters had lower output and higher food insecurity than a random individual from the sample. However, adopters had higher output and lower food insecurity than a random individual from the sample. These results confirm Kassie et al., (2015) who stated that managing risk is an important aspect of reducing food insecurity, protecting livelihoods and opening up investment opportunities and income growth since it is clear that risk is an unavoidable part of economic and social activities in agriculture. Lastly, the log-likelihood ratio is significant at 1%, which implies that the recursive bivariate regression model is overall a good fit.

Determinants of adoption

The results from the selection equation are presented in Tables 2 and 3 together due to the fact that the empirical results in the selection equation can be interpreted as normal probit coefficients. It is worthy of note that estimates for variables with the same name in the selection equation (probability of adopting risk management strategies) have similar effects on the dependent variable. As shown in the results, increase in age of the respondents tends to increase the probability of being non-adopter of risk management strategies in ESR and RBP models. This may be traced to their inability to cope with the laborious nature of risk management due to old age. The outcome of this study is in conformity with Ullah et al. (2015) who reported that increase in age reduced the adoption of risk management strategies.

Household size, level of education, non-farm income and quantity of feed had negative but significant

relationship with adoption status. The implication of this scenario is that these variables increase the likelihood of adopting risk management strategies. The reason for this could be attributed to the fact that increase in level of education assists women fish farmers in the area of adoption of new technologies in spite of the associated risk since they know that risk always comes with great benefits, hence the need to adopt risk management strategies. This is in line with Olawuyi and Olawuyi (2015), who reported that number of years spent in school increased adoption of risk management strategies. Also, negative relationship between household size and adoption of risk management strategies may be due to the fact that some risk management strategies are laborious, which require more hands that can be gotten from household members. Saqib et al. (2016) reported that family size increases the probability of adopting risk management strategies.

The relationship that exists between non-farm income and risk management strategies' adoption could be linked to the importance of diversification of means of livelihood as one of the risk management strategies. Ullah and Shivakoti (2014) explained that off- farm income is capable of assisting farmers in investing on risk management options that can reduce other risks on the farm. Also, awareness about risk management strategies and risk attitude exhibit negative but significant relationship with adoption status, indicating that being aware about risk management strategies and risk seeking are likely to increase women fish farmers' chance of adopting risk management strategies across the two specifications. Ullah et al. (2015) reported a similar result which stated that risk perception and attitude of the farmers are important factors in farm risk management decisions. However, credit constraint and pond system are positive and significant in ESR and RBP models, which indicates that being credit constrained and using earthen pond system tend to reduce the probability of adopting risk management strategies. This result is in support of outcome of study by Deressa et al. (2010) who reported that access to credit will increase adoption of various risk management strategies.

	Selection		**Adopters**		**Non-adopters**	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Constant	5.920	2.24	3.010	4.71	5.335	7.45
Age	0.208***	2.76	0.421**	2.01	0.314*	1.89
Age^2	-0.241	0.10	-1.326	1.21	-0.759	0.32
Household size	-0.041***	9.62	0.736**	2.11	0.114	1.43
Experience	0.132	0.34	0.132	1.52	0.527	1.48
Marital status	0.541	0.46	0.335	0.95	0.796	0.74
Education	-0.134***	4.30	1.493**	2.01	0.309***	4.47
Non-farm income	-1.034**	2.12	0.663***	4.21	0.759	1.34
Labour cost	-0.271	1.53	0.801	0.14	-0.955	0.92
Credit constraint	0.482***	3.72	-0.823**	2.00	-0.612*	1.92
Pond system	0.624***	7.23	-0.553***	3.10	0.321	1.13
Quantity of feed	-0.575**	2.11	0.421***	8.67	0.022	0.22
Risk attitude	-0.544***	5.76	0.542	1.54	0.545***	4.22
Awareness	-0.417***	2.95				
Credit residual	0.062	1.23				
$\ln\sigma_1$			8.172***	13.19		
ρ_1			0.161**	2.15		
$\ln\sigma_2$					4.253***	10.13
ρ_2					-0.474***	6.42
Log likelihood	-470.25					
Likelihood ratio of independence: $\chi^2(1)$			11.42**			

Note: *, ** and *** represent significance at 10%, 5% and 1% levels respectively
Source: own processing

Table 2: Full information maximum likelihood estimates of endogenous switching regression model for adoption and impact of adoption on fish output.

