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Empirical analysis of macroeconomic variables towards agricultural productivity in South Africa

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Abstract. Agricultural sector can impact positively the nation's development in terms of job creation and food security which promote good nutrition and boost well-being of every individual. However, in South Africa a developing country with a growing economy, the agricultural sector is still a traditional one with limited productivity and developments. Therefore, this study aims to analyses the impact of macroeconomic variables towards agricultural productivity in South Africa. The study used three variations of equations to acquire variety of conclusions to assist in determining which set of macroeconomic variables have strong impact on agricultural productivity. Nine variables were used to make the analyses of the three sets of equations and agricultural productivity as a dependent variable appeared in all the three equations. The results indicated that there is a long run equilibrium existing among the variables in all estimated equations. Overall results demonstrate that GDP and capital formation play a positive significant role in stimulating agricultural productivity. Furthermore, the results suggest that there is an evidence of causality between macroeconomic variables and agricultural productivity. In conclusion, the results suggest that for South Africa, in order to increase agricultural productivity, policy makers should give adequate financial support to the agricultural sector by ways of providing development skills and funding the improvement of agricultural infrastructure. In addition, the results provide guidance to the farmers on how various macroeconomic variables may impact productivity whether it is positive or negative.

Keywords: agricultural productivity, macroeconomic variables, VECM, South Africa.
JEL codes: B22, E23, Q1

1. INTRODUCTION

Studies carried out by a variety of neo-classical and classical scholars revealed that agricultural sector plays a crucial role in an economy. The agricultural sector's position can therefore be shown in terms of maximizing productivity and minimizing production costs within the sector. The sector can thus impact positively the nation's progression, social welfare, job creation, and food security. Most prominently, as South Africa is a developing country with a growing economy, its agricultural sector needs to be improved. DAFF[1] (2015) states that developing nations across the world can focus on the sector to increase job creation and improve economic development. This may result from the readily available food and earnings from foreign exchange. However, agricultural sector has certainly not been the pillar of South African economy. Thus, this has been the reason behind the misfortunes of this sector.

According to Cristea, Marcu, Meghisan (2015) the poor governance and policy implementation inconsistency play a leading role to the lack of development for agricultural sector. In the 21st century, the shift of agriculture and agricultural productivity structure continued to indicate an ongoing decline on agricultural productivity by 0.19% in South Africa according to BFAP[2] (2011). The slowdown of the sector's productivity was due to the low productivity, particularly in output of field crops which were surpassed by development in the agricultural sector. The reality is that agricultural sector has contributed less than 4% to the South African economy since 2004, from its highest contribution of 21% in 1910, as stated by the DAFF (2017).

The BFAP[2] (2011) states that the South African agricultural growth continued to decline further in 2010 due to the slow recovery of the economy and stagnant commodity of prices. In 2015, the agricultural productivity's total gross value in Rand was estimated at R233 million, compared to R220 million of 2014, marking an increase of 5.5%. The increase was mostly ascribable to the growth in the value of animal products. In 2016/2017, according to DAFF (2017), agricultural productivity registered an increase of 12.5% when compared to the prior year of 2014/2015, this was ascribable to an increase of field crops and animal products and its share to the GDP was approximately R80 million in 2016. According to Ramali, Mahlangu and Tuit (2015), 70% of agricultural products are used as intermediate products by other sectors of the economy. Those products are often partly processed, those include products such as vegetable oils, wheat flour and soybean meal among others. The agricultural sector is an imperative sector and one of the engines that improves the growth of the economy. Nonetheless, to argue that the sector is more important than its share to the economy is understandable, as the sector utilized 79.8% of total land available in the year 2014 and used almost 60% of the water available for irrigation. According to World Bank (2017) the sector also generated R243 million in income and R225 million in expenditure. The sector created job opportunities directly and indirectly for more than 700 000 people in 2015, this was in line with the government New Growth Path plan to generate 5 million vacancies not later than 2020, as indicated by Dewbre and Cervantes-Godoy (2010). This makes agricultural sector be one of the biggest employers among other sectors of the economy.

Limited studies have been conducted relating to this kind of study and previous empirical evidence does not give thorough analysis on the impact of macroeconomic variables on agricultural productivity in South Africa. It is on this basis that this study fills the gap of the previous empirical literature by adding other key macroeconomic variables that were not included before. Rather than focusing on environmental factors, most of which among the limited studies in South Africa have focused on, the current study focuses on macroeconomic variables. Moreover, the study attempts to carry on an investigation by using three variations of equations. The essence of such approach is to achieve a robust feedback on the analysis of macroeconomic variables to agricultural productivity. The key objective of the study is to investigate the impact of macroeconomic variables towards agricultural productivity in South Africa. This study attempts to identify what are macroeconomic variables determining agricultural productivity. Therefore, this study is structured as follows: next section examines the theoretical and empirical literature underpinning the subject; Section 3 presents the methodology applied in the study. Empirical findings of the study are reported and discussed in section 4 while section 5 presents conclusion and policy recommendation.

2. REVIEW OF RELATED LITERATURE

The study is underpinned by several theoretical literatures. According to Solow (1956), growth accounting framework of neo-classical indicates that the output of growth model is the sum of growth in labour and capital accumulation growth, technological progress and productivity growth. On the other hand, Schultz (1964) and Mellor (1966) focused on agricultural development models whereby each theorist indicated the types of agriculture, whether that agriculture is traditional or technologically dynamic agriculture. Mellor (1966) agrees with Schultz (1964) on those development models but, comparatively, his approach is more pragmatic and extensive in nature. Mellor (1966) explains systematically the evolution of agriculture from primitive technology to modern agricultural

[1] Department of Agriculture Forestry and Fisheries.

[2] Bureau for Food and Agricultural Policy.

technology, whereas Schultz focused on explaining traditional agriculture.

In addition, several studies have been carried out to investigate the impact of macroeconomic variables towards agricultural productivity. However, contradicting findings were reached based on econometric techniques, data and period of study along with countries that were studied. Many studies carried out by various authors, i.e. Oyetade, Applanaidu, Abdul-Razak (2015), Browson, Vincent, Emmanuel, Etim (2012), Kadir, Tunggal (2015), Enu, Atta-Obeng (2013) and Abba, Barro, Mosca (2015), Bhide, Rajeev, Vani (2005), Huffman, Evenson (2001), Wang, Heisey, Schimmelpfennig, Ball (2015), Gil, Kaabia (2000), Dritsakis (2003), Awokuse (2009) and Awan, Alam (2015) focused on macroeconomic variables and their influence on agricultural productivity. These studies have led to different conclusions, mainly due to several variables utilized. Most studies included variables such as inflation, whereby in most studies the variable resulted to having negative impact in relation to agriculture and its productivity in the long run. Variables such as agricultural exports, exchange rates, interest rates, human capital, money supply, GDP and external debt dominated in most studies above mentioned. Thus, the study at hand will continue to fill the gap of the above empirical literature by adding other key macroeconomic variables that were not included.

In the South African context, there are nonetheless studies by Letsoalo and Kirsten (2003) and Kargbo (2007) that were not mainly focused on macroeconomics variables and their impact on agricultural productivity. Conversely, the work of Letsoalo and Kistern (2003) focused on analysing macroeconomic importance of trade policies on the South African agricultural sector. Kargbo (2007), on the other hand, focused on the effect of macroeconomic factors on the South African agriculture. Therefore, it is necessary that this study takes place, as there is insufficient empirical literature for South Africa that focuses on the topic at hand. Furthermore, this study employs a variation of equations unlike the previous studies. The study does confirm the importance to refocus on agricultural productivity since this sector affects every individual and other economic sectors in different ways. The empirical literature shows that macroeconomic variables can have either negative or positive relationship towards agricultural productivity depending on estimation approach of each study. The literature that was reviewed has also pointed out that agricultural productivity mostly increases in developed countries compared to developing countries, as stated by Ramabali *et al.*, (2011). The following section discusses the methodology of this study.

3. RESEARCH METHODOLOGY

3.1. Model specification

The study modifies and adopts the model by Kadir and Tunggal (2015) by using three variations of equations. Agricultural productivity is a function of selected macroeconomic variables among the three equations. It also takes into consideration the study by Bentivoglio, Finco and Bucci (2018), Eita and Jordaan (2013) who applied similar econometric technique (Johansen cointegration and granger causality). These studies indicate that the Johansen approach is more powerful than the Engle-Granger. Therefore, the following equations are presented:

$$AGRI_t = \beta_0+\beta_1GDP_t+\beta_2GE+\beta_3GCF+\beta_4RINT+\mu_t \quad (1)$$

$$AGRI_t = \beta_0+\beta_1GDP_t+\beta_2GE+\beta_3GCF+\beta_4REER+\beta_5AX+\mu_t \quad (2)$$

$$AGRI_t = \beta_0+\beta_1GDP_t+\beta_2GE+\beta_3M2+\beta_4REER+\beta_5AX+\mu_t \quad (3)$$

Where β_0 is the intercept and $\beta_1,\beta_2,\beta_3,\beta_4,\beta_5$ are explanatory variables coefficients and μ_t is the error term. AGRI: Agricultural productivity, GDP: Gross Domestic Product, GE: Government Expenditure, GCF: Gross Capital Formation, M2: Money Supply, RINT: Real Interest Rate, REER: Real Effective Exchange Rate, CPI: Consumer Price Index and AX: Agricultural exports. Certain variables are therefore converted into logarithms to obtain the elasticity of coefficients and remove the outlier effect. In terms of log linear form, the functions are as follows:

$$LAGRI_t = \beta_0+\beta_1LGDP_t+\beta_2GE+\beta_3LGCF+\beta_4RINT+\mu_t \quad (1)$$

$$LAGRI_t = \beta_0+\beta_1LGDP_t+\beta_2GE+\beta_3LGCF+\beta_4REER+ \beta_5LAX+\mu_t \quad (2)$$

$$LAGRI_t = \beta_0+\beta_1LGDP_t+\beta_2GE+\beta_3LM2+\beta_4REER+ \beta_5LAX+\mu_t \quad (3)$$

Where LGDP is log of gross domestic product, LGCF is log of gross capital formation, LAX is log of agricultural exports, LAGRI log of agricultural productivity and LM2 is log of money supply.

3.2. Study area and data source

The study used annual time series data for the period 1975 to2016 in order to analyses the impact of macroeconomic variables towards agricultural productiv-

Tab. 1. Summary of the description of variables.

Variables	Indicator name	Measurement	Source of dataset
AGRI	Agricultural productivity	% of GDP	World Bank & DAFF
AX	Agricultural exports	Rand value	WTO
REER	Real effective exchange rate	Rand currency	Quantec
GCF	Gross capital formation	% of GDP	Quantec
GDP	Gross domestic product	% of GDP	Quantec
GE	Government expenditure	% of GDP	Quantec
INT	Real interest rate	Annual %	World Bank
CPI	Consumer price index	Annual %	World Bank
M2	Money supply	Rand value	Quantec

ity in South Africa. The data used was online sourced from Quantec, World Trade Organization, World Bank and Department of Forestry and Fisheries. The data covered a variety of macroeconomic variables such as gross domestic product, government expenditure, gross capital formation, consumer price index, agricultural exports, real effective exchange rate, real interest and money supply along with agricultural productivity. Table 1 summaries the description of the variables used in the study.

The data is firstly tested for stationarity based on the test of Dickey and Fuller (1979) and Phillips-Perron (1986). In order to test for cointegration, the Johansen (1991-1995) cointegration technique is applied using two statistics tests. These are the value of likelihood ratio test based on the trace value of the stochastic matrix and maximum Eigen-value. The likelihood ratio is used to test Johansen cointegration. Up to (r–1) co-integrating relationships may exist between a set of r variables. The Johansen statistic is also adopted to resolve the issue of endogeneity of explanatory variables by allowing error correction model with lag restrictions. It is chosen as it can test multiple cointegration vectors (Bentivoglio *et al.*, 2018). The VECM is used to determine the long run and short run determinants of the dependent variable in the model. The Johansen technique envisages therefore the following steps: *Firstly*, all variables have to be integrated in the same order before moving to the cointegration test. *Secondly*, the correct lag length of the model has to be determined. Furthermore, this step envisages the estimation of the model and the determination of the rank of Π. *Lastly*, after ascertaining the existence of co-integrating relationship, the vector error correction model is estimated to test dynamics of the short run. The Johansen approach considers the starting point of VAR of order P by the following:

$$Y_t = A_1 Y_{t-1} + \ldots A_p Y_{t-p} + \beta x_t + \varepsilon_t \quad (7)$$

Therefore, to apply the Johansen test, VAR needs to be transformed into VECM model and be written as:

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma i \Delta Y_{t-1} + \beta x_t + \varepsilon_t \quad (8)$$

Where

$$\Pi = \sum_{i=1}^{p} Ai - 1 \ and \ \Gamma i = -\sum_{j}^{p} = i + 1Aj \quad (9)$$

If the coefficient matrix Π has reduced rank r < k then there exists k x matrices α and β each with rank r such that $\pi = \alpha\beta'$ and $\beta' Y_t$ is $I(0)$. R is the number of cointegrating relationships, the elements of α are known as the adjustment parameters in the vector error correction model and each column of β is a cointegrating vector. It can be shown that for a given r, the maximum likelihood estimator of β defines the combination of Y_{t-1} that yields the r largest canonical correlations of ΔY_t with Y_{t-1} after correcting for lagged differences and deterministic variables when present. The above process determines the number of co-integrating vectors. Thereafter causality test on the VECM is applied to identify a structural model and determine whether the estimated model is reasonable. Diagnostic tests were conducted afterwards to test the stochastic properties of the models, and all the models pass the basic tests. Lastly the granger causality test was employed.

4. EMPIRICAL RESULTS

Table 2 presents the descriptive statistics for the variables employed in the study. The results show that, on average, the variables of the study are AGRI 1.38, AX 21.78, REER 4.68, GCF 3.04, GDP 37.62, GE 2.87, RINT 3.74, CPI 54.34 and M2 26.14. Overall GE is the variable with the lowest mean value.

Tab. 2. Descriptive statistics for variables under study.

	AGRI	AX	REER	GCF	GDP	GE	RINT	CPI	M2
Mean	1.387	21.787	4.682	3.045	37.620	2.872	3.746	54.346	26.141
Median	1.373	21.634	4.672	3.000	37.707	2.921	3.848	45.366	26.319
Maximum	2.035	23.155	5.128	3.530	38.275	3.030	13.012	138.90	28.312
Minimum	0.844	18.643	4.241	2.719	32.976	2.555	-12.315	3.427	23.103
Std.Dev.	0.350	0.833	0.236	0.210	0.892	0.143	4.345	44.067	1.709
Skewness	0.055	-0.817	0.135	0.717	-3.987	-1.119	-0.895	0.520	-0.295
Kurtosis	1.871	6.292	2.171	2.598	20.092	2.934	6.571	1.979	1.793
Jarque-Bera	2.249	23.080	1.330	3.883	622.54	8.778	26.590	3.716	3.159
Probability	0.325	0.000	0.514	0.144	0.000	0.012	0.000	0.156	0.206
Sum	58.20	893.30	196.6	127.9	1580.0	120.64	149.85	2282.5	1097.9
Sum Sq.Dev	5.02	27.75	2.28	1.81	32.63	0.84	736.34	7967.4	119.71
Observation	42	42	42	42	42	42	42	42	42

4.1. Unit root test results

Often macroeconomics time series data are generally characterized by a stochastic trend which can be eliminated by differencing the series. Firstly, in Johansen procedure, time series data are tested for stationarity of all variables. Hence this part of the study examines the order of integration by applying two formal tests namely Augmented Dickey Fuller and Phillips-Perron. Table 3 and 4 disclose the results of ADF and PP unit root tests.

Johansen cointegration requires a preliminary test to be done to ensure that variables are integrated in the same order. The unit root test for all variables used was applied and the results are shown in Table 3 above which includes Augmented Dickey Fuller and table 4 which consists of Phillips-Perron test. The analysis from the ADF indicates that in levels majority of the variables were not stationary however after first difference all the variables became stationary. Similar goes to the PP test whereby in levels the variables were non stationary and, after having firstly differencing them, the variables became stationary. Overall it can be concluded that orders of integration for all series in ADF and PP are in mixed order as they are integrated of order zero and order one.

4.2. Lag length criterion

After determining that most of the variables are integrated of order one, it is part of the process to determine whether there is existence of long run relationship among agricultural productivity and macroeconomic variables. Before carrying out the cointegration test, the Johansen procedure requires that lag length is determined. Therefore, the Table 5 shows different criterions to determine the lag length.

Table 5 confirms the criteria selected for equation (4) which chooses lag length 2 and for equation (5) the lag length selected is 1 and lastly lag length 2 is selected for equation (6). Thus, the Johansen cointegration test is conducted using the lag length selected for each equation.

4.3. Long run cointegration results

The second step of the analysis is to identify the presence of cointegration among variables using the Johansen (1991) cointegration technique after the series has been integrated. The purpose of performing this cointegration test in the study is to determine existence of the long run relationship between macroeconomic variables and agricultural productivity. Table 6 shows the results of Johansen cointegration test.

The results of both trace and maximum eigenvalue statistics tests are reported in Table 6 for all equations. Equation (4) includes variables such as LAGRI, LGDP, LGCF, GE and RINT. The trace and maximum eigenvalue statistics results of equation (4) highlight that there is at least one co-integrating vector that exists at 5% level of significant. The null hypothesis of no cointegrating vectors is rejected since the trace statistics of 93.444 is greater than 5% critical value of 88.803. Equation (5) is represented by LAGRI, LAX, REER, LGCF, GE and LGDP and RINT as variables, in both trace and maximum eigenvalue statistics tests it indicated two cointegrating vectors. The results show that they are significant at 5% level. LAGRI, CPI, LGDP, GE, REER and LM2 for equation (6) shows that trace test reflects to be having two cointegrating vectors at 5% level of significant similar to equation (5), however equation (4) indicated 1 cointegrating vector for

Tab. 3. Unit root results for Augmented Dickey Fuller test.

Variables	Formula	ADF			
		Levels	5% Critical value	1st difference	5% Critical value
AGRI	Intercept	-1.312	-2.935	-5.368**	-2.943
	Trend & intercept	-5.079**	-3.533	-5.293**	-3.524
AX	Intercept	-4.451**	-2.937	-14.923**	-2.939
	Trend & intercept	-7.008**	-3.527	-14.364**	-3.530
REER	Intercept	-1.191	-2.935	-5.431**	-2.937
	Trend & intercept	-3.823**	-3.527	-5.364**	-3.527
GCF	Intercept	-2.383	-2.935	-6.447**	-2.937
	Trend & intercept	-2.085	-3.524	-6.520**	-3.527
GDP	Intercept	-5.173**	-2.935	-7.315**	-2.939
	Trend & intercept	-6.845**	-3.524	-7.219**	-3.530
GE	Intercept	-1.875	-2.935	-6.905**	-2.937
	Trend & intercept	-2.026	-3.524	-6.937**	-3.527
RINT	Intercept	-3.324**	-2.939	-6.698**	-2.943
	Trend & intercept	-3.466	-3.530	-6.621**	-3.537
CPI	Intercept	-4.926**	-2.935	-3.528**	-2.937
	Trend & intercept	0.120	-3.524	-5.291**	-3.527
M2	Intercept	-2.521	-2.937	-2.906	-2.937
	Trend & intercept	0.996	-3.530	-3.968**	-3.527

Notes: Reported values under levels and first difference are ADF t-statistics values.
* Statistically significant at 1% level.
** Statistically significant at 5% level.
*** Statistically significant at 10% level.

Tab. 4. Unit root for Phillips- Perron test.

Variable	Formula	PP			
		Levels	5% Critical value	1st difference	5% Critical value
AGRI	Intercept	1.275	-2.935	-11.006**	-2.937
	Trend & intercept	-3.746**	-3.524	-10.740**	-3.527
AX	Intercept	-3.993**	-2.937	-15.064**	-2.939
	Trend & intercept	-6.096**	-3.527	-14.364**	-3.530
REER	Intercept	-0.973	-2.935	-5.905**	-2.939
	Trend & intercept	-3.059	-3.524	-5.735**	-3.527
GCF	Intercept	-2.371	-2.935	-6.551**	-2.937
	Trend & intercept	-2.025	-3.524	-7.520**	-3.527
GDP	Intercept	-5.177**	-2.935	-24.180**	-2.937
	Trend & intercept	-6.918**	-3.524	-25.654**	-3.527
GE	Intercept	-1.911	-2.935	-6.905**	-2.937
	Trend & intercept	-1.996	-3.524	-7.018**	-3.527
RINT	Intercept	-3.322**	-2.939	-8.599**	-2.941
	Trend & intercept	-3.496	-3.530	-8.513**	-3.533
CPI	Intercept	-4.346**	-2.935	-3.444**	-2.937
	Trend & intercept	0.038	-3.524	-5.266**	-3.527
M2	Intercept	-2.919	-2.935	-2.864	-2.937
	Trend & intercept	1.956	-3.524	-3.701**	-3.527

Notes: Reported values under levels and first difference are ADF t-statistics values.
* Statistically significant at 1% level.
** Statistically significant at 5% level.
*** Statistically significant at 10% level.

Tab. 5. Lag length criterion.

Equation	Lag	Log L	LR	FPE	AIC	SC	HQ
4	1	20.934	NA	8.64e-07*	0.220*	2.883	1.473
	2	36.945	23.368	1.49e-06	0.706	1.308*	0.603*
	3	54.318	20.660	2.69e-06	1.118	4.383	2.269
5	1	25.925	NA	6.96e-08*	0.530*	2.082*	1.082*
	2	51.868	35.501	1.33e-07	1.060	4.162	2.164
	3	81.102	30.773	2.72e-07	1.416	6.070	3.072
6	1	87.667	NA	2.89e-09	-2.650	-1.140*	-2.099*
	2	132.349	61.867*	2.06e-09*	-3.095*	-0.024	-1.992
	3	165.607	35.817	3.30e-09	-2.954	1.653	-1.301

Notes: * indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.

Tab. 6. Unrestricted cointegration rank tests results.

Equation	Hypothesis Number of CE	Eigenvalue	Trace	Statistics	Maximum statistics	Eigenvalue
			Trace Statistics	0.05 critical value	Maximum eigenvalue Statistics	0.05 critical value
4	None	0.647	93.445**	88.804	38.517**	38.331
	At most 1	0.390	54.927	63.876	18.319	32.118
	At most 2	0.361	36.608	42.915	16.568	25.823
	At most 3	0.268	20.041	25.872	11.555	19.387
	At most 4	0.205	8.486	12.518	8.486	12.518
	Trace test indicates 1 cointegrating equation(s) at the 0.05 level. Max-eigenvalue test indicates 1 cointegrating equation(s) at the 0.05 level. * denotes rejection of the hypothesis at the 0.05 level.					
5	None	0.684	137.736**	117.708	44.902**	44.497
	At most 1	0.644	92.833**	88.804	40.279**	38.331
	At most 2	0.440	52.554	63.876	22.641	32.118
	At most 3	0.309	29.912	42.915	14.419	25.823
	At most 4	0.205	16.493	25.872	8.938	19.387
	At most 5	0.155	6.555	12.518	6.555	12.518
	Trace test indicates 2 cointegrating equation(s) at the 0.05 level. Max-eigenvalue test indicates 2 cointegrating equation(s) at the 0.05 level. * denotes rejection of the hypothesis at the 0.05 level.					
6	None	0.832	161.428**	117.708	69.560**	44.497
	At most 1	0.578	91.868**	88.804	33.602	38.331
	At most 2	0.523	58.266	63.876	28.885	32.118
	At most 3	0.307	29.380	42.915	14.322	25.823
	At most 4	0.234	15.058	25.872	10.419	19.387
	At most 5	0.112	4.638	12.518	4.638	12.518
	Trace test indicates 2 cointegrating eqn(s) at the 0.05 level. Max-eigenvalue test indicates 1 cointegrating equation(s) at the 0.05 level. * denotes rejection of the hypothesis at the 0.05 level.					

trace test. This kind of results for equation (6) has been influenced by CPI and LM2 whereas in equation (4) and equation (5) those two variables do not exist. Therefore, the study concludes that there is significant long run relationship between agricultural productivity and macroeconomic variables.

4.4. Vector Error Correction Model

In this study the dynamics of agricultural productivity in the short run are investigated and their adjustment speed parameter. Also, how agricultural productivity responds to long-run equilibrium after random shock using the Vector Error Correction Model. Table 7 includes the long run parameters while Table 8 includes short run parameters.

Table 7 represents long run parameters; those estimated parameters do determine whether there is positive or negative relationship existing between macroeconomic variables and agricultural productivity. For equation (4), it shows that in a long run 1% increase in LGDP leads to 0.084 increase in agricultural productivity. In terms of GE a 1% increase will lead to a 1.212 increase in agricultural productivity. Also, an increase of 1% in LGCF will lead to a 0.475 increase in agricultural productivity. Lastly, a 1% increase in RINT will lead to 0.004 increase in agricultural productivity. In the long run all the variables of this model show a positive relationship with agricultural productivity. A 1% increase in LGDP for equation (5) will lead to -0.029 decrease in agricultural productivity. Also 1% increase in GCF will lead to -0.147 decrease in agricultural productivity. This indicates that LGDP and LGCF have a negative relationship with agricultural productivity in the long run. Whilst, on the other hand, 1% increase in GE will lead to a 0.134 increase in agricultural productivity. Furthermore, a 1% increase in LAX will lead to 0.055 increase in agricultural productivity.

Tab. 7. Long run parameter results.

ORDER	Equation 4 Coefficient	Equation 5 Coefficient	Equation 6 Coefficient
CONSTANT	5.92	2.034	37.81
TREND	0.038 (11.352)*	0.031 (6.676)*	0.059 (3.887)*
VARIABLES			
LGDP	0.084 (2.258)*	-0.029 (-1.547)	0.386 (7.996)*
GE	1.212 (3.326)*	0.134 (0.613)	3.364 (6.598)*
GCF	0.475 (2.621)*	-0.147 (-1.127)	-
RINT	0.004 (0.862)	-	-
LM2	-	-	0.835 (4.168)*
LREER	-	-	-0.004 (-2.798)*
CPI	-	-	-1.452 (-5.880)*
LAX	-	0.055 (0.921)	-

Notes: Values in brackets are t-statistics.
* Statistically significant at 1% level.
** Statistically significant at 5% level.
*** Statistically significant at 10% level.

In equation (5), since there was existence of more than one cointegrating vectors, it is not rational to take those unrestricted estimates of the vectors directly, as they are for long run parameter estimates. Thus, it is important that restrictions are imposed on the two vectors to obtain structural relationship among the variables. Therefore, the two cointegrating vectors that were established are shown in the following equation:

$$\Pi z_{t-1=\alpha\beta' z_{t-1}=} \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & 0 \\ \alpha_{31} & 0 \\ \alpha_{41} & \alpha_{42} \\ \alpha_{51} & \alpha_{52} \\ \alpha_{61} & \alpha_{62} \end{bmatrix} \begin{bmatrix} 1 & 0 & \beta_{31} & \beta_{41} & \beta_{51} & \beta_{61} \\ 0 & 1 & \beta_{32} & \beta_{42} & \beta_{52} & \beta_{62} \end{bmatrix} \begin{bmatrix} LAGRI_{t-1} \\ REER_{t-1} \\ LAX_{t-1} \\ LGCF_{t-1} \\ LGDP_{t-1} \\ GE_{t-1} \\ Constant \end{bmatrix} \quad (10)$$

In the first cointegrating vector, long run zero restriction was imposed on real effective exchange rate as it is a dependent variable in the second cointegrating vector. Also, zero restriction were imposing on agricultural productivity as it is dependent variable in the first cointegrating vector. The restrictions imposed do indicate that real effective exchange rate does not play an important role in determining agricultural productivity in South Africa. This implies that the study can have agricultural productivity equation without real effective exchange rate. In second equation we can have real effective exchange rate equation without agricultural productivity. The first long-run cointegration vector equation can be written as:

$$LAGRI= 0.649LAX+3.065\ LGCF+1.469LGDP+4.890GE-99.873 \quad (11)$$

In the long run a 1% increase in LAX increases agricultural productivity by 0.649. An increase of 1% in LGCF will lead to an increase of agricultural productivity by 3.065% and an increase by 1% in LGDP will lead to an increase of 1.469 towards agricultural productivity. Lastly, a 1% increase in GE will lead to an increase of 4.890 of agricultural productivity. Second long run cointegrating vector is presented by the equation below:

$$REER=2.708LAX-0.825LGCF+0.970LGDP+10.445GE-73.228 \quad (12)$$

The results of the second cointegration show that a 1% increase in LAX will lead to 2.708 increase in real effective exchange rate. LGCF has a negative impact on real effective exchange rate by -0.825. The 1% increase in GDP will lead to an increase of 0.970 towards real effective exchange rate. Lastly a 1% increase in GE will lead to increase of 10.445 of real effective exchange rate. However, it should be noted that the second cointegrating vector interpretation is not the interest of the study but was interpreted on the basis of econometrics purpose. Nonetheless, the first cointegrating equation results are of interest of this study.

Finally, equation (6) indicates that a 1% increase in LGDP will lead to 0.386 increase in agricultural productivity. Moreover a 1% increase in GE will lead to 3.364 increase in agricultural productivity in the long run. An increase of 1% in LM2 indicates an increase in 0.835 in agricultural productivity. However, with 1% increase in REER, agricultural productivity decreases by approximately -0.004, despite that, it resulted to be statistically significant. The equation reflects that CPI has a negative long run relationship with agricultural productivity. Consequently, the results suggest that a 1% increase in CPI decreases agricultural productivity by -1.452. The CPI indicates that it is statistically significant along with LGDP, GE and LM2.

Tab. 8. Short run parameters results.

ORDER	Equation 4 Coefficient	Equation 5 Coefficient	Equation 6 Coefficient
ECT	-0.466 (-3.504)*	-0.883 (-4.455)*	-0.243 (-2.508)*
VARIABLES			
D(LGDP)	5.714 (4.022)*	6.101 (3.516)*	3.045 (4.654)*
D(GE)	-0.081 (-0.095)	0.069 (0.563)	0.058 (1.109)
D(GCF)	0.373 (2.256)*	-0.216 (-0.818)	-
D(RINT)	0.790 (0.096)	-	-
D(LM2)	-	-	0.167 (0.262)
D(REER)	-	58.043 (2.525)*	17.761 (1.288)
D(CPI)	-	-	-0.026 (-0.407)
D(LAX)	-	-0.113 (-0.240)	-

Notes: Values in brackets are t-statistics.
* Statistically significant at 1% level.
** Statistically significant at 5% level.
*** Statistically significant at 10% level.

VECM results in Table 8 are presented to capture the short run dynamics in agricultural productivity equation and to determine the speed of adjustment. The results for equation (4) point out that the speed adjustment is approximately 46.6%. This implies that, if there is any deviation from equilibrium, only 46.6% of agricultural productivity is corrected in a single year as the variable moves towards restoring equilibrium. Equation (5) shows that the speed of adjustment is 88.3% whereas only that percentage can be corrected in one year. The ECT is also statistically significant at 1% level. Furthermore equation (5) imposed restrictions also in the short run since there was existence of two cointegrating vectors. Therefore, the exogeneity test results are presented in the table below which shows speed adjustment in long run equilibrium.

In Table 9, the exogeneity shows LR of 0.474 and probability of 0.490 which indicate that the equations are well specified. The error correction term of first cointegrating equation is negative with coefficient of -0.030 and t-statistics of -2.652 which is statistically significant. This implies that 3.0% of gap between agricultural productivity and equilibrium is eliminated every year. In the second cointegrating equation the error correction term in 0.032 and its t-statistics is 2.996, implying that 3.2% is adjusted in one year. The restrictions are imposed on real effective exchange rate and agricultural exports in cointegrating equation (10). This indicates that the study of agricultural productivity can function without those two variables. The coefficient of error term in equation (6) is found to be negative but statistically significant at 1% level. Approximately 24.3% of long-run disequilibrium is adjusted from lagged period

Tab. 9. Exogeneity test for Equation 10.

	Cointegrating equation 1	Cointegrating equation 2
ECT	-0.030 (-2.652)	0.032 (2.996)
D(LREER)	6.731 (5.196)	0.000 (NA)
D(AX)	0.017 (0.658)	0.000 (NA)
D(GCF)	-0.021 (-3.382)	-9.000 (0.007)
D(LGDP)	-0.492 (-4.849)	0.585 (-6.019)
D(GE)	0.003 (0.474)	-0.001 (-0.270)

LR test for binding restrictions (rank=2): $X^2 = 0.474$.
Probability = 0.490.

Tab. 10. Granger causality results.

Equation	Null hypothesis	Obs	Chi-Sq	Prob
4	Dlog_GDP does not granger cause Dlog_AGRI	37	5.374	0.068
	Dlog_AGRI does not granger cause Dlog_GDP	37	7.734	0.021**
	Dlog_GCF does not granger cause Dlog_AGRI	37	5.055	0.082
	Dlog_AGRI does not granger cause Dlog_GCF	37	2.091	0.352
	Dlog_GE does not granger cause Dlog_AGRI	37	13.323	0.001**
	Dlog_AGRI does not granger cause Dlog_GE	37	0.539	0.764
	Dlog_RINT does not granger cause Dlog_AGRI	37	5.048	0.080
	Dlog_AGRI does not granger cause Dlog_RINT	37	0.615	0.735
5	Dlog_REER does not granger cause Dlog_AGRI	39	0.119	0.730
	Dlog_AGRI does not granger cause Dlog _REER	39	0.647	0.421
	Dlog_AX does not granger cause Dlog _AGRI	39	2.901	0.089
	Dlog_AGRI does not granger cause Dlog_AX	39	0.899	0.343
	Dlog_GCF does not granger cause Dlog _AGRI	39	0.177	0.674
	Dlog_AGRI does not granger cause Dlog _GCF	39	1.070	0.301
	Dlog_GDP does not granger cause Dlog _AGRI	39	0.116	0.733
	Dlog_AGRI does not granger cause Dlog _GDP	39	1.070	0.301
	Dlog_GE does not granger cause Dlog _AGRI	39	4.289	0.038**
	Dlog_REER does not granger cause Dlog _GE	39	0.096	0.757
6	Dlog_CPI does not granger cause Dlog_AGRI	39	7.138	0.028**
	Dlog_AGRI does not granger cause Dlog_CPI	39	0.006	0.998
	Dlog_GDP does not granger cause Dlog_AGRI	39	9.755	0.008**
	Dlog_AGRI does not granger cause Dlog_GDP	39	5.703	0.058
	Dlog_GE does not granger cause Dlog_AGRI	39	18.103	0.000**
	Dlog_AGRI does not granger cause Dlog_GE	39	1.118	0.572
	Dlog_M2 does not granger cause Dlog_AGRI	39	1.398	0.497
	Dlog_AGRI does not granger cause Dlog_M2	39	5.663	0.059
	Dlog_REER does not granger cause Dlog_AGRI	39	2.078	0.354
	Dlog_AGRI does not granger cause Dlog_REER	39	1.961	0.375

Notes: Granger cause if P< 0.05.
* Statistically significant at 1% level.
** Statistically significant at 5% level.
*** Statistically significant at 10% level.

error shock. The diagnostic checks for the study were performed to the agricultural productivity models to validate the evaluation of parameter outcomes achieved by the three equations. In most of the checks the models have satisfied all the assumptions of linear modelling. Thus, after validating the parameters outcomes for the equations granger causality test is determined. According to Granger (1969) the test gives direction of casual association among the variables and it establishes directional causality between the two variables. Table 10 below gives an indication of causality results among the variables from equation (4), (5) and (6).

As stated by Erjavec and Cota (2003), if common trend exists between two variables then causality should exist in, at least, one direction. Therefore, after conducting the granger causality test in all three equations, the results show that government expenditure in all estimations granger causing agricultural productivity. It indicates that it is the most influential macroeconomic variable towards agricultural productivity. Following is gross domestic product in equation (4) and equation (6) whereas in equation (4) agricultural productivity granger causes gross domestic product and equation (6) is vice versa, where gross domestic product granger causes agricultural productivity. In equation (6) consumer price index granger causes agricultural productivity however the remaining variables do not have any casual relation with agricultural productivity. Overall, granger causality test results indicate that there is significant impact of macroeconomics variables towards agricultural productivity and vice versa. In summary, some of causalities in this study are similar to those of Kadir and Tunggal (2015).