	Selection		Food Security		Marginal Effects
	Coefficient	t-value	Coefficient	t-value	
Constant	9.920	4.14	4.918	1.89	
Risk management adoption			0.029***	4.24	0.571
Age	0.008***	5.77	0.009	0.24	0.083
Age2	-0.041	1.10	0.172	1.11	0.012
Household size	-0.043***	3.61	0.010***	4.43	0.038
Experience	0.032	1.34	-0.241***	2.97	0.031
Marital status	0.742	1.46	-1.054	1.32	0.567
Education	-0.539***	8.31	-0.131***	3.03	0.167
Non-farm income	-1.081**	2.10	-0.197***	4.52	0.188
Labour cost	-0.578	0.53	-0.633	1.30	0.184
Credit constraint	0.289***	2.72	0.619***	3.34	0.207
Pond system	0.929***	8.23	0.694	0.81	0.067
Quantity of feed	-0.270**	1.87	0.225	0.64	0.131
Risk attitude	-0.841***	7.36	-0.440*	1.94	0.345
Awareness	-0.210***	5.95			
Credit residual	0.081	0.73			
ρ	-0.735***	17.45			
Log likelihood	-98.421***				

Note: *, ** and *** represent significance at 10%, 5% and 1% levels respectively
Source: own processing

Table 3: Full information maximum likelihood estimates of Recursive Bivariate Probit Model for adoption and impact of adoption on food security.

Impact of determinants

The estimates in the outcome equation in the columns for adopters and non-adopters in Table 2 generally show the impact of household and farm-level characteristics of women fish farmers on fish output. The impact estimates suggest that age of the respondent and level of education positively and significantly influenced fish outputs among adopters and non-adopters of risk management strategies. This implies that age and level of education tend to contribute to increasing fish output. The positive and significant relationship between age and fish output could be due to the sufficient knowledge that farmers have gathered through experience over the years of fish farming. This confirms the findings of Raufu et al. (2009) where it is reported that a positive and significant relationship existed between age of respondents and fish output. The positive and significant relationship between level of education and fish output reported in this study is in conformity with Ike and Chuks-Okonta (2014) who also reported a direct relationship between level of education and fish output.

Also, household size, non-farm income and quantity of feed are positively and significantly related to fish output among risk management strategies' adopters, indicating that these variables contribute to increasing fish output. The direct relationship between non-farm income and fish output shows the importance of non-farm income as it is used to cope with financial shocks. Ogundari and Akinbogun (2010) reported positive and significant relationship between quantity of feed and fish output, while Oluwasola and Ige (2015) recorded a positive and significant relationship between catfish profitability (as a proxy for fish output) and quantity of feed. Conversely, the negative and statistically significant coefficient of credit constraint and pond system indicate that being credit constrained and using earthen pond system would reduce fish output. This shows the importance of credit availability in fish production which supports Saqib et al. (2016) who stated that agricultural credit plays vital role as it has significant impacts on farmers' production, income and food security.

The impact estimates as shown in Table 3 under food security column show that there is a positive relationship between adoption of risk

management strategies and food security status (headcount index), indicating that non-adoption of risk management strategies among women fish farmers tend to increase the probability of being food insecure. This is a clear indication that adoption of risk management strategies is very important when food security issue is being discussed. This confirms the statement of Kassie et al. (2015) which states that managing risk is an important aspect of reducing food insecurity, protecting livelihoods and opening up investment opportunities and income growth. Moreover, household size exhibits positive and significant relationship with food security (headcount index), which implies that increase in household size tends to increase the likelihood of being food insecure among women fish farmers. This could be linked to increased pressure on household resources (such as food) as household size increases, which may make such households to be food insecure. This is in line with the findings of Ibok et al. (2014) which explained that large size households tend to be more food insecure than small size households.

However, experience of women fish farmers, level of education and non-farm income negatively and significantly influenced food security (headcount index). This indicates that experience, level of education and non-farm income tend to increase the fish farmers' chance of being food secure. This may not be unconnected with the fact that experienced fish farmers are aware of some practices to put in place in order to realize optimum fish output which helps to be food secure. Ahmed et al. (2015) reported that food insecurity may arise as a result of low production and income caused by limited farming experience. The coefficients of credit constraint and risk attitude of women fish farmers had positive and negative significant relationship with food security (headcount index) respectively. The implication of this is that being credit constrained will likely lead to increase in the probability of being food insecure, while being risk seeking may bring about more chance of being food secure. These findings have further confirmed the findings of Saqib et al. (2016) who stated that agricultural credit plays vital role as it has significant impacts on farmers' food security.