5. CONCLUSION AND RECOMMENDATIONS

The purpose of this study was to investigate the impact of macroeconomic variables towards agricultural productivity in South Africa. On the estimation technique, the study employed VECM procedures for the period covering 1975 to 2016 using annual data. The results of Johansen cointegration show that there is long run relationship existing among variables within the three equations estimated. Furthermore, results from VECM indicated a positive relationship between most of macroeconomic variables and agricultural productivity, thus showing that an increase in GE, LGCF, LAX, LGDP and LM2 will lead to a certain increase of agricultural productivity.

The study has also determined the speed of adjustment for each estimated model, showing the correct expected signs. The equation (4) revealed a 46.6% convergence towards equilibrium in the long run compared to equation (5) of 88.3% and equation (5) of 24.3%. This concluded that equation (6) has the lowest speed of adjustment compared to other equations. Furthermore, the study applied granger causality and it was found that there is causality existing between macroeconomic variables and agricultural productivity in South Africa. It is on this base that the study recommends that government spend more on agricultural sector so that the sector can be able to acquire advanced machineries to increase its productivity. Also, policy makers should encourage the use of those machineries for the sector to maximize their production. As per estimation of results, the more productivity of the agricultural sector the more products can be exported to other countries, leading to an increase of foreign earnings. Moreover, increased capital formation through investment on labor, land and other agricultural machineries will tend to increase productivity, as it will enable farmers to use resources efficiently. Policy makers should also ensure sufficient financial support from both private and public sector as it can guarantee maximum productivity and development of the agricultural sector. This study could not focus on all aspects impacting agricultural productivity in South Africa. For example, it investigated only certain key macroeconomic variables, rather than the environmental factors such as land, climate, soil and water which also have an impact on the productivity of agriculture. Due to the lack of sufficient and consistent available data some of the macroeconomic variables were not included in the study, however for future studies, when data become available some environmental variables which were left out in the study may be incorporated.

REFERENCES

Abba M., Barros C., Mosca J. (2015). The macroeconomy and agricultural production in Mozambique. *Basic Research Journal of Agricultural Science and Review*, 4 (8): 246-255. Available at: https://basicresearchjournals.org/agric/pdf/Abbas%20et%20al.pdf (accessed 05 November 2018).

Awan A.G., Alam A. (2015). Impact of agriculture productivity on Economic growth. A case study of Pakistan, 5(7). Available at: https://iiste.org/Journals/index.php/IEL/article/viewFile/23896/24467 (accessed 10 November 2016).

Awokuse O.T. (2009). Does Agriculture Really Matters for Economic Growth in Developing Countries? 2009 Annual Meeting, July 26-28, Agricultural and Applied Economics Association. Available at: https://core.ac.uk/download/pdf/7130483.pdf (accessed 08 November 2016).

Bentivoglio D., Finco A., Bucci G. (2018). Factors affecting the Indonesian Palm Oil Market in Food and fuel industry: Evidence from a time series analysis. *International Journal of Energy Economics and Policy*, 8(5): 49-57. Available at: https://www.econjournals.com/index.php/ijeep/article/download/6795/3924 (accessed 08 November 2018).

Bhide S., Rajeev M., Vani B. (2005) Do Macroeconomics Conditions Matter for Agriculture. The Indian Experience. Institute for Social and Economic Change. 55(4): 647-670. DOI: 10.1142/s0217590810003997

Bureau for Food and Agricultural Policy (2011). The South African Agricultural Baseline. Available at: http://www.sagis.org.za/BFAP_2011.pdf (accessed 10 December 2016).

Brownson S., Vincent I., Emmanuel G., Etim D. (2012). Agricultural productivity and Macroeconomic variable fluctuation in Nigeria. *International Journal of Economics and Finance*, 4 (8). DOI: 10.5539/ijef.v4n8p114

Cristea M., Marcu N., Meghisan G. (2015). The Influence of Macroeconomic Variables on the Romanian agriculture. The publishing house of the Romanian academy, Available at: https://pdfs.semanticscholar.org/882f/e42656cbbfab88a4b033dc350846da85fa1e.pdf?_ga=2.158678136.333063144.1563612371-1311250018.1563612371 (accessed 11 January 2017).

Department of Agriculture Forestry and Fisheries (2015). Economic review on the South Africa African agriculture. Pretoria. Available at: https://www.daff.gov.za/Daffweb3/Portals/0/Statistics%20and%20Economic%20Analysis/Economic%20Analysis/Economic%20Review_2014_15.pdf (accessed 05 December 2016)

Department of Agriculture Forestry and Fisheries (2017). Trends in the agricultural sector. Available at: https://www.daff.gov.za/Daffweb3/Portals/0/Statistics%20and%20Economic%20Analysis/Economic%20Analysis/Economic%20Review%202016_17.pdf (accessed 02 August 2017).

Debrew J.H., Cervantes-Godoy D. (2010). Economic Importance of Agriculture for Poverty Reduction. *OECD Food, Agriculture and Fisheries Working Papers* No. 23. OECD Publishing. DOI:10.1787/5kmmv9s20944-en

Dickey D.A., Fuller W.A. (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root, *Journal of the America Statistics Association*, 74 (366): 427-431. DOI: 10.2307/2286348

Dritsakis N. (2003). The agricultural sector in the Macroeconomic Environment. An Empirical Approach for EU. University of Macedonia, 1(4). Available at https://ideas.repec.org/a/ags/aergaa/26419.html (accessed 02 August 2017).

Eita J.H., Jordaan A.C. (2013). Real Exchange Rate Misalignment and Economic Perfomance in Namibia. Coporate Ownership and Control, 10(3). Available at: http://hdl.handle.net/2263/43869 (accessed 01 June 2018).

Enu P., Attah-Obeng P. (2013). Which macroeconomic factors influence agricultural production in Ghana? *Academic Research international*, 4 (5): 333-346. Available at: http://www.savap.org.pk/journals/ARInt./Vol.4(5)/2013(4.5-33).pdf (accessed 01 June 2018).

Erjavec N., Cota B. (2003). Macroeconomic Granger-casual dynamics in Croatia: Evidence based on a vector error-correction modeling analysis. *Ekonomski pregled*, 54(1-2): 139-156. Available at: https://hrcak.srce.hr/25291 (accessed 01 June 2018).

Granger C.W.J. (1969). Investigating Causal Relations by Econometric Models and Cross-Spectral Methods. *Journal of Econometrica,* 37: 424-38. DOI: 10.2307/1912791

Huffman W.E., Evenson R.E. (2001). Structural and Productivity Change in US agriculture, 1950-1982. Agricultural Economics, 24 (2):127-147. DOI: 10.1016/S0169-5150(00)00065-7

Johansen S. (1991). Estimation and Hypothesis Testing of Co-integration Vectors in Gaussian Vector Autoregressive Models. *Econometrica*, 59: 1551-1580. DOI: 10.2307/2938278

Johansen S. (1995). Likelihood-Based Inference in Cointegration Vector Auto-Regressive Models. *Economic Theory.* 14(4): 517-524. Available at: https://www.jstor.org/stable/pdf/3533216.pdf?refreqid=excelsior%3A2b38df47e9d037316b88a922d6f8fe62 (accessed 01 June 2018).

Kaabia M.B., Gil J.M. (2000). Short and long run effects on macroeconomic variables on the Spanish agricultural sector. *European review of Agricultural Economics.* 27 (4): 449-471. Available at: https://ideas.repec.org/a/oup/erevae/v27y2000i4p449-471.html (accessed 20 July 2018).

Kadir S.U.S.A., Tunggal N.Z. (2015). The impact of macroeconomic variables towards agricultural productivity in Malaysia. *South East Asia journal of Contemporary Business Economics and Law*. University of Malaysia Sabar, 8 (3):21-27. Available at: http://seajbel.com/wp-content/uploads/2016/01/Econ-13.pdf (accessed 01 June 2018).

Kargbo M.J. (2007). The effects of macroeconomic factors on South African agriculture. *Applied Economics*, 39(17): 2211-2230. DOI: 10.1080/00036840600735374

Letsoalo A., Kirsten J. (2003). Modeling the impacts of macroeconomic and trade policies on the South Africa agricultural sector. Agricultural Economic Association of South Africa. Available at: https://ageconsearch.umn.edu/record/19085/files/cp03le02.pdf (accessed 08 November 2016)

Mellor J.W. (1966). The Economics of Agricultural Development, American *Journal of Agricultural Economics*, 49(2): 533-535. DOI: 10.2307/1237235

Oyetade O., Applanaidu S.D., Abdul-Razak N.A. (2015). Macroeconomic factors and agricultural sector in Nigeria, University of Utara, Malaysia, Elsevier Ltd. DOI: 10.1016/j.sbspro.2016.05.035

Perron P. (1986). Trends and Random Walks in Macroeconomic Time Series: Further Evidence from a New Approach. Universite de Montreal, Department de sciences economiques. *Biometrika*, 75(2): 335-346. https://doi.org/10.1016/0165-1889(88)90043-7

Quantec (2017). RSA economic data. Available at: http://quanteceasydata.co.za, (accessed 01 December 2016).

Ramalai M., Mahlangu S., Tuit D. (2011). Agricultural productivity in South Africa: Literature

Review, Department of Agriculture Forestry and Fisheries. Available at: https://www.daff.gov.za/docs/GenReports/AgricProductivity.pdf (accessed 11 January 2017).

Schultz T.W. (1964). Transforming the Agriculture. *The Economic Journal,* 74(296):996-999. DOI: 10.2307/2228861.

Solow R.M. (1956). A contribution to the Theory of Economic Growth. *The Quarterly Journal of Economics*, 70: 65-94. DOI: 10.2307/1884513

Wang S.L., Heisey P., Schimmelpfennig D., Ball E. (2015). Agricultural Productivity Growth in the United States: Measurement, Trends and Drivers. U.S Department of Agriculture, Economic Research Service. Available at: https://ideas.repec.org/p/ags/uersrr/207954.html (accessed 01 July 2019).

World Bank (2017). South African dataset; World Economic Indicators. Available at: http:/data.worldbank.org. (accessed 03 March 2018).

World Trade Organisation (2017). Statistics database. Available at: http://stat.wto.org. (accessed 29 November 2016).

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Development of weather derivatives: evidence from the Brazilian soybean market

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Abstract. The purpose of this study is to design a weather derivative contract and evaluate the hedging efficiency into the Brazilian soybean market against lack of rainfall in the crop cycle. We adopt European put options with two different types of underlying rainfall index (equal-weighted index and growth-weighted index), using a dataset of daily precipitation and annual production for six areas located in the south of Brazil. Pricing follows the index modeling method, using the estimated payoff distribution for fair premium calculation. The contract premium varied from 10% to 15% of revenue per hectare. Results show that the adoption of the weather-based derivatives reduced the producers' income volatility substantially (around 30%).

Keywords: weather derivative, rainfall derivative, weather risk, soybeans.
JEL codes: G22, G32, Q02, Q14.

1. INTRODUCTION

Over the last decades, new risk management tools have been developed in order to help different types of businesses reduce income variability. The weather derivative is an example. Introduced in the late 1990s in the U.S., temperature derivative contracts have been used by the energy industry to protect against adverse weather conditions. Recently, weather risks have also been managed using derivatives based on rainfall, snowfall, wind, frost, hurricane, etc., attracting the attention of other industries such as agriculture, entertainment, tourism, construction, and retail (Jewson, Brix, 2005).

Focusing on agriculture, rainfall derivatives play a similar role to that performed by crop insurances. However, the advantage of these contracts over conventional crop insurances is their payoff structure, which depends exclusively on the occurrence of a specific weather event measured by an available index. Despite the correlation of weather events with yield variations, the payoff of the weather risk product is independent of crop yields, i.e. there is no loss adjustment at the farm-level. Consequently, moral hazard and adverse selection problems, which arise from information asymmetry and are inherent in crop insurances, are eliminated (Turvey, 2001; Vedenov, Barnett, 2004; World Bank, 2005). Nevertheless, even with these advantages, weather-based derivatives have low usage (Khan *et. al.*, 2013; Sibiko *et. al.* 2018). Leblois and Quirion (2013) point to some barriers that restrict the adoption of these contracts. Among several factors, one key element is the misunderstanding about the weather insurance design, highlighting issues related to farmers' educational background. In addition, basis risk has been pointed as a relevant concern for adopting weather derivatives[1] (Woodard, Garcia, 2008a). Under specific circumstances, weather basis risk could be significantly high, reducing hedging effectiveness.

Previous studies have investigated the use of weather derivatives in agriculture (Khan *et. al.*, 2013; Pelka, Musshoff, 2013; Musshoff *et. al.*, 2011; Zhou *et. al.*, 2018), including basis risk analysis and hedging effectiveness (Woodard, Garcia, 2008a; Torriani *et. al.*, 2008; Möllmann *et. al.*, 2019). However, little attention has been paid to the use of weather derivatives in agricultural activity in emerging markets, which play an important role in world commodity supply. Taking into account the current climate change scenario and considering the limited scope of crop insurances in these economies (in general, strongly dependent on government subsidies), the weather-related insurance products could offer new ways to manage risk in agricultural markets.

Therefore, the objective of this study is to design a rainfall put-option and evaluate the hedging efficiency in the soybean market in the south of Brazil. Brazil was chosen for its dynamism and importance in the international market, being responsible for around 1/3 of the worldwide soybean production in 2010s (USDA, 2019). In addition, the focus on the south of Brazil is particularly relevant since it is a traditional grain-producing region with an unstable weather. Furthermore, between 2010 and 2018, soybean crop responds around 40 to 50% of financial volume of agricultural insurances in Brazil, as well as south region responds around 25% of total insured areas in the country, reinforcing the importance of the analysis for this crop and region (MAPA, 2018).

Overall, our main hypothesis is that the use of this contract can reduce farmer income volatility, offering new risk management instruments for agricultural production. Using European put options and a dataset of daily precipitation and annual production from 1992 to 2016, our findings confirmed the hypothesis. Results suggest that the adoption of rainfall put-option reduced the producers' income volatility by around 30%.

2. LITERATURE REVIEW

Several recent studies have investigated the use of weather-based derivatives. A number of factors have stimulated these studies, such as the current climate change scenario, the increasing availability of alternative crop insurance products, and the expansion of derivative markets in different countries.

Previous studies have investigated the factors influencing the adoption of weather derivatives, as well as uncovering the characteristics and the limits associated to the use of such contracts. Seth *et. al.* (2009), for example, evaluated the use of weather derivatives among small farmers in India. Their findings show that the producers would be willing to pay a maximum premium equal to 8.8% of the payout of the operation for these instruments. In addition, Leblois and Quirion (2013) analyzed different experiences of using weather derivatives in India, Ethiopia, and Malaui. Despite positive results in terms of the number of insured producers, the authors question the benefits of these experiences, given the high costs of the programs and the difficulty in measuring the direct effects of adopting weather derivatives. Further, Khan *et. al.* (2013) explored the climate risk strategies by Canadian wheat producers. The authors verified that the low adoption of weather-based derivatives by producers is a result of lack of knowledge about these instruments - 59% of those who did not use index-based insurance were not aware of this type of contract. In line with these studies, Sibiko *et. al.* (2018) provided interesting points into this topic, evaluating the use of weather index insurance (WII) by farmers located in Embu County, Kenya. The authors observed that, even with the implementation of WII initiatives since 2009, the adoption of these insurance contracts by farmers was lower than 10%. The lack of understanding of the WII and the price of the insurance were pointed as some of the problems that impacted the demand for these contracts.

Another group of studies focused on hedging effectiveness. Vedenov and Barnett (2004), for example, investigated the efficiency of weather derivatives as insurance instruments in producing areas of maize, cotton, and soybean in the United States. They concluded that the effectiveness of such instruments varies sub-

[1] The basis risk arises from «the fact that the correlation between crop yield and the meteorological index cannot be perfect» (Leblois, Quirion, 2013, p.1). In general, this correlation is impacted by the spatial variability of the weather conditions considering meteorological station and hedged location. The nonlinear relationship between weather indexes and crop yield brings more complexity to this topic (Richards *et al.*, 2004). In addition, crop yield can be also impacted by biological factors (such as the occurrence of pests and diseases), which are not necessarily directly associated with weather events.

stantially across crops and regions. Berg *et. al.* (2006) focused the analysis on the potato market in Germany. The authors found that the hedge was less effective in situations of low correlation between the meteorological index (used in the derivative) and the crop yield. Further, Stoppa and Hess (2003) explored the adoption of rainfall derivatives by grain producers in Morocco. The use of a rainfall put option helped to protect producers' income losses caused by low rainfall. In addition, Zhou *et. al.* (2018) examined the effectiveness of rainfall index insurances on the crop yield risk, taking into account corn activity in Illinois, US. Findings suggested that the income variance decreased around 50% with the adoption of a weather-based insurance portfolio.

Turvey (2001) also contributed to this debate, comparing the efficiency of weather derivatives based on temperature and rainfall indexes for hay, maize, and soybean in Canada. Results suggested that such contracts helped to manage agricultural production risk, indicating that pricing must be location specific. Musshoff *et. al.* (2011) and Pelka and Musshoff (2013) conducted similar analysis, taking into account the German wheat market and temperature and rainfall-related option contracts. Their findings showed that the weather derivatives based on simple and mixed weather indices had high hedging effectiveness. Further, Shi and Jiang (2016) created a composite weather index insurance model, showing that such instruments consistently reduced yield risk in rice crops in China.

The aspects of weather basis risk have been also explored by a number of studies. Martin *et. al.* (2001), for example, evaluated the hedging effectiveness and basis risk of a flexible rainfall option in the U.S cotton market, showing that basis risk did not significantly undermine the benefits of these instruments. In addition, Woodard and Garcia (2008a) investigated the basis risk in the U.S. corn market, demonstrating that hedging effectiveness could increase by adopting basket weather derivatives from diverse locations. In a complementary study, Woodard and Garcia (2008b) provided new empirical evidence related to the use of weather derivatives, taking into account high levels of spatial aggregation. Results showed that the idiosyncratic risk decreases when production exposures were aggregated, suggesting a higher efficiency of weather derivatives for hedging yield exposures. These findings indicate the potential of weather derivatives in agriculture, particularly for reinsurers. In line with these studies, Torriani *et. al.* (2008) identified that, despite the occurrence of high basis risk, rainfall derivatives contributed to manage drought risks in grain maize production in Switzerland. Furthermore, Möllmann *et. al.* (2019) evaluated the adoption of weather derivatives using three remotely sensed vegetation indexes - vegetation condition index (VCI), temperature condition index (TCI) and vegetation health index (VHI). Focusing on the winter wheat production in Germany, the authors showed that the use of VHI- and VCI-based weather contracts reduced basis risk, improving hedging effectiveness.