The marginal effect estimates of the RBP specifications are interpreted as elasticities, which give the magnitude of the response of food security (headcount index) to any increase in each of the independent variables. For example, the marginal effect of household size with positive and significant estimate shows that additional household member is more likely to increase food insecurity by 3.8%. The negative and statistically significant marginal effect estimate of level of education suggests that an additional year spent in school by women fish farmers is more likely to contribute to the household being food secure by 16.7%. Also, the negative and significant marginal effect estimate of non-farm income implies that an additional amount of money in Naira by women fish farmers is more likely to increase the chance of being food secure by 18.8%.

Fish output and food security impacts

Table 4 presents impact of adoption on fish output and food security from the ATT estimates of the ESR and RBP specifications. In order to examine the impact of risk management strategies' adoption on fish output and food security (headcount index), the average treatments effects (ATT) on the expected outcomes are estimated. It is worthy of note that ATT estimates account for other confounding factors which include selection bias resulting from potential differences between adopters and non-adopters. The results indicate that adoption significantly increases fish output and reduces food security headcount index. To be specific, the expected fish output from adopters is 1,172.2 kg compared with 753 kg from non-adopters. This difference represents increase in causal effect in fish output from adoption by 55.7%. However, there is a negative impact of adoption on food security headcount from RBP estimates. The implication is that there is increase in the probability of reducing food insecurity from 87% from non-adopter to 58% from adopter. Kassie et al. (2015) explained that managing risk is an important aspect of reducing food insecurity, protecting livelihoods and opening up investment opportunities and income growth since it is clear that risk is an unavoidable part of economic and social activities in agriculture.

Variable	Adopter	Non-adopter	ATT
Output (kg)	1,172.2	753.00	419.2***
Food security headcount	0.58	0.87	-0.29***

Note: *** represent significance at 1% levels
Source: own processing

Table 4: Impact of risk management.

Conclusion

This article examined the impact of risk management strategies adoption on fish output and food security among women aquaculture farmers. The study through the mean differences

revealed that there are statistically significant differences in fish output and food security status between adopters and non-adopters of risk management strategies among women fish farmers. Despite the fact that these results can be interpreted as impacts, this study further analysed the data so as to observe the impacts while considering the effect of other factors, those that influenced adoption inclusive. This is necessary because of the failure of the mean differences to account for other factors. Endogenous Switching Regression model was used to estimate the adoption and impact of adoption on fish output, while Recursive Bivariate Probit model was employed to estimate the adoption impacts on food security (headcount index). It is indicated in this study that adoption of risk management strategies had positive and statistically significant influence on fish output but negative and statistically significant influence on food security (headcount). The empirical findings revealed that farmer's age, credit constraint, pond system, household size, education, non-farm income, quantity of feed and risk attitude had significant influence on adoption across the specifications. Also, household size, risk management strategies' adoption, experience, education, non-farm income, credit constraint and risk attitude had significant impact on food security among the respondents. Furthermore, the results showed that sample selection bias could have occurred while estimating the impact of risk management strategies' adoption on the outcomes without accounting for observable and unobservable factors. Women fish farmers who are non-adopters had lower output and higher food insecurity than a random individual from the sample. However, adopters had higher output and lower food insecurity than a random individual from the sample.

Based on the findings of this study, it is recommended that development agents should encourage women aquaculture farmers to adopt risk management strategies in order to have increased fish output and reduced food insecurity which can help in bridging the fish supply-demand gap and reducing their level of vulnerability. This is necessary since adoption of risk management strategies among women aquaculture farmers is capable of increasing fish output and reducing food insecurity. Also, since non-farm income has been reported to be one of the important factors that influenced adoption of risk management strategies, women fish farmers should be encouraged to involve in income diversification. This will help them to benefit from the importance of non-farm income in the risk management strategies' adoption process. The study revealed that non-credit constrained women fish farmers were reported to adopt risk management strategies more than their credit constrained counterparts. Therefore, reducing the problem of credit constraints will go a long way in increasing fish output through adoption of various risk management strategies. The study showed that increase in the level of education increased the likelihood of adopting risk management strategies. In view of this, policy measures that target increase in education investment should be put in place especially for women. Being aware about risk management strategies and risk seeking are likely to increase women fish farmers' chance of adopting risk management strategies. Therefore, proper attention should be given to women fish farmers' risk attitude and awareness about risk management when decisions are being made on risk management strategies in fish farming. Having seen the wonderful results coming from this study, it is recommended that further studies that expand the study to cover the whole country should be carried out.

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