Finally, weather-based derivatives were also examined in other markets. For instance, Chen *et. al.* (2006) and Deng *et. al.* (2007) evaluated the use of relative humidity and temperature derivatives to manage profit risk in dairy industry. Following the same idea, Cortina and Sánchez (2013), Cyr *et. al.* (2010), and Zara (2010) examined the use of temperature options in wine production in a context of climate changes. In addition, Štulec (2017) investigated the impact of the adoption of temperature options on beverage sales in Croatian food stores.

3. RESEARCH METHOD

The methodology used in this research is developed following three main steps. First, exploring the structure of the weather-based derivative. Second, developing a premium calculation. Third, analyzing hedge effectiveness. For a better understanding, the following sections provide a detailed discussion on these points.

3.1. Structure of the weather-based derivative

In order to reduce farmer income volatility, this study uses a European put option for the following reasons. First, considering the soybean activity in the south of Brazil, one of the most common risk events is based on droughts. Thus, put options can help to manage this type of risk, providing an indemnity if rainfall falls below a certain limit. Second, in order to enable a straightforward pricing method, along with considering the low chances of an early exercise of the put option, we adopted a European-style option. Consequently, this analysis is strictly focused on the risk of low precipitation, not assessing the risk of excessive rainfall events. In addition, the put option can only be exercised by hedgers (farmers) on the contract expiration date (at the end of the crop), not allowing early exercise. Under these conditions, three variables have to be defined to structure the weather-based derivative: underlying asset, strike price, and time to maturity. Based on such variables, the cost of rainfall insurance for the producer (known as an option premium) can be obtained.

According to Stoppa and Hess (2003) and Martin *et. al.* (2001), the weather hedging effectiveness increases as the correlation between the underlying asset of the contract (weather index) and the crop yield increases. Thus, the weather index must be able to explain most of the variability in crop yield. Consequently, the construction of the rainfall index (F_t) of the contract is weighted according to the stages of the crop – equation (1). Herein, the maximum correlation between the underlying rainfall index of the contract and the crop yield is achieved (Stoppa, Hess, 2003).

$$F_t = \sum_{i=1}^{12} \omega_i f_{it} \quad (1)$$

where ω_i is the weight given to each subperiod i of ten days, taking into account the Brazilian soybean crop cycle of 120 days (December to March), and f_{it} corresponds to the sum of daily rainfall for each subperiod i in the crop year t. The period was defined according to the 2017 Brazilian Agricultural Zoning.

The weights of the rainfall index are determined using an optimization problem – equation (2), which maximizes the correlation between the rainfall index and crop yield (Y).

$$max_{\omega_i} corr(F,Y) = \frac{\sum_t^T (F_t - \bar{F})(Y_t - \bar{Y})}{\left[\sum_t^T (F_t - F)^2\right]^{1/2}\left[\sum_t^T (Y_t - \bar{Y})^2\right]^{1/2}} \quad (2)$$

subject to $0 \leq \omega_i$, $\forall i$.

where t is the first year and T is the last year of the sample.

The study also uses an index of equal weights for each period of the plant's growth, giving the same importance to different cropping periods. In addition, to avoid inaccuracies from the calculation of the rainfall index, the study uses a limiting factor (equal to 75mm) of the daily capacity of water absorption by the soil (Fontana *et. al.*, 2001). Therefore, excessive rainfall cannot impact the result of the index.

After determining the underlying asset of the contract, the next step is to define the strike price of the option (K). This is given by the average rainfall index calculated between 1992 and 2016.

With respect to the payoff structure, the indemnity (I) is triggered when the index rainfall (F) falls below a specific strike (K) – equation (3). The payment is proportional to a previously defined maximum indemnity (θ). Summarizing, the greater the difference between the strike and the rainfall index, the greater the payoff (Stoppa and Hess, 2003; Musshoff *et. al.*, 2009).

$$I_t = \begin{bmatrix} 0 \;\; se \;\; F_t \geq K \\ \dfrac{K - F_t}{K} \;\; se \;\; F_t < K \end{bmatrix} \theta \quad (3)$$

At the limit, considering no rainfall, the producer receives the total indemnity, θ as defined by equation (4):

$$\theta = \left(\frac{1}{5} \sum_{i=1}^{5} Y_{t-i} \right) \times A_t \times P \quad (4)$$

The indemnity calculation takes into account a five-year moving average of crop yields (Y), in kg per hectare. In addition, A_t represents the harvested area in year t and P is the expected price of the soybean at the end of the contract. The price was fixed at US$ 0.346/kg, thus the effect on the producer's financial result is solely a consequence of the change in productivity. In other words, the focus of this study is strictly based on yield risk. The protection against adverse price fluctuations should be done using other risk management tools. This price corresponds to the average of the future prices for soybean nearby futures contracts from the CME Group (Chicago Mercantile Exchange) between 1993 and 2016.

3.2. Option pricing and hedge effectiveness

The option pricing approach is based on index modelling, following Jewson and Brix (2005) and Musshoff *et. al.* (2011)[2]. Firstly, the empirical distribution of the rainfall indexes is derived from the historical data, obtaining the distribution parameters. Given these parameters, 10,000 Monte Carlo simulations are carried out to achieve random values of the rainfall indexes, and then hypothetical payoffs are analyzed. The fair value of the rainfall put-option is the average of the hypothetical payoffs.

The hedging effectiveness is examined by calculating the relative reduction of the producers' risk exposure (standard deviation of the soybean revenue) since using the weather-based derivative. The producer's revenue in year $t(R_t)$ assuming that the rainfall derivative is not used, is given by the farm production φ_t multiplyed by the price of the soybean (P_t) – equation (5). As mentioned in section 3.1, a fixed price is used.

$$R_t = \varphi_t \times P_t \quad (5)$$

With the use of the rainfall put option, the producer's income in year $t(R_t^*)$ is given by equation (6), where the indemnity (I_t), received by the producer in year t, is included, subtracting the premium paid for the weather derivative (pr). Since the option premium is paid for previously, when it is purchased, this amount is updated to the expiration date of the contract, using an annual risk-free interest rate (equal to 4%).

$$R_t^* = R_t + I_t - pr \bullet e^{r \cdot \Delta t} \tag{6}$$

Based on yearly revenues from 1992 to 2016, the average and the standard deviation of these series are obtained comparing the result of the operations with and without the use of weather derivatives. The effect of the basis risk on hedge effectiveness is also investigated, comparing the revenue of the farmers located in cities with weather stations and with no weather stations. Finally, the study investigates the insurance claims, evaluating the indemnities paid and premiums received by the insurance company during the period 1992-2016.

3.3. Data

A dataset of daily precipitation and annual production are used. Six important producing areas in the south of Brazil are considered - Cruz Alta, Santa Maria, São Luiz Gonzaga, Cachoeira do Sul, Tupanciretã, and Vacaria, which are located in the state of Rio Grande do Sul – Appendix Figure A.1. The study focuses on this area because it consists of a traditional soybean producing region, which is characterized by unstable weather, since the climate is subtropical and highly influenced by polar air masses.

In the first three cities, there are rainfall stations. On the other hand, in the last three, there are no stations, being necessary to use the data of the nearest rainfall station. Table 1 presents the distances between these two groups of cities.

The daily precipitation data are provided by the Brazilian Institute of Meteorology (INMET), for the period between January 1st 1992 and December 31st 2016. The soybean production data are obtained from the Brazilian Institute of Geography and Statistics (IBGE) and prices are provided by the CME Group, between 1992 and 2016.

Tab. 1. Distance (in miles) between the cities considered in the study.

	Cities with rainfall station			
	Areas	Cruz Alta	Santa Maria	São Luiz Gonzaga
Cities with no rainfall station	Cachoeira do Sul	105.92	53.69	170.37
	Tupanciretã	35.18	51.51	74.10
	Vacaria	161.54	185.88	246.59

Note: the distances were calculated using the stations' location and the central areas of the cities

4. RESULTS

4.1. Rainfall indexes

Table 2 shows the evolution of the two rainfall indexes during the 1992-2016 period, except for 2001, due to a lack of complete data. The first index, an equal-weighted index, gives the same importance to different cropping periods. The second, a growth-weighted index, takes into account different weights, depending on the stage of the soybean crop cycle. Both indexes were only calculated for three producing areas (Cruz Alta, Santa Maria, Luiz Gonzaga), since these are the only ones with meteorological stations. Results indicate high variability of both indexes. We observe years (for example, 2005 and 2012) with low precipitation and, consequently, low index values. On the other hand, there are years (1998 and 2016) with excessive rainfall, resulting in higher index values.

Tab. 2. Cumulative rainfall indexes between December and March during 1992-2016.

Year	Cruz Alta		Santa Maria		São Luiz Gonzaga	
	Equal-weighted index	Growth-weighted index	Equal-weighted index	Growth-weighted index	Equal-weighted index	Growth-weighted index
1992	70.3	60.2	58.6	58.5	-	-
1993	52.1	65.8	52.6	48.2	54.4	61.0
1994	57.4	40.2	50.6	44.2	66.2	56.4
1995	46.0	57.3	46.6	60.2	43.3	49.9
1996	51.9	48.7	61.1	43.4	62.0	52.8
1997	32.5	28.8	46.3	34.2	49.0	56.5
1998	80.1	62.0	79.1	68.9	95.3	67.7
1999	36.9	43.0	37.4	19.5	35.4	28.8
2000	36.9	43.0	55.1	53.4	53.7	44.3
2002	42.2	36.6	44.7	49.2	46.4	25.3
2003	94.8	94.4	79.0	81.1	71.7	69.2
2004	45.7	38.3	45.0	29.3	37.9	41.8
2005	23.1	20.8	18.9	14.1	31.6	27.4
2006	45.2	45.2	35.4	41.6	43.1	34.9
2007	43.5	48.5	47.2	59.4	61.3	65.7
2008	23.9	32.1	43.4	46.1	35.4	43.8
2009	33.2	39.0	40.9	47.2	28.5	35.8
2010	56.5	67.9	70.6	62.3	75.5	99.0
2011	80.2	77.2	42.1	51.8	54.5	57.4
2012	20.2	18.2	27.2	16.9	16.6	15.3
2013	74.3	83.4	60.4	54.6	76.7	87.7
2014	49.2	50.6	45.5	52.2	54.4	63.1
2015	61.3	87.0	57.4	61.9	71.9	81.5
2016	79.9	91.4	61.3	63.4	94.0	89.2

Tab. 3. Weights for each 10-day period during the soybean crop cycle.

Period	Month											
	December			January			Febuary			March		
	34	35	36	1	2	3	4	5	6	7	8	9
Santa Maria	0.16	0.05	0.06	0.10	0.00	0.00	0.00	0.02	0.25	0.11	0.06	0.19
Cruz Alta	0.00	0.12	0.12	0.19	0.16	0.03	0.00	0.04	0.07	0.12	0.03	0.13
S. L. Gonzaga	0.04	0.14	0.05	0.19	0.13	0.06	0.00	0.14	0.09	0.09	0.03	0.05

Table 3 shows the weights of each of the 12 10-day periods, between December and March, for the growth-weighted index - equation (2). Based on these weights, the index-yield correlation was maximized. In general, the weights were higher at the initial and final stages of the crop cycle, when, respectively, sowing and flowering/physiological maturation of the soybean crop take place. These stages are the most sensitive to water shortages - yield tends to be drastically reduced in case of a water shortage during flowering and physiological maturation of the plant (Mudstock, Thomas, 2005).

The rainfall index-yield correlations are given in Table 4. Taking into account the cities with rainfall station, Santa Maria exhibited the lowest correlations, 0.41 (0.62) for equal-weighted (growth-weighted) index. On the other hand, the cities of Cruz Alta and São Luiz Gonzaga showed higher correlations and smaller differences among each other. The correlation obtained from the equal-weighted index (growth-weighted) exceeded 0.70 (0.85) for both cities - i.e. the rainfall index could explain a significant proportion of yield variations in these areas.

In the cities with no meteorological stations (Cachoeira do Sul, Tupanciretã, Vacaria), we use the index of the closest city with a weather station to obtain the correlations. For Cachoeira do Sul, we assume data from Santa Maria, while for Vacaria and Tupanciretã, we take into account Cruz Alta index (Tab. 2). The highest coefficients were observed in Tupanciretã, given that it is located closer to the station located in Cruz Alta (around 35 miles).

Tab. 4. Correlation coefficient between rainfall index and soybean yield.

	City	Equal-weighted index	Growth-weighted index
With rainfall stations	Santa Maria	0.42	0.63
	Cruz Alta	0.76	0.87
	São Luiz Gonzaga	0.73	0.83
With no rainfall station	Cachoeira do Sul	0.45	0.69
	Tupanciretã	0.68	0.85
	Vacaria	0.54	0.75

As expected, and in line with previous studies (e.g. Stoppa, Hess, 2003; Martin *et. al.*, 2001), the growth-weighted index exhibited higher correlations for all regions of the study. In other words, this index showed better performance in explaining the variability of soybean yield, since it considers different weights for each stage of plant´s growth.

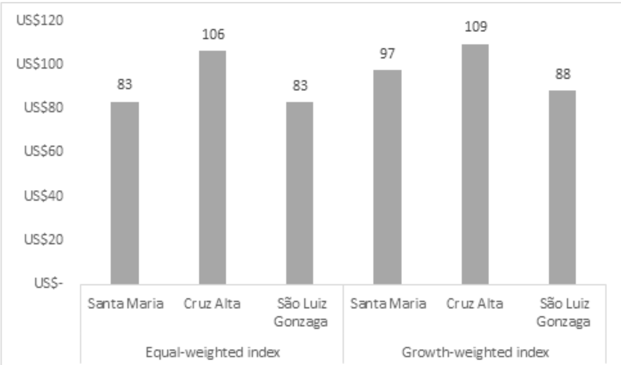
4.2. Premium calculation

In line with the methodology presented by Jewson and Brix (2005), the Jarque Bera, Komogorov-Smirnov and Shapiro-Wilk tests were carried out in order to validate if the rainfall indexes are normally distributed. Considering a 5% significance level, all of the tests indicated that both indexes have normal distribution (Appendices Tab. A.1., A.2. and A.3.). Based on the indexes parameters Monte Carlo simulations were simulated for each of the distributions. For each index, 10,000 simulations were applied and payoffs were obtained for each type of contract. Thus, the fair premium of the derivative was estimated as the expected value of the distribution of the payoffs. Figure 1 shows the estimated average premium paid by the producer.

Overall, the option premium changed according to the structure of the contract. Contracts based on the growth-weighted index were priced higher. This reflected the greater protection capacity of the contract given the higher rainfall index-yield correlation.

In addition, Table 5 shows that the ratio between the option premium and the producer's revenue was higher (lower) for the growth-weighted (equal-weighted) index in the city of Tupanciretã (Santa Maria). Overall, the cost of insurance was very high for all contracts, ranging from 10% to 14% (12% to 15%) of revenue per hectare for the contracts based on equal-weighted index (growth-weighted index).

Fig. 1. Average premium (US$/hectare) of put options during 1992-2016.



Tab. 5. Average ratio between option premium and producer revenue during the 1992-2016 period.

	City	Equal-weighted index	Growth-weighted index
With rainfall stations	Santa Maria	*10.68%*	*12.56%*
	Cruz Alta	*13.97%*	*14.31%*
	São Luiz Gonzaga	*13.83%*	*14.66%*
With no rainfall station	Cachoeira do Sul	*10.84%*	*12.74%*
	Tupanciretã	*14.06%*	*15.14%*
	Vacaria	*14.04%*	*14.38%*

4.3. Weather derivatives performance

A reduction in income variability was verified when the producer used the rainfall put option (Table 6). The revenue fluctuation decreased between 10% and 37%, depending on the city and the contractual structure. The cities in which the index-yield correlation was higher (Cruz Alta, São Luiz Gonzaga and Tupanciretã) showed higher reductions in income volatility - above 20% (30%) for contracts with the equal-weighted index (growth-weighted index).

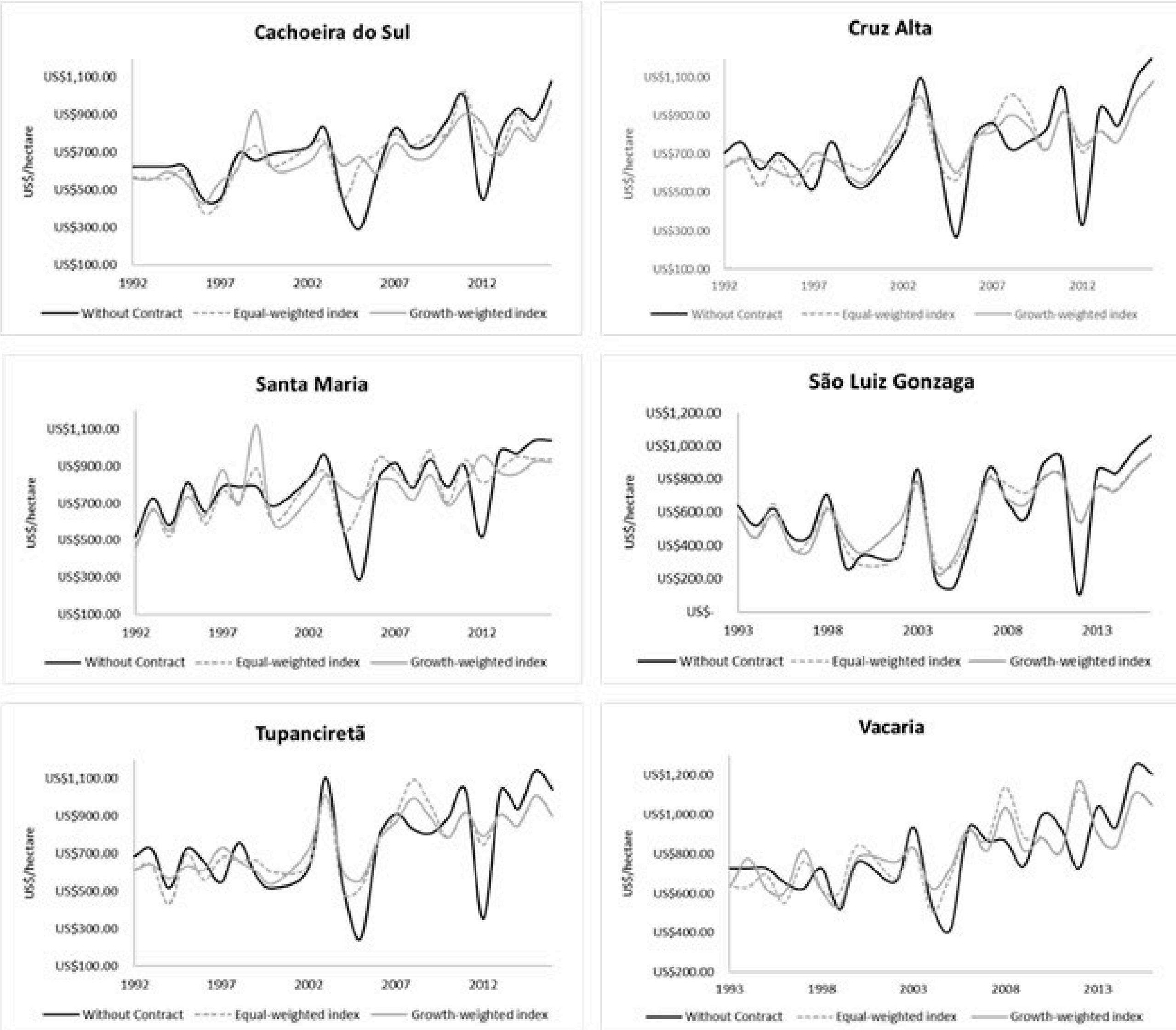
The fall in income variance was larger for the growth-weighted index. The best result occurred in the city of Cruz Alta, exhibiting a reduction of 36.71% (growth-weighted index), while the least expressive result was found in Vacaria, with a reduction of 10.12% (equal-weighted index). The result for Vacaria can be explained by the large distance of this city from the closest meteorological station (around 162 miles). In addition, the amount paid for the rainfall option had no relevant influence on income over time.

Figure 2 shows that the use of weather derivatives stabilized the producer income during the period of 1992-2016. Thus, the use of these contracts would allow a better return predictability of the activity, even in situations of significant water shortage. In certain years, 2005 and 2012, rainfall showed a relevant decrease, resulting in significant reductions in soybean productivity among the regions. Thus, this would particularly affect those producers that did not adopt the rainfall put option. However, the contracts based on an equal-

Tab. 6. Average standard deviation of income per hectare (US$/hectare) and average income per hectare (US$/hectare) from 1992 to 2016.

City	Without contract ($/hectare) (A)	With contract / Equal-weighted index ($/hectare) (B)	Percent change (B *versus* A)	With contract / Growth-weighted index ($/hectare) (C)	Percent change (C *versus* A)
Average standard deviation of income					
Cachoeira do Sul	191.07	160.68	*-15.90%*	136.59	*-28.51%*
Cruz Alta	226.97	158.44	*-30.20%*	143.64	*-36.71%*
Santa Maria	185.27	152.20	*-17.85%*	144.35	*-22.03%*
S. L. Gonzaga	282.37	212.47	*-24.76%*	194.26	*31.20%*
Tupanciretã	237.33	182.18	*-23.24%*	154.34	*-34.97%*
Vacaria	202.53	182.03	*-10.12%*	166.83	*-17.63%*
Average income					
Cachoeira do Sul	693.37	694.68	*0.19%*	699.31	*0.86%*
Cruz Alta	754.87	759.82	*0.66%*	763.38	*1.13%*
Santa Maria	777.83	777.68	*-0.02%*	775.65	*-0.28%*
S. L. Gonzaga	598.65	598.31	*-0.06%*	600.92	*0.38%*
Tupanciretã	750.15	752.96	*0.37%*	756.86	*0.89%*
Vacaria	800.63	801.6	*0.12%*	805.46	*0.60%*

Fig. 2. Evolution of income per hectare (US$/hectare) by city from 1992 to 2016.



weighted index and growth-weighted index were able to maintain soybean crops revenue at historical levels.

The analysis of average contractual claims shows the potential financial sustainability of the operation from the point of view of insurance companies. During the 1992-2016 period, the average of the indemnity-premium ratio exceeded 100% for most of the contracts based on the growth-weighted index, albeit by a narrow margin. Table 7 indicates the years in which these ratios exceeded 100%, showing that the contract could provide highly negative financial results for the insurance company, despite being compensated for in other periods (years). These simulations ignored the administrative costs and profits for the insurance companies. As an alternative to resolving these issues, the insurance companies could vary the strike price, adjusting the risk of the contract. However, on the other hand, this adjustment would result in a lower hedge performance for the farmer.

Finally, the impact of the distance of the weather station on hedge effectiveness was relevant, in agreement with Woodard and Garcia (2008a), pointing that the remote weather stations would entail high transaction costs and render contracts infeasible. As shown in Table 8, hedge effectiveness decreased significantly when the distance was greater than 150 miles from the station used for data collection.

For the city of Vacaria, where all stations are located more than 150 miles away, none of the contracts were

Tab. 7. Average of the indemnity-premium ratio during the 1992-2016 period.

City	Equal-weighted index	Growth-weighted index
Cachoeira do Sul	*93.18%*	*91.87%*
Cruz Alta	*99.60%*	*104.10%*
Santa Maria	*93.18%*	*91.87%*
São Luiz Gonzaga	*96.92%*	*100.35%*
Tupanciretã	*99.61%*	*104.12%*
Vacaria	*99.61%*	*104.12%*

able to reduce volatility by more than 20%. In addition, the contract based on the furthest station (São Luiz Gonzaga, approximately 247 miles away) presented the worst result for both indexes. On the other hand, the city of Tupanciretã, which has three stations under 75 miles away presented a decrease in the income standard deviation of more than 25%, using the growth-weighted index. The highest value, at almost 35%, was found when the rainfall index from the closest station (Cruz Alta) was used.

The results obtained confirm the hypothesis that the basis risk must be treated with caution when creating weather derivatives based on rainfall indexes. This is due to the existence of different edaphoclimatic structures in the regions considered. Overall, findings suggest that hedge effectiveness was reduced when the distances between the producing areas and the weather station were higher, as shown by Woodard and Garcia (2008a; 2008b) and Deng *et. al.* (2007). However, this loss is only relevant for large distances, which would be easily mitigated by installing meteorological stations in different regions, resulting in a fall in the contracts' basis risk (Collier *et. al.*, 2009).

5. CONCLUSIONS

The use of weather derivatives as risk management tools in Brazilian agribusiness is almost non-existent. Thus, the development of new and more efficient contracts can result in new elements to improve producers' decisions and to benefit the management of agricultural activity. In this context, this study analyzed the viability of using rainfall put options as a risk management tool in southern Brazilian soybean production.

A put option was structured with the underlying asset based on two types of rainfall indexes: growth-weighted and equal-weighted. Findings showed that the growth-weighted index exhibited greater hedging efficiency. The pricing of the contracts reflects this fact, given the higher premiums for this type of insurance. Similar results were obtained by Stoppa and Hess (2003), Pelka and Musshoff (2013), Shi and Jiang (2016) and Torriani *et. al.* (2018) when analyzing the crop production risks in several markets.

Using a rainfall derivative, producers were able to reduce their climate risk, resulting in a significant fall in income variation per hectare. A large proportion of the producers' losses during periods of low rainfall were recovered, without a decrease in income. However, the cost of insurance was high for all contracts simulated in the study, ranging from 10% to 15% of revenue per hectare. In addition, with regards to the financial sustainability of the contract, results suggest that without a risk adjustment the contract can be unsustainable in the long run, since the indemnity-premium ratio exceeded 100% in most of the growth-weighted contracts.

Finally, we also observed that basis risk is a key challenge for weather-based derivatives. The hedging effectiveness was lower when distances were above 150 miles from the meteorological stations used in the contract. These results reinforce the importance of well-designed contracts developed for hedging weather issues in the agricultural markets. Regions with different climatic conditions or distinct geographical characteristics can be affected differently by rainfall patterns and cause a significant change in hedge effectiveness, according to the findings of Musshoff *et. al.* (2011).

The study provides useful insights for risk management strategies adopted by producers, insurance companies and other players along the soybean production

Tab. 8. Average variation in the standard deviation of income per hectare from 1992 to 2016.

	Cruz Alta		Santa Maria		São Luiz Gonzaga	
	Equal-weighted index	Growth-weighted index	Equal-weighted index	Growth-weighted index	Equal-weighted index	Growth-weighted index
Cachoeira do Sul	*-15.04%*	*-26.99%*	*-15.90%*	*-28.51%*	*-16.37%*	*-12.63%*
Tupanciretã	*-23.24%*	*-34.97%*	*-19.78%*	*-33.22%*	*-20.58%*	*-25.82%*
Vacaria	*-10.12%*	*-17.63%*	*-12.44%*	*-19.46%*	*-9.93%*	*-10.24%*

chain. Insights from this research can be particularly helpful for policy makers in the conduction of agricultural policies related to risk management. In this context, previous studies have indicated the key role of the institutional and regulatory environment in stimulating insurance and related markets (Stoppa and Hess, 2003; Leblois and Quirion, 2013; Henderson, 2002).

The findings of this study may also be relevant for soybean market players in Argentina and Paraguay, since part of their production is located near the areas considered in this study. Thus, the development of a weather contract based in south of Brazil can, at least partially, help a number of players located in these countries to manage their risks.

Finally, the results provide interesting points for academic discussion regarding weather derivatives and their use in agricultural activity. Future research can explore the potential benefits and limitations of the weather derivatives in hedging strategies for several crops and areas. Moreover, an important issue to investigate is the analysis of the adoption of mixed-based weather derivatives, which in turn use composite weather indexes, considering the potential to reduce basis risk. Further, the efficiency of these strategies can be evaluated from the insurers' perspectives, investigating the financial sustainability of these operations.

REFERENCES

Berg E., Schmitz B., Starp M., Trenkel H. (2006). Weather derivatives as a risk management tool in agriculture. In: Cafiero C.; Cioffi A. (Org.). *Income Stabilization in Agriculture. The Role of Public Policies*. Edizione Scientifiche Italiane. Italy, 379-396.

Chen G., Roberts M.C., Thraen C.S. (2006). Managing dairy profit risk using weather derivatives. *Journal of Agricultural and Resource Economics*, 31(3): 653-666. Available at: https://www.jstor.org/stable/40987341 (accessed 04 October 2018).

Collier B., Skees J., Barnett B. (2009). Weather index insurance and climate change: opportunities and challenges in lower income countries. *The Geneva papers on Risk and Insurance Issues*, 34(3): 401-424. DOI: 10.1057/gpp.2009.11

Cortina E., Sánchez I. (2013). Hedging late frost risk in viticulture with exotic options. *Agricultural Finance Review*, 73(1): 136-160. DOI: 10.1108/00021461311321366

Cyr D., Kusy M., Shaw A.B. (2010). Climate change and the potential use of weather derivatives to hedge vineyard harvest rainfall risk in the Niagara Region. *Journal of Wine Research*, 21(3): 207-227. DOI: 10.1080/09571264.2010.530112

Deng X., Barnett B.J., Vedenov D.V., West J.W. (2007). Hedging dairy production losses using weather-based index insurance. *Agricultural Economics*, 36(2): 271-280. DOI: 10.1111/j.1574-0862.2007.00204.x

Embrapa (2017). Zoneamento de risco climático, 2017. Available at: http://indicadores.agricultura.gov.br/zarc/index.htm (accessed 04 February 2017).

Fontana D.C., Berlato M.A., Lauschner M.H., Melo R.W.D. (2001). Modelo de estimativa de rendimento de soja no Estado do Rio Grande do Sul. *Pesquisa Agropecuária Brasileira*, 36(3): 399-403. DOI: 10.1590/S0100-204X2001000300001

Henderson R. (2002). *Weather risk management: Markets, products and applications*. Palgrave Macmillan: New York, NY.

Jewson S., Brix A. (2005). *Weather derivative valuation. The meteorological, statistical, financial and mathematical foundations*. Cambridge University Press, UK.

Jewson S., Caballero R. (2003). Seasonality in the statistics of surface air temperature and the pricing of weather derivatives. *Meteorological Applications*, 10(4): 367-376. DOI: 10.1017/S1350482703001105

Khan S., Rennie M., Charlebois S. (2013). Weather risk management by Saskatchewan agriculture producers. *Agricultural Finance Review*, 73(1): 161-178. DOI: 10.1108/00021461311321375

Leblois A., Quirion P. (2013). Agricultural insurances based on meteorological indices: realizations, methods and research challenges. *Meteorological Applications*, 20(1): 1-9. DOI: 10.1002/met.303

MAPA – Brazilian Ministry of Agricultural, Livestock and Forestry (2018). Rural Insurance Atlas. Available at: http://indicadores.agricultura.gov.br/atlasdoseguro (accessed 17 March 2019).

Martin S.W., Barnett B.J., Coble K.H. (2001). Developing and pricing precipitation insurance. *Journal of Agricultural and Resource Economics*, 26(1): 261-274. Available at: https://ageconsearch.umn.edu/record/31155/ (accessed 05 March 2019).

Möllmann J., Buchholz M., Musshoff O. (2019). Comparing the hedging effectiveness of weather derivatives based on remotely sensed vegetation health indices and meteorological indices. *Weather, Climate, and Society*, 11(1): 33-48. DOI: 10.1175/WCAS-D-17-0127.1

Mudstock C.M., Thomas A.L. (2005). *Soja: fatores que afetam o crescimento e o rendimento de grãos*. Evangraf/ UFRGS, Porto Alegre.

Musshoff O., Odening M., Xu W. (2011). Management of climate risks in agriculture–will weather derivatives permeate? *Applied Economics*, 43(9): 1067-1077. DOI: 10.1080/00036840802600210

Pelka N., Musshoff O. (2013). Hedging effectiveness of weather derivatives in arable farming – is there a need for mixed indices? *Agricultural Finance Review*, 73(2): 358-372. DOI: 10.1108/AFR-10-2012-0055

Richards T.J., Manfredo M.R., Sanders D.R. (2004). Pricing weather derivatives. *American Journal of Agricultural Economics*, 86(4): 1005–1017. DOI: 10.1111/j.0002-9092.2004.00649.x

Seth R., Ansari V.A., Datta M. (2009). Weather-risk hedging by farmers: an empirical study of willingness-to-pay in Rajasthan, India. *The Journal of Risk Finance*, 10(1): 54-66. DOI: 10.1108/15265940910924490

Shi H., Jiang Z. (2016). The efficiency of composite weather index insurance in hedging rice yield risk: evidence from China. *Agricultural Economics*, 47(3): 319-328. DOI: 10.1111/agec.12232

Sibiko K.W., Veettil P.C., Qaim M. (2018). Small farmers' preferences for weather index insurance: insights from Kenya. *Agriculture & Food Security*, 7(1): 1-14. DOI: 10.1186/s40066-018-0200-6

Stoppa A., Hess U. (2003). Design and use of weather derivatives in agricultural policies: the case of rainfall index insurance in Morocco. International Conference Agricultural Policy Reform and the WTO: where are we heading? Capri (Italy), June 23-26. Available at: https://agriskmanagementforum.org/doc/design-and-use-weather-derivatives-ag-policies-case-rainfall-index-insurance-morocco (accessed 4 October 2018).

Štulec I. (2017). Effectiveness of weather derivatives as a risk management tool in food retail: the case of Croatia. *International Journal of Financial Studies*, 5(1). DOI: 10.3390/ijfs5010002

Taib C.M.I.C., Benth F.E. (2012). Pricing of temperature index insurance. *Review of Development Finance*, 2(1): 22-31. DOI: 10.1016/j.rdf.2012.01.004

Torriani D.S., Calanca P., Beniston M., Fuhrer J. (2008). Hedging with weather derivatives to cope with climate variability and change in grain maize production. *Agricultural Finance Review*, 68(1): 67-81. DOI: 10.1108/00214660880001219

Turvey C.G. (2001). Weather derivatives for specific event risks in agriculture. *Review of Agricultural Economics*, 23(2): 333-351. Available at: https://www.jstor.org/stable/1349952. (accessed 4 October 2018).

USDA – United States Department of Agriculture (2019). World Agricultural Production. Foreign Agricultural Service (FAS), USDA, Circular Series, 3-19. Available at: https://apps.fas.usda.gov/psdonline/circulars/production.pdf (accessed 19 March 2019).

Vedenov D.V., Barnett B.J. (2004). Efficiency of weather derivatives as primary crop insurance instruments. *Journal of Agricultural and Resource Economics*, 29(3): 387-403. Available at: https://www.jstor.org/stable/40987240 (accessed 05 March 2019).

Woodard J.D., Garcia P. (2008a). Basis risk and weather hedging effectiveness. *Agricultural Finance Review*, 68(1): 99-117. DOI: 10.1108/00214660880001221

Woodard J.D., Garcia P. (2008b). Weather derivatives, spatial aggregation, and systemic risk: implications for reinsurance hedging. *Journal of Agricultural and Resource Economics*, 33(1): 34-51. Available at: https://www.jstor.org/stable/41220612 (accessed 4 October 2018).

World Bank (2005). *Agriculture investment sourcebook*. The World Bank. Washington, DC. Available at: http://documents.worldbank.org/curated/en/633761468328173582/Agriculture-investment-sourcebook (accessed 06 March 2019).

Zara C. (2010). Weather derivatives in the wine industry. *International Journal of Wine Business Research*, 22(3): 222-237. DOI: 10.1108/17511061011075365

Zhou R., Li J.S-H., Pai J. (2018). Evaluating effectiveness of rainfall index insurance. *Agricultural Finance Review*, 78(5): 611-625. DOI: 10.1108/AFR-11-2017-0102

APPENDIX

Tab. A.1. Jarque-Bera tests.

City	Index	Obs.	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
Cruz alta	Equal-weighted	24	0.3408	0.6378	1.2200	0.5427
	Growth-weighted	24	0.3459	0.4768	1.5200	0.4671
Santa Maria	Equal-weighted	24	0.7250	0.5101	0.5800	0.7470
	Growth-weighted	24	0.2455	0.6224	1.7500	0.4178
S. L. Gonzaga	Equal-weighted	23	0.6483	0.7062	0.3600	0.8367
	Growth-weighted	23	0.5893	0.6981	0.4600	0.7959

Tab. A.2. Shapiro-Wilk tests.

City	Index	Obs.	W	V	z	Prob>z
Cruz alta	Equal-weighted	24	0.9593	1.0980	0.1900	0.4247
	Growth-weighted	24	0.9554	1.2030	0.3770	0.3532
Santa Maria	Equal-weighted	24	0.9697	0.8170	-0.4130	0.6601
	Growth-weighted	24	0.9525	1.2810	0.5050	0.3068
S. L. Gonzaga	Equal-weighted	23	0.9751	0.6520	-0.8680	0.8074
	Growth-weighted	23	0.9797	0.5310	-1.2870	0.9010

Tab. A.3. Komogorov-Smirnov tests.

City	Smaller Group	Equal-weighted index		Growth-weighted index	
		D	p-value	D	p-value
Cruz Alta	Simple	0.1145	0.5330	0.1332	0.4270
	Cumulative	- 0.0876	0.6920	-0.0840	0.7120
	Combined K-S	0.1145	0.9110	0.1332	0.7880
Santa Maria	Simple	0.1250	0.4740	0.0973	0.6350
	Cumulative	- 0.0910	0.6700	-0.1311	0.4380
	Combined K-S	0.1250	0.8490	0.1311	0.8040
S. L. Gonzaga	Simple	0.0915	0.6810	0.0781	0.7550
	Cumulative	- 0.0689	0.8040	-0.0651	0.8230
	Combined K-S	0.0915	0.9910	0.0781	0.9990

Fig. A.1. Geographical location of the cities considered in the study.

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Soybean cropping by family farmers: a new institutional path for rural development in Brazilian Central-West

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Abstract. Soybean cropping in Mato Grosso is historically present in large farms. However, in recent years, small farmers have joined this supply chain. In this study, we aimed to identify how small farmers can surpass the paradigm of large-scale production in soybean production in Mato Grosso. A case study in six municipalities in Mato Grosso was conducted to gather data from 72 family farmers. A pooled panel data regression analysis was performed to verify the impact of small farmers solutions in the economic results of soybean. Results showed that small farmers reduce long-term needs of investment in markets of used machines and third-party harvest service market; trading companies contractually provide the short-term inputs, which family farmers can pay for in soybean equivalent; suppling farmers lack financial resources. Economies of scale is present in small farms. In spite of that, prices, climate risks and other environmental problems make it difficult for soybean to increase family farmers competitiveness and sustainability.

Keywords: mechanization, transaction costs, production costs, institutions, innovation.

JEL codes: Q12, Q13.

1. INTRODUCTION

Brazil is recognized worldwide for the high agriculture productivity. The expansion of its agriculture followed the liberalization trends in developing countries – mostly since the 1990s, with strategic economic liberalization (Serrano, Pinilla, 2014). Nowadays, agribusiness is a national strategic economic sector, accounting for 21.6% of the Gross Domestic Product (GDP) in 2017 (CEPEA/ESALQ 2017). Soybean figures do represent the main national commodity, with a total production of 114 million tons in 2015/2016, according to the National Supply Company (CONAB, 2017), accounting for 25.717 billions of dollars (MDIC 2018). In this scenario, the State of Mato Grosso is national reference in technological and institutional innovations in agribusiness. In 2016/2017, the state was the national leader in soybean production

(26.7%), maize (29.5%), cotton (66%), and cattle (13.88% of total livestock in 2016), (CONAB, 2017; IBGE, 2018).

In contrast to different regions in Brazil, the soybean supply chain in Mato Grosso, is based on a strong relationship between industry, farmers and large trading companies (Wesz Jr., 2016). It is also organized and oriented by technical and economic constraints, which establish the land as a solution for economic efficiency (economy of scale). This productive paradigm is responsible for the leadership of Mato Grosso in soybean production and sets Brazil as a major exporter of the commodity (Wesz, 2016). But, historically, this has excluded small farmers in favor of large farmers, who can replicate technological packages.

Distant from the requirements of commodities markets, small farmers are driven to develop alternative activities (e.g. non-farm rural labor) or join markets with lower coordination and added value, which have reduced capital, technology and land requirements (Haggblade *et al.,* 2010). Consequently, government policies in Brazil are oriented to poverty reduction, income distribution and subsidized credit to economic diversification (Nunes, Mariano, 2015). But, in recent years, small farmers in rural areas have been planting soybean with economic efficiency using the same technological patterns of large farmers, contradicting the existent technological and capital constraints. Has the productive paradigm changed or have small farmers adapted to existing mechanisms to join themselves in this market?

Previous studies have already dealt with some problems faced by small farms and rural areas in Brazil, such as cash transfer programs and support policies in rural areas (Dou *et al.,* 2017), food insecurity and the role of small farmers to reduce poverty (Nolasco *et al.,* 2017), the impacts of emerging biofuels markets to smallholders (Watanabe *et al.,* 2012; Dal Belo Leite *et al.,* 2015; Petrini *et al.,* 2017), and development of small farmers' rural areas in Brazil focusing on cash transfer programs and support policies (Dou *et al.,* 2017). More than income distribution policies, market mechanisms are necessary to small farmers so they can adjust the costs structure and capital needs to their reality and develop new alternatives of rural development.

We aimed to identify how small farmers can surpass the paradigm of large-scale production of soybean production in Mato Grosso. We sustain that small farmers adhere to soybean production supply chain by replicating efficient parameters of production through new institutional mechanisms. In order to break barriers brought about by economies of scale, family farmers resort to governance structures that reduce their long-term investment and supply short-term funding needs.

2. SOYBEAN IN MATO GROSSO: TECHNICAL, HISTORICAL AND INSTITUTIONAL DETERMINANTS

Over the last three decades, Brazil has become an agricultural exporter thanks to the expansion of capital-intensive agriculture in the Brazilian savannah (*Cerrado*), in the Central-West part of the country. Mato Grosso increased its production from 0.45 millions of tons in 1976/1977 (3.71% of the national total) to 31.49 millions of tons in 2016/2017 (26.7% of the national total). This leadership in grain production has been historically driven by technical, cultural and institutional determinants.

The Brazilian Central-West occupation in the 1970's was propelled by large private colonization projects and government support to increase demography in the frontier (Jepson, 2006). The occupation of Central and Northern Mato Grosso was predominantly done by flows of immigrants from the southern states of Brazil (Paraná, Santa Catarina, Rio Grande do Sul), where grain farming was historically predominant (Mier y Terán Giménez Cacho, 2016). This cultural vocation for grain production, added to the investment in research and the subsides for agriculture, paved the way for soybean production in Mato Grosso.

However, the economic crises in the 1990's reduced significantly the participation of government in agriculture (Delgado, 2009). The liberalization of economy was then necessary as a means to rescue the agricultural sector, allowing large companies (trading) to replace the government as funding source (Wesz Jr., 2016). The new institutional environment replaced the historical subsided agriculture with a productive paradigm oriented by intensive mechanization and use of modern inputs (fertilizers, pesticides, quality seeds). Consequently, the agricultural area of *Cerrado* expanded by 87% between 2000 and 2014 (Filho, Costa, 2016). In the same period, soybean in Mato Grosso increased from 9.6 to 26.4 million tons (average growth of 13.41% per year) (Conab, 2017).

The fast expansion of soybean not only lead to economic growth but also raised new problems regarding the environment and human health. The pressure of new arable lands over the Amazon and *Cerrado* increased deforestation (Fearnside, 2001; Barona *et al.,* 2010) and new mechanisms of control – e.g. the Soy Moratorium – had to be developed (Gibbs *et al.,* 2015; Rudorff *et al.,* 2011). Intensive use of agrochemical pesticides in this new model can lead to health problems, contaminating not only the grain but also soil, air and water (Pignati *et al.,* 2014). The importance of agroindustry for local and national economy challenges the social interests for health (Berger, Ortega, 2010). Such issues increase the debate about how sustainable is the soybean production and if the integration of small farmers can be justified in this environment of medium-to-long term of exposure to agrochemicals.

In contrast to other Brazilian regions – e.g. Southern states with predominance of cooperatives as main agents in soybean (Clasadonte *et al.,* 2013) – Mato Grosso shows a close relationship between farmer and trading companies. In the current scenario, the short-term purchase contracts, signed by tradings companies and large farmer, do prevail providing the funding sources for cropping (Brum *et al.,* 2011; Rodrigues, Marquezin, 2014). Due to techniques (e.g. zero tillage, culture rotation, spacing), high mechanization and production costs, large-scale cropping is so far the only way to achieve economic efficiency (Vander Vennet *et al.,* 2016). Consequently, small farmers should remain outside the soybean production chain (Tab. 1).

In terms of efficiency, large farms have more economic advantages than small farms –with lower cost per unit of production and more production per unit of labor –, suggesting that agricultural production may shift from small to large farms (MacDonald *et al.,* 2013). Small scale farming must develop alternative economic use of land with higher use of labor and less area requirements (avoiding economies of scale). Activities with such characteristics include dairy production (Monteiro *et al.,* 2013), organic agriculture (Qiao *et al.,* 2018) and fish farming (Lima *et al.,* 2018).

Medium and large farms are predominant in soybean production in Mato Grosso, as observed in Table 1, farms with less than 100 hectares are just 8.84% of total properties that cultivated soybean in 2006 (Ibge, 2006). Yet, a growing number of small family farmers have shifted to soybean cropping in Mato Grosso in the last years, opposing to the shift from small to large farms in agricultural commodities production. Considering the constraints of soybean, the phenomena should be the reverse (decrease or disappearance of small farms in this type of production). To support the empirical evidences in this study, the New Institutional Economics (NIE) provides an important theoretical background.

Tab. 1. Comparison between soybean and total rural properties in Mato Grosso by groups of area.

Classes of area	Number of rural properties		Ratio (a/b)
	Soybean [a]	Total [b]	
Very small farmers (Less than 10 ha)	3	16005	*0.02%*
Small Farmers (10-100 ha)	393	61781	*0.64%*
Medium Farmers (100-1000 ha)	1706	26457	*6.45%*
Large Farmers (More than 1000 ha)	2378	8744	*27.20%*
Total	4480	112987	*3.97%*

Source: IBGE (2006).

According to North (1990, p.3) «institutions are the rules of the game in a society or, more formally, are the devised constraints that shape human exchange, whether political, social, or economic». For Greif (2006, p.30) «an institution is a system of rules, beliefs, norms, and organizations that together generate a regularity of (social) behavior». They specify mechanisms of enforcement that monitor and punish deviations. An organization is a group of individuals with a common objective (a small or large farmer or a trading company). All these organizations exist in a competitive environment with limited resources (North, 2008, p.22).

The institutional environment has the basic institutions that arrange the social and economic relations. They are hard to be changed by the influence of one individual organization itself. The institutional arrangements are, in turn, the rules that organizations establish in a given institutional environment. These arrangements create structures to change property rights or change the ways by which organizations cooperate (Davis, North, 1971). The result is the institutional matrix with a set of possible opportunities for organizations, which will invest knowledge and skill to find the most beneficial structure for its purpose (North, 2008). This institutional matrix determines the costs of the organization.

The total cost of a good or service is the sum of the production costs – land, capital and labor – and the transaction costs. As pointed by Williamson (1985, p.1) "a transaction occurs when a good or service is transferred across a technologically separable interface. One stage of activity terminates, and another begins". A transaction is the transference of an asset between agents. The transaction costs are the costs involved in this process. They exist because transaction informations are incomplete, generating uncertainty. In this scenario, agents manage to obtain better information and safety, increasing the transaction costs.

In nations where property rights are uncertain, the transaction costs are higher. Hence, organizations have few incentives for investment. Their main option is high return activities that do not contribute to development (Shirley, 2008). Institutions matter because they affect the economic performance of agents and the economic development. Some studies have demonstrated the relations between trading and development, and how they are affected by the institutional environment (Knack, Keefer, 1995; Lin and Fu, 2016; Mavragani *et al.,* 2016).

The liberalization of economy in Brazil in the 1990's favored the trading companies because the institutional environment changed, creating safe mechanisms for transaction and reducing transaction costs.

The institutional environment impacts heavily the economic performance of agents in the soybean production chain. Institutional constraints, such as phytosanitary norms, product characteristics, trading laws, the soy moratorium (Gibbs *et al.,* 2015) affect the terms of contracts, forcing the agents to rework their strategies. Aimed at reducing transactions costs, the institucional arrangements adapt to these constraints, and in the historical case of Mato Grosso, have resulted in an increase in the scale of production among large farmers (economy of scale). On the other hand, institutional inovations allowing the insertion of small farmers in the soybean production chain indicate the creation of mechanisms to reduce costs and provide funding.

Watanabe, Bijman, and Slingerland (2012) highlighted the importance of transaction costs in agricultural markets in their study on the supply of raw materials by family farmers to biodiesel industries in Minas Gerais. The authors verified that castor beans are the product with the highest specificity because there is only one buyer in the region – i.e. a monopsony. Thus, the contracts are, at the same time, a part and evidence of a hierarchical structure of governance. Uncertainty and risk on the part of the small farmers do not allow an efficient reduction of transaction costs, which is the reason why fewer small farmers still produce castor beans, which compromises public policies in the biodiesel sector.

In China, the solution for land tenure conflicts that threatened small herders began with the support of institutional arrangements, which included their sustainable practices in public policies (Chen, Zhu, 2015). In Brazil, Vilpoux (2011) identified six institutional arrangements ruling the relations between cassava producers and starch industries. He concluded that, even though the traditional governance structures reduced the transaction costs, they did not meet the industrial demand for raw materials. Intermediate safeguard and guarantee mechanisms are more suitable for cassava farmers and the industries.

Wander and Zeller (2002) studied family farmers' behavior in Rio Grande do Sul when switching from using their own machinery to contracting third-party service providers. According to the authors, 94.6% of the properties had no harvester. Instead of acquiring expensive machinery, small farmers contract outsourced services. From this strategy emerged a new, low-cost institutional arrangement, namely the market of harvesting services – and vice versa. The contracts specify payments per ton of harvested crop and include guarantees related to delays that can cause losses during harvesting.

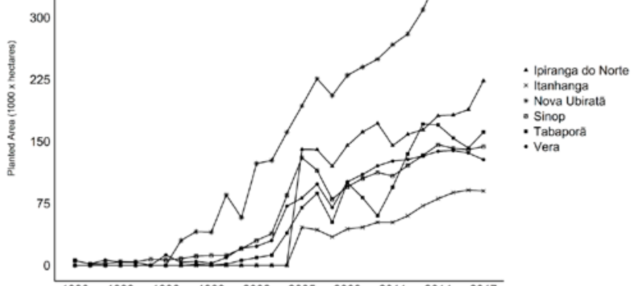
The transaction cost approach contributes to understanding how economic agents behave in a given institutional environment. It applies to several fields of study, both within and outside agriculture, such as production decisions and participation in public programs according to the quality of the land (Hallmann, Amacher, 2014), preservation or use of biodiversity (Badstue *et al.,* 2006) and so forth. In this study, we connect the transaction costs and institutional environment of soybean production by small farmers with the mechanisms developed to increase their competitiveness.

3. METHODOLOGY

This research was conducted in Northern Mato Grosso. The region is characterized as a biome transition zone between the *Cerrado* and the Amazon. Also, in the selected municipalities the soybean production had a great expansion in the 2000's (Figure 1 shows the evolution of soybean planted area in the municipalities of this study). This late boost – when compared with other municipalities from Southern Mato Grosso – was fundamental to economic viability of soybean in small farms; the institutions developed were based in new market solutions.

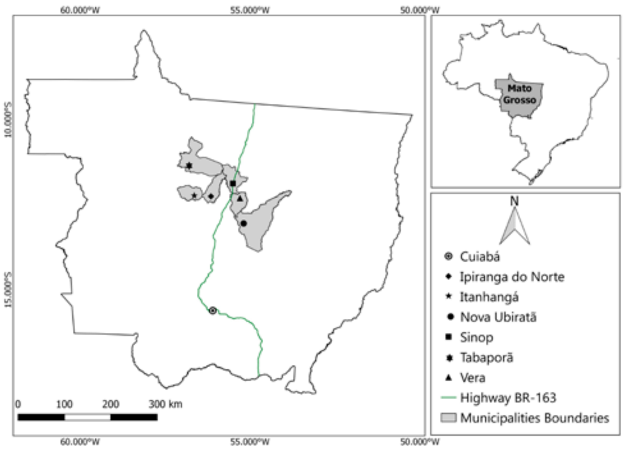
We selected the case study as the best research method (Yin 2009) to understand how small farmers – against all odds – are switching to soybean cropping. These municipalities were select because they have some similarities: they where recently founded by private colonization projects; large settlements established in the 1990's by the federal government; later expasion of soybean; market and logistic infrastructure developed to

Fig. 1. Soybean cropping area in studied municipalities – 1990 to 2017.



Source: Brazilian Statistical Office (Ibge, 2019).

Fig. 2. Map of Mato Grosso and the researched municipalities.



Source: Authors.

attend large soybean farmers – but that also attend small ones – and the presence of Mato Grosso public technical assistance company (EMPAER-MT) in proximities. An official list of small farmers that cultivate soybean does not exist. Hence, to identify the farmers we rely on informations of the EMPAER-MT of each municipality, which indicates some small farmers and spots that cultivate soybean (chain-referral sampling).

From January to December of 2016 we surveyed 72 farmers in six municipalities of Mato Grosso, namely Ipiranga do Norte, Itanhangá, Nova Ubiratã, Sinop, Tabaporã, and Vera (Fig. 2). The exploratory approach provides specific recent data from small farmers in this new wave of soybean expansion in Mato Grosso, while the New Institutional Economics provides the theoretical background to understand the role of governance, institutions and transaction between agents.

The questionnaire had three sections: I. Characteristics of family farmers (age, gender, family origins, total number of family members); II. Characteristics of land use (economic use, non-economic activities, total land area and its economic use, improvements and equipment use); and III. Characteristics of soybean production (production costs and techniques, costs funding source, prices, productivity, machines, commercialization). Family farmers had different forms of land tenure – own area, rural settlement and rented area. But, to respect federal legislation the threshold of farm size[1] for farmers in Sinop, Vera and Nova Ubiratã was 360 hectares and in Ipiranga do Norte, Itanhangá and Tabaporã was 400 hectares.

The total cost for soybean cropping had three elements: I) the inputs, such as seeds, fertilizers, pesticides, fuel, labor and other crop expenses; II) land leasing costs; III) costs with mechanization services for farmers that contracted machinery services. Total revenue was obtained by multiplying the average price of soybean by total production. Small farmers have scarce use of management tools, the crop profit was obtained by subtracting revenue from the total cost.

To identify if the mechanism developed in the institutional arrangement has impact in total profit of family farms we performed a pooled panel data regression with four crop year (2012/2013, 2013/2014, 2014/2015 and 2015/2016) – Equation 1.

$$P_{it} = \beta_1+\beta_2 CPR_{it}+\beta_3 BIO_{it}+\beta_4 LAND_{it}+\beta_5 MC_{it}+\gamma_{it} D+\varepsilon_{it}$$

P_{it} is the total profit of family farm (i) in the year t. The independent variables are the CPR, the Rural Product Contracts, in R$1000; BIO is the revenue from biodiesel market, in R$1000; LAND is the total cultivated area with soybean (in hectares); MC is a dummy variable identifying if the farmer rents machinery (1) or has his own machines (0); β_1 is the respective coefficient of each independent variable and, ε is the random error term. D is a matrix of dummies that represents each crop year (Y1314 = crop year 2013/2014; Y1415 = crop year 2014/2015; Y1516 = crop year 2015) to verify if external events change the profit of soybean cropping (prices, climate) and γ_i is the coefficient associated with each crop year. We used the Brazilian General Index Price (*Índice Geral de Preços* – IGP-DI) to fix the inflation effects.

4. RESULTS AND DISCUSSION

According to data, each family owns on average 131.75 hectares (ha), of which an average 114 ha is arable land. Less than 18 ha remain for native forest preservation, housing, gardening and other needs. Indeed, land shortage does not allow cropping based on gains of scale. The suveyed farmers are predominantly born in Southern Brazilian states (90,3%), which are one of the main drives for the production of this commodity. When questionned about the reasons for chosing soybean production instead other agriculal activity, 56% of farmers appointed that «soybean is the best option in Mato Grosso», followed by «experience/tradition» with 24%, and «other activities were unsuccessful» with 16%. Other reasons just accounted for 2%. Farmers mentioned

[1] Brazilian federal law considers family farmers those who meet all the criteria: i) have up to four *módulos fiscais* in total area size, which varies for each municipality; ii) predominance of income from rural activities; iii) predominance of family labor and; iv) family management of activities in the farm.

that fewer climate changes, market support, infrastructure and technology are also factors for choosing soybean in the state.

Since the 1960's, INCRA – the national authority for colonization and land reform – expropriates inefficient or idle large farms and provides landless rural families with small farms within official settlement projects. In the 1970's and 1980's, INCRA also used public vacant land for the same purpose. After decades, some rural researchers argue that, from the very beginning, most of the new small farms have been inefficient and not able to overcome the limitations of self-subsistence (Alves *et al.,* 2012). Furthermore, inefficiency and rural poverty lead to food insecurity (Portal *et al.,* 2016). 75% of the interviewed farms were located within such settlement projects, while 19.4% were outside them. The remaining 5.6% are lessee farms. At times, some farmers aimed at gains of scale also rent neighboring areas.

Although soybean cropping is the main activity, small farmers also grow other crops, especially maize, which is present in 98.6% of the surveyed farms. Despite the lower gains, large farmers also sow maize after soybean harvests. The consecutive use of the arable land – so-called «safrinha» – allows farmers to take full advantage of the nitrogen and other macro-nutrients left behind in the soil. Rice cropping is also significant and is present in 40.3% of the farms. As reported by small farmers, the low natural fertility of recently deforested savannah areas supports two or three rice crops at most, before switching to soybean and the use of industrial fertilizers became unavoidable. All farmers reported to use zero tillage agriculture.

Highest soybean productivities are then associated with the utilization of a standardized technological package prescribed by the trading companies support agents (e.g. research, technical assistance, input industries). It includes the use of modern inputs (fertilizers, agrochemicals, pesticides, and high-quality seeds), and implies long-term investment in labor-saving machinery, and amortization requires large extensions of arable land. Pressed by downstream and upstream oligopolistic market structure, determining production cost and soybean prices, liquid revenue of soybean farmers depends on the size of their arable land. The necessity of inputs is very stable and practically does not vary with the production scale and long-term costs play a central role by determinating the production scale that maximizes profits. Below this optimum, the smaller the disponibility of land is, the smaller the profit margin becomes until it finally turns negative.

In general, farmers make use of Rural Product Contracts (*Cédula de Produto Rural* – CPRs) to meet their annual capital needs. The trading company involved provides production inputs, and the farmers pay their costs in soybean equivalent. Rodrigues and Marquezin (2014) reported that in 2012 the CPRs funded 65% of the annual costs of soybean and maize cropping in Sinop.

As shown in Table 2, the CPRs are also the main credit source for 57.66% of the surveyed farmers in crop year 2015/2016. Surprisingly, 45.28% of them allocate their own resources, showing the oft-mentioned risk avoidance by small farmers. The Nation Program from Family Agriculture (PRONAF) is an official program offering subsidized credit for small farmers in Brazil. However, its credit limits per family are far below the capital needs even for a small soybean cropper. That is the reason why only 2.41% of them use this credit line.

The CPR is an important institutional breakthrough in Brazilian Central-West agriculture. It establishes a cooperative relationship between croppers and trading companies, reducing both uncertainty and transaction costs. Because of the bankrupt of the Brazilian rural credit system in the 1980's, the following expansion of soybean crops in the region would not has been feasible without alternative credit lines. As seen above, small farmers resort to CPRs as well. To verify the impact of CPR in farms profit we performed a pooled panel data regression (Tab. 3).

The results showed that the variable is significant and negative, the increase in dependence of CPR decreases the farm profit. The inverse dependence of this variable with profit is associated with the bargain

Tab. 2. Market contracts for family farmers' soybean production.

Variable		2012/2013	2013/2014	2014/2015	2015/2016
	CPR	*46.99*	*45.84*	*47.08*	*57.66*
Funding Sources as % of total funding	Pronaf	*1.9*	*1.86*	*1.82*	*2.41*
	Self funding	*42.83*	*43.76*	*45.28*	*31.53*
Harvest services as % of total cost		*8.44*	*7.85*	*8.93*	*9.77*
Average biodiesel bonus price contribution to total revenue (%)		*2.63*	*2.50*	*2.60*	*2.33*

Source: research results.

Tab. 3. Coefficients of pooled panel data regression.

Variable	Coefficient
Intercept	-10.166
CPR	-0.232 *
BIO	0.570
LAND	0.705 *
MC	6.382
Y1314	6.199
Y1415	10.600
Y1516	-44.995 *

Source: research results.
Note: CPR = Rural Product Contracts, in R$1000; BIO = Revenue from biodiesel market selling, in R$1000; LAND = total cultivated area with soybean (in hectares); MC = dummy identifying if the farmer rent machinery (1) or has his own machines (0); Y1314 = dummy for crop year 2013/2014; Y1415 = dummy for crop year 2014/2015; Y1516 = dummy for crop year 2015/2016;
* p-value < 0.05.

force of trading companies. Although this contract has negative impacts on farm's profit, it is essential to small farmers since their lack of resources is complemented with CPR. Besides, CPR does not compromise soybean production in small units as will be discussed.

The long-term capital needs to acquire machinery, such as harvesters, tractors, and sprayer and it demands diversified institutional solutions. The harvester, by far the most expensive equipment[2], can raise a hard obstacle for potential soybean cropper, whose land availability is not sufficient to meet annual capital amortization needs. Hence, the real barrier is not the access to credit lines, bearing in mind that machinery contractors also provide the funds and accept payments in soybean equivalent in installments, but the low production scale due to land shortages. In practice, if there is no enough land it is not worth acquiring harvesters.

Nowadays, there are two market solutions designed to reduce family farmers' long-term investment needs. The first solution is to acquire a second-hand harvester that is already technologically obsolete for a large producer. Low cost and the use of family labor for maintenance compensate the technological lag, and the machinery performance fits the small scale of production. Thus, 52.8% of surveyed farms (average size of 128.76 ha) employ a second-hand harvester, whose price hardly reaches 20% of a new one. In general, the buyer can pay it in installments or in soybean equivalent. Due to the widespread knowledge about harvester characteristics, such as harvest efficiency, depreciation, fuel consumption, maintenance costs, the transaction costs are very low.

The second solution is to engage third-party harvesting services provided by specialized firms through frequent informal contracts. This practice occurred with 36.1% of the surveyed farmers, especially with the smallest farms (average size of 66,19 ha). As payment, the firms received 5% up to 7% of harvested soybean plus fuel costs, which represented 8.93% of total costs in crop year 2014/2015. In the panel data model (Tab. 3), machinery renting did not show significant impact in farm's profit. For small-scale farmers, machinery renting is an important contract, which reduces their dependence of long-term funding to acquire machines.

According to Watanabe, Bijman, and Slingerland (2012), family farmers' soybean production in Minas Gerais would not be possible without sharing the use of machinery. This kind of solution presupposes a different set of institutions based on social capital such as confidence and equity of information. Agricultural cooperatives of small farmers in Rio Grande do Sul also employ non-market services for soybean crops. In turn, in the recently colonized northern Mato Grosso, where the foundations of cooperative practices are still lacking, small farmers have managed to become soybean producer by using new market mechanisms with low transaction cost.

Just 11.1% of surveyed farmers have acquired new machines. On average, each of them owns 314.38 hectares. Even if this area is compatible with some gains of scale, the profit income per ha is relatively low in comparison to larger farms. However, the family income can increase with the provision of third-party harvesting services.

An important public policy that aims to increase income for small farmers is the Brazilian National Program of Biodiesel (*Programa Nacional de Produção e Uso do Biodiesel* (PNPB). Refineries that process soybean produced by small farmers receive tax incentives. In return, they must provide small farmers with price incentives and technical assistance.

In the crop years 2012/2013, small farmers received an additional R$1.20 per sack (60 kilograms). The incentive rose to R$1.35 in 2015/2016, when the local soybean price reached US$ 20.00 per sack at a currency exchange rate of R$3.20 for US Dollar. The program benefited 43.1% of the surveyed farmers. Price bonus reduces risks associated with market events. In 2014/2015 the price bonus contributed with 2.60% to small farmers' income. In 2015/2016 climatic events reduced soybean productivity, and price bonus contributed with 2.33% to that income (Tab. 2). The BIO variable in panel data did not

[2] In regional market, a harvester can cost up to US$ 300,000.00.

show significance in the increase of soybean profits; few farmers (41,6%) joined the program. As the Biodiesel Program develops and the demand for oilseeds also increases, new small farmers can join the program and increase its importance for rural development.

Technical parameters of production depend on the employed technological package. The average productivity by small farmers reached 47.37, 50.37, 53.17 and 44.02 sack/ha in 2012/2013, 2013/2014, 2014/2015 and 2015/2016, respectively. According to data from the Instituto Matogrossense de Economia Agropecuária (IMEA), the average in the state (considering both large and small farms) was 49.8, 51.9, 51.9 and 49.8 sack/ha in the same years (IMEA, 2016; IMEA, 2015). In 2014/2015, the average productivity by small farmers was even higher than the state average. Only in crop years 2015/2016 a significant divergence of productivity per ha occurred due to climate events that particularly affected the harvest. Therefore, given the relatively stable weather conditions of Brazilian Central-West, only the divergence of labor productivity is significant. It has claimed institutional solutions in addition to CPR.

In 2014/2015[3], farmers owning up to 50 ha obtained an average annual profit of US$7,694.15. In the next stratum –50 to 100 ha – the profit rose to US$ 16,893.09, and to R$ 33,113.63 in the stratum from 100 to 200 ha. It reached US$ 63,188.36 in the stratum over 200 hectares (Table 4). The results show a significant difference of profit per stratum of the area, demonstrating that even in small farmers soybean production is correlated to economies of scale. These data are corroborating with panel data results (Tab. 3), where LAND variable showed to be positive and significant. However, even farmers with less than 100 hectares can assure a family income many times greater than the national minimum wage of monthly US$ 300.00/month. Climate variations in 2015/2016 increased soybean price. However, the lower productivity and increased costs of production showed how risky for families' incomes is soybean production. The average net profit in that year reduced by 49.4% (all farmers) comparing with 2014/2015. This result is also verified in Table 3, variable Y1516 showed to be negative and significant.

Tab. 4. Average crop profit for sampled small farmers.

Class of Area (hectares)	Average net profit (US$)[1]			
	2012/2013	2013/2014	2014/2015	2015/2016
0 ├─ 50	6185,66	7374,77	7694,15	3661,45
50 ├─ 100	13947,04	14572,37	16893,09	8357,98
100├─ 200	26947,76	27579,61	33113,63	22753,95
200 ├─┤400	53481,43	52171,58	63188,36	26826,27

Source: research results. [1] Cambial exchange rate of R$3,20 = 1 US$.

[3] A very stable crop in climate phenomena and prices.

Institutional paths of innovation are allowing small farms to switch to soybean production with potential economic results in stable market and climate conditions. The benefits of this mechanism are spread throughout the entire network, reducing investment costs (second-hand machines, markets, and harvest services), funding the production (CPR) and increasing revenue (biodiesel).

Some of these institutional innovations aim to protect the rainforest and, therefore, have impacts on family farms located in rainforest areas. The Soy Moratorium, for example, is an agreement signed by Greenpeace, farmers, and the trading companies that since 2008 establish trading barriers for soybean produced in the deforested Brazilian Amazon rainforest (Gibbs *et al.*, 2015; Rudorff *et al.*, 2012). The Brazilian Forest Code sets limits for deforestation in farms as well. Since the productive paradigm is still conflicting with sustainable agriculture and social interests, new institutional mechanisms are necessary to face this problem and enhance the opportunities for rural development, reducing the risks for small farmers in highly integrated commodity markets.

5. CONCLUSION

This study addressed the mechanisms that contributed to the economic viability of soybean production in family farms in Mato Grosso. The traditional soybean technological package implies gains of scale and intensive use of modern inputs. Despite this, in Northern Mato Grosso, family farmers are shifting to soybean cropping thanks to new institutional market mechanisms created within the soybean production chain. The Rural Product Contracts signed by trading companies and family farmers cover the annual requirements for soybean cropping. Second-hand machinery markets and third-party harvesting services, in turn, contribute to reducing the long-term capital need. Lastly, the official biodiesel program provides family farmers with a stable stream of income through price incentives and contractual trade connections with refineries – biodiesel policies are still restricted to a few farmers and need improvements though.

These market innovations are not changing the technological paradigm, they are creating contitions for family farmers to engage in the soybean production with satisfactory economic efficiency. However, pressure for increased productivity with intense use of inputs and economies of scale is present even in small farming systems. And soybean cropping is risky for small farmers in short-term because small changes in productivity and prices can lead to insecurity in families' incomes as observed in crop year 2015/2016. Also, future studies can verify the environmental, social and health impacts of soybean production to improve the debate of how sustainable soybean can be in medium and long term.

The NIE promises to analyze how small farmers can join highly verticalized markets, establishing institutional arrangements to surpass some economic barriers. Nonetheless, these institutional arrangements differ in the various regions of Brazil – e.g. the case of cooperatives in Southern states –, so it does not allow such generalization. Current policies and institutional environment must be reviewed to face the consequences of large monocultures and set soybean as a solid path for local rural development.

REFERENCES

Alves J., Figueiredo A.M.R., Zavala A.A.Z. (2012). *(In) Eficiência dos Assentamentos Rurais em Mato Grosso*. EdUFMT, ed. Cuiabá: EdUFMT.

Badstue L.B. *et al.* (2006). Examining the Role of Collective Action in an Informal Seed System: A Case Study from the Central Valleys of Oaxaca, Mexico. *Human Ecology*, 34(2): 249–273. https://doi.org/10.1007/s10745-006-9016-2.

Barona E. *et al.* (2010). The role of pasture and soybean in deforestation of the Brazilian Amazon. *Environmental Research Letters*, 5(2): 024002.

Berger M., Ortega F. (2010). Poblaciones expuestas a agrotóxicos: autoorganización ciudadana en la defensa de la vida y la salud, Ciudad de Córdoba, Argentina. *Physis: Revista de Saúde Coletiva*, 20(1): 119–143.

Brum L.A. *et al.* (2011). Financement agricole par l'échange grains / intrants : l'impact de la NPR à Sapezal–MT entre 2004 et 2009. *Confins*, 13: 7265.

CEPEA/ESALQ. (2017). PIB do agronegócio brasileiro de 1996 a 2018. Available at: http://www.cepea.esalq.usp.br/upload/kceditor/files/PIB Agronegócio_Cepea_1996_2017.xlsx (accessed 09 October 2018).

Chen H., Zhu T. (2015). The dilemma of property rights and indigenous institutional arrangements for common resources governance in China. *Land Use Policy*, 42: 800–805. Available at: http://www.sciencedirect.com/science/article/pii/S0264837714002257.

Clasadonte L. *et al.* (2013). Network companies: a new phenomenon in South American farming. *British Food Journal*, 115(6): 850–863. https://doi.org/10.1108/BFJ-Dec-2009-0257.

Conab (2017). Séries Históricas – Soja. Available at: http://www.conab.gov.br/conteudos.php?a=1252&t=2&Pagina_objcmsconteudos=3#A_objcmsconteudos (accessed 27 October 2017).

Dal Belo Leite J.G. *et al.* (2015). Socioeconomic and environmental assessment of biodiesel crops on family farming systems in Brazil. *Agricultural Systems*, 133: 22–34.

Davis L.E., North D.C. (1971). *Institutional Change and American Economic Growth*. Cambridge: Cambridge University Press.

Delgado N.G. (2009). Política econômica, ajuste externo e agricultura. In S. P. LEITE, ed. *Políticas públicas e agricultura no Brasil*. Porto Alegre: Editora da UFRGS, pp. 17–54.

Dou Y. *et al.* (2017). Impacts of Cash Transfer Programs on Rural Livelihoods: a Case Study in the Brazilian Amazon Estuary. *Human Ecology*, 45(5): 697–710. https://doi.org/10.1007/s10745-017-9934-1.

Fearnside P.M. (2001). Soybean cultivation as a threat to the environment in Brazil. *Environmental Conservation*, 28(1): 23–38.

Filho A.C., Costa K. (2016). *The expansion of soybean production in the Cerrado Paths to sustainable territorial occupation, land use and production*. São Paulo: Agroicone. Available at: http://www.inputbrasil.org/wp-content/uploads/2016/11/The-expansion-of-soybean-production-in-the-Cerrado_Agroicone_INPUT.pdf.

Gibbs H.K. *et al.* (2015). Brazil's Soy Moratorium. *Science*, 347(6220): 377–378. Available at: http://www.sciencemag.org/content/347/6220/377.short.

Greif A. (2006). *Institutions and the Path to the Modern Economy: Lessons from Medieval Trade*. Cambridge: Cambridge University Press.

Haggblade S., Hazell P., Reardon T. (2010). The Rural Non-farm Economy: Prospects for Growth and Poverty Reduction. *World Development*, 38(10): 1429–1441. http://dx.doi.org/10.1016/j.worlddev.2009.06.008.

Hallmann F.W., Amacher G.S. (2014). Uncertain emerging biomass markets, ecosystem services, and optimal land use. *Forest Policy and Economics*, 47: 46–56. Available at: http://www.sciencedirect.com/science/article/pii/S138993411400080X.

Ibge (2006). Censo Agropecuário. *Censo Agropecuário - 2006*. Available at: www.ibge.gov.br (accessed 30 March 2018).

Ibge (2019). Sistema IBGE de Recuperacao automatica– SIDRA. Available at: http://www.sidra.ibge.gov.br/ (accessed 1 April 2019).

IMEA (2015). Quinta Estimativa da Safra de Soja – 2014/15. Available at: http://www.imea.com.br/upload/publicacoes/arquivos/R404__5a_Estimativa_de_safra_de_Soja_2014-15___23-04-2015_AO.pdf (accessed 31 October 2017).

IMEA (2016). Sexta Estimativa da Safra de Soja – 2015/16. Available at: http://www.imea.com.br/upload/publicacoes/arquivos/R404_6_Estimativa_Soja_safra_2015-16__16-04_29.pdf (accessed 31 October 2017).

Jepson W. (2006). Private agricultural colonization on a Brazilian frontier, 1970-1980. *Journal of Historical Geography*, 32: 839–863.

Knack S., Keefer P. (1995). Institutions and economic performance: cross-country tests using alternative institutional measures. *Economics & Politics*, 7(3): 207–227. http://dx.doi.org/10.1111/j.1468-0343.1995.tb00111.x.

Lima A.F. *et al.* (2018). Small-scale fish farming in seasonal ponds in Brazil: technical and economic characterization. *Latin American Journal of Aquatic Research*, 46: 314+.

Lin F., Fu D. (2016). Trade, Institution Quality and Income Inequality. *World Development*, 77: 129–142. Available at: http://www.sciencedirect.com/science/article/pii/S0305750X15001989.

MacDonald J.M., Korb P., Hoppe R.A. (2013). *Farm Size and the Organization of U.S. Crop Farming, ERR-152.*

Mavragani A., Nikolaou I.E., Tsagarakis K.P. (2016). Open Economy, Institutional Quality, and Environmental Performance: A Macroeconomic Approach. *Sustainability*, 8(7): 601–613.

MDIC (2018). Brazilian Trade Balance - consolidated data. Available at: http://www.mdic.gov.br/index.php/comercio-exterior/estatisticas-de-comercio-exterior/balanca-comercial-brasileira-unidades-da-federacao (accessed 9 April 2018).

Mier y Terán Giménez Cacho, M. (2016). Soybean agri-food systems dynamics and the diversity of farming styles on the agricultural frontier in Mato Grosso, Brazil. *The Journal of Peasant Studies*, 43(2): 419–441. https://doi.org/10.1080/03066150.2015.1016917.

Monteiro A. *et al.* (2013). Feasibility and competitiveness of intensive smallholder dairy farming in Brazil in comparison with soya and sugarcane: Case study of the Balde Cheio Programme. *Agricultural Systems*, 121: 63–72.

Nolasco L.C. *et al.* (2017). Scenarios of Vegetable Demand vs. Production in Brazil: The Links between Nutritional Security and Small Farming. *Land* , 6(3).

North D.C. (1990). *Institutions, Institutional Change and Economic Performance*. New York: Cambridge University Press.

North D.C. (2008). Institutions and the Performance of Economies Over Time. In C. Ménard & M. M. Shirley, eds. *Handbook of Institutional Economics*. Heidelberg: Springer, pp. 21–30.

Nunes J., Mariano J. (2015). Effects of Income Transfer Programs on Working Non-Agricultural Offers in Rural Areas of Northeast Brazil J. Nunes, ed. *Revista de Economia e Sociologia Rural*, 53(1): 71–90.

Petrini M.A., Rocha J.V., Brown J.C. (2017). Mismatches between mill-cultivated sugarcane and smallholding farming in Brazil: Environmental and socioeconomic impacts. *Journal of Rural Studies*, 50: 218–227. Available at: http://www.sciencedirect.com/science/article/pii/S074301671730027X.

Pignati W., Oliveira N.P., da Silva A.M.C. (2014). Surveillance on pesticides: quantification of use and prediction of impact on health, work and the environment for Brazilian municipalities. *Ciência & Saúde Coletiva*, 19: 4669+. Available at: http://link-galegroup.ez3.periodicos.capes.gov.br/apps/doc/A395462182/AONE?u=capes&sid=AONE&xid=4bf4043a.

Portal R.D., Lima S.C.G., Joele M.R.S.P. (2016). Food access and consumption in a rural settlement in Castanhal, PA, Brazil. *Food Science and Technology*, 36: 19–22.

Qiao Y. *et al.* (2018). Certified Organic Agriculture as an Alternative Livelihood Strategy for Small-scale Farmers in China: A Case Study in Wanzai County, Jiangxi Province. *Ecological Economics*, 145: 301–307.

Rodrigues M., Marquezin W.R. (2014). CPR como um instrumento de crédito e comercialização. *Revista de Política Agrícola*, 23(2): 40–50.

Rudorff B.F.T. *et al.* (2012). Remote Sensing Images to Detect Soy Plantations in the Amazon Biome-The Soy Moratorium Initiative. *Sustainability*, 4: 1074–1088.

Rudorff B.F.T. *et al.* (2011). The soy moratorium in the Amazon biome monitored by remote sensing images. *Remote Sensing*, 3(1): 185–202.

Serrano R., Pinilla V. (2014). New directions of trade for the agri-food industry: a disaggregated approach for different income countries, 1963–2000. *Latin American Economic Review*, 23(1): 10. https://doi.org/10.1007/s40503-014-0010-6.

Shirley M.M. (2008). Institutions and Development. In C. Ménard & M. M. Shirley, eds. *Handbook of Institutional Economics2*. Heidelberg: Springer, pp. 611–638.

Vander Vennet B., Schneider S., Dessein J. (2016). Different farming styles behind the homogenous soy production in southern Brazil. *The Journal of Peasant Studies*, 43(2): 396–418. https://doi.org/10.1080/03066150.2014.993319.

Vilpoux O. (2011). Performance of institutional arrangements and minimization of transaction costs: transactions between producers and manufacturers of cassava starch O. Vilpoux, ed. *Revista de Economia e Sociologia Rural*, 49(2): 271–294.

Wander A.E., Zeller M. (2002). Contractual arrangements and transaction costs: The case of smallholder mechanization in Southern Brazil. *Quarterly Journal of International Agriculture*, 41(4): 317–334.

Watanabe K., Bijman J., Slingerland M. (2012). Institutional arrangements in the emerging biodiesel industry: Case studies from Minas Gerais—Brazil. *Energy Policy*, 40: 381–389. Available at: http://www.sciencedirect.com/science/article/pii/S030142151100807X.

Wesz Jr. V.J. (2016). Strategies and hybrid dynamics of soy transnational companies in the Southern Cone. *The Journal of Peasant Studies*, 43(2): 286–312. https://doi.org/10.1080/03066150.2015.1129496.

Wesz V.J. (2016). La filiera della soia nell'America del Cono Sud: dinamiche, processi e attori. *Rivista di Economia Agraria*, 71(1): 25–45.

Williamson O.E. (1985). *The Economic Institutions of Capitalism*. New York: The Free Press.

Yin R.K. (2009). *Case Study Research: Design and Methods*. 4th ed. SAGE Publications.

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La diversificazione dell'agricoltura: tra esigenze conoscitive e lacune informative*

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Abstract. The paper analyses the evolution of agricultural diversification activities in Italy by comparing data from national and European statistical sources. From this exercise critical aspects emerge in the classifications currently in use, at both National and, more in particular, at European levels. Results of the analysis show how the EU categorization isn't suitable for describing the wide process of diversification ongoing in European agriculture and ensuring a homogeneous comparison across Member States. Finally, it formulates recommendations to fill data gaps and to improve the quality of data in the framework of the future revision of European agricultural statistics and the common agricultural policy post 2020.

Keywords: diversificazione, agricoltura, conti economici nazionali.
JEL codes: Q18, C80.

1. INTRODUZIONE[1]

Negli ultimi decenni le aziende agricole italiane si sono caratterizzate per la progressiva intensificazione dei processi di diversificazione delle attività produttive, il cui consolidamento è considerato tra i più rilevanti cambiamenti strutturali che hanno coinvolto il settore agricolo nazionale. Sulla base delle ultime indicazioni fornite dall'Istat (2016), il complesso delle aziende agricole che utilizza i fattori produttivi aziendali per la realizzazione di beni e servizi, diversi da quelli strettamente agricoli, è pari all'8% del totale nazionale (CREA, 2019). Negli ultimi anni, il rapido sviluppo di queste attività ha costituito per una fetta consistente di aziende agricole il mezzo principale di miglioramento dei redditi e dell'occupazione.

D'altro canto, i processi di diversificazione costituiscono, in tutti i settori produttivi, una delle strategie cardine su cui impostare una scelta gestionale di riduzione del rischio di impresa (Floreani, 2004). In agricoltura, tali processi sono stati stimolati da molteplici determinati, sia aziendali che di

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contesto, tra le quali il ruolo principale è stato rivestito appunto dall'esigenza della crescita e stabilizzazione dei redditi aziendali (Henke, Salvioni, 2011; Henke, Salvioni, 2013). La diffusione delle attività di diversificazione ha, altresì, svolto un ruolo di rilievo nel ricollocare l'attività agricola in una nuova cornice rispetto alle aspettative della società moderna, in particolare nei confronti di un settore produttivo fortemente sostenuto dalle politiche pubbliche e spesso fonte di criticità legate alla protezione della salute pubblica e alla tutela dell'ambiente naturale (Fanfani, Sardone, 2017).

Nell'affrontare il tema della diversificazione, tuttavia, non si può prescindere dal citare il tema della sua definizione, muovendo dall'osservazione che, nella letteratura degli ultimi anni, concetti come diversificazione, multifunzionalità, attività connesse, congiunte o complementari sono stati spesso utilizzati come sinonimi. Questa ambiguità terminologica ha contribuito a far sì che non venisse riconosciuto un sistema di classificazione delle attività di diversificazione unico e condiviso del fenomeno (Roep, Van der Ploeg, 2003; Henke, 2004; Finocchio, 2008; Nazzaro, 2008; Aguglia, Henke, Salvioni, 2008; Renting *et al.*, 2008; Henke, Povellato, 2012). Nel trattare della diversificazione, larga parte della letteratura esistente si è rifatta all'efficace classificazione di Roep e Van der Ploeg del 2003, basata sui concetti di *deepening*, *broadening* e *regrounding*. Questa classificazione, in seguito, è stata a volte utilizzata in combinazione con quella più recente dell'OCSE (2009), basata invece sul punto di vista della localizzazione delle attività di diversificazione intrapresa (*on-farm* e *off-farm*)[2].

In un tale contesto, il presente lavoro non si sofferma sulle differenze definitorie in merito alla diversificazione, rintracciabili nell'ampia letteratura esistente, adottando un approccio che si rifà, quasi integralmente, alle regole stabilite dalla *Nomenclature statistique des activités* économiques *dans la Communauté européenne* (Nace). Quest'ultimo costituisce un sistema di classificazione generale, a sua volta derivato dall'*International Standard Industrial Classification* delle Nazioni Unite, finalizzato a sistematizzare e uniformare le definizioni delle attività economico/industriali dei paesi dell'Unione europea (UE)[3]. Questa scelta permette di circoscrivere l'oggetto dell'analisi della diversificazione alle sole attività realizzate dall'azienda agricola, indifferentemente svolte al suo interno o al suo esterno, impiegando i fattori produttivi aziendali per realizzare beni e/o servizi che vengono scambiati sul mercato. Si tratta di attività per le quali le aziende agricole ricevono una remunerazione, diretta o indiretta e non unicamente una forma di sostegno pubblico. Vengono, pertanto, escluse le attività aziendali tese alla produzione di eventuali beni pubblici, che non costituiscono oggetto di contabilizzazione nel valore economico del settore agricolo[4].

Lo scopo finale del lavoro è quello di analizzare i sistemi di classificazione in uso per la contabilizzazione economica delle attività di diversificazione, a livello nazionale ed europeo, al fine di evidenziarne le criticità e le lacune informative. Ciò risulta di particolare importanza per consentire una più efficace comparazione dei percorsi di diversificazione intrapresi dai diversi paesi membri dell'Ue, nell'ottica di una migliore definizione degli obiettivi di sviluppo e rafforzamento dell'agricoltura europea nell'ambito della Politica agricola comune (PAC) post 2020 (Jongeneel, 2018). Quanto detto va considerato unitamente al fatto che, i processi di diversificazione sono in continua evoluzione, mentre i corrispondenti sistemi di classificazione tendono a modificarsi in modo più lento. Tale evoluzione appare legata, quantomeno nel caso dell'Italia, anche alla dinamicità della normativa nazionale di riferimento che ha portato con sé il riconoscimento di nuove attività di diversificazione agricola, le quali però stentano a trovare spazio nelle statistiche ufficiali. In tal senso, un maggiore sforzo di rilevazione e omogeneizzazione delle informazioni potrebbe contribuire a catturare in modo più analitico lo sviluppo del fenomeno, su scala nazionale ma soprattutto europea dove il livello di adeguatezza delle informazioni appare più debole e lacunoso.

Il lavoro è articolato come segue: nel Paragrafo 2, viene realizzato un esercizio comparativo delle diverse voci di diversificazione, contemplate dal sistema di contabilità adottato dall'Istat, derivante dal quadro centrale dei Conti Nazionali[5] e da quello previsto da Eurostat, basato sui Conti Economici dell'Agricoltura (Conto CEA)[6]. Il quadro che ne emerge viene, a sua volta, posto in relazione con le attività di diversificazione previste dalla normativa nazionale, sia disposta dal codice civile, che dalla normativa settoriale di carattere fiscale (Par. 3). I risultati ottenuti permettono di disegnare una pri-

[2] Per una più attenta disamina dei più diffusi sistemi definitori adottati, si veda Henke e Salvioni (2011).

[3] La classificazione Nace è stata creata da Eurostat nel 1970, successivamente revisionata fino alla Rev. 2 del 2006, in vigore dal 2007 ad oggi.

[4] Alcuni tentativi di misurazione del valore dei beni pubblici prodotti in agricoltura sono stati condotti; tuttavia, le regole della contabilità agricola non rappresentano uno strumento adatto alla loro quantificazione e, allo stato dell'arte, è impossibile la loro inclusione nel valore della produzione della branca.

[5] Questo si basa sul nuovo Sistema europeo dei conti (Sec2010), costruito in coerenza con il sistema Nace. È stato applicato in Italia a partire dal 2014 e ha comportato importanti innovazioni e miglioramenti ai conti agricoli (Istat, 2015).

[6] In questo caso la metodologia di riferimento è definita nel *Manuale dei conti economici dell'agricoltura e della silvicoltura* (CEA/CES97). Pertanto, la base di calcolo dei conti per Eurostat non è stata più adeguata dopo il 1997, neppure a seguito dell'adozione del Sec2010.

ma mappatura delle voci di diversificazione fino ad oggi contemplate (Par. 4), ma soprattutto di avanzare delle proposte di adeguamento, nel rilevamento e nella presentazione, di queste informazioni a livello europeo, al fine di assicurare un quadro comparativo tra i paesi più efficace di quello attuale (Par. 5).

2. IL QUADRO DELLE ATTIVITÀ DIVERSIFICAZIONE NELLE STATISTICHE UFFICIALI DI CONTABILITÀ

I fenomeni di diversificazione, seppure analizzati solo dal punto di vista del loro valore economico, continuano a sfuggire ad una definizione completamente uniforme dei diversi sistemi statistici. Ciò va riportato a numerosi fattori ma, primo tra questi, all'evoluzione della stessa definizione di agricoltura, sia a livello nazionale che europeo. A questo riguardo, va, infatti, osservato come essa si sia progressivamente ampliata nel tempo, finendo per ricomprendere al suo interno, sia alcune attività che si configurano come una naturale estensione dell'attività primaria in senso stretto (coltivazione e allevamento), sia attività che esulano del tutto o in parte dall'ambito agricolo (come, ad esempio, la produzione di energia da alcune fonti rinnovabili o l'offerta di attività sociali e ricreative). Le attività di diversificazione agricola sono state, tuttavia, rilevate in modo parzialmente diverso nei singoli Stati membri dell'UE, rendendone così complessa la comparazione. Ciò è avvenuto sulla base delle regole del Manuale dei Conti che consente una certa flessibilità necessaria per tener conto delle caratteristiche specifiche di ciascuna agricoltura, oltre che alle diverse esigenze conoscitive, espresse su scala nazionale e europea. Peraltro, la disponibilità di un sistema di misurazione più coerente e dettagliato delle informazioni sulla diversificazione agricola appare particolarmente importante per una migliore gestione delle politiche pubbliche settoriali nei singoli paesi dell'UE. Quanto detto va considerato in relazione al fatto che gli agricoltori hanno la possibilità di accedere a numerose forme di supporto dovute all'attuazione della PAC o a specifiche normative tributarie e contributive previste a livello nazionale.

Di seguito vengono analizzati gli aspetti caratterizzanti l'articolazione delle voci di diversificazione dell'agricoltura nella contabilità nazionale italiana ed europea, al fine di approfondire le modalità con cui vengono classificate tali attività nei due sistemi di rilevazione. In particolare, ci si soffermerà esclusivamente sulle classificazioni riguardanti le attività secondarie che, nella logica generale della contabilità nazionale, come si vedrà meglio più avanti, corrispondono all'effettiva diversificazione agricola. Successivamente, i sistemi di classificazione di queste attività verranno posti a confronto con l'obiettivo di evidenziarne i tratti comuni, ma anche i fattori di differenziazione, in grado di determinare importanti limitazioni per l'analisi dei processi evolutivi in atto.

2.1. La contabilità nazionale

La contabilizzazione delle attività di diversificazione è considerata tra le principali novità del nuovo sistema di calcolo dettato in agricoltura dalle linee guida del Sec2010 per la determinazione del valore della produzione agricola (Ciaccia D., Moro R., 2017).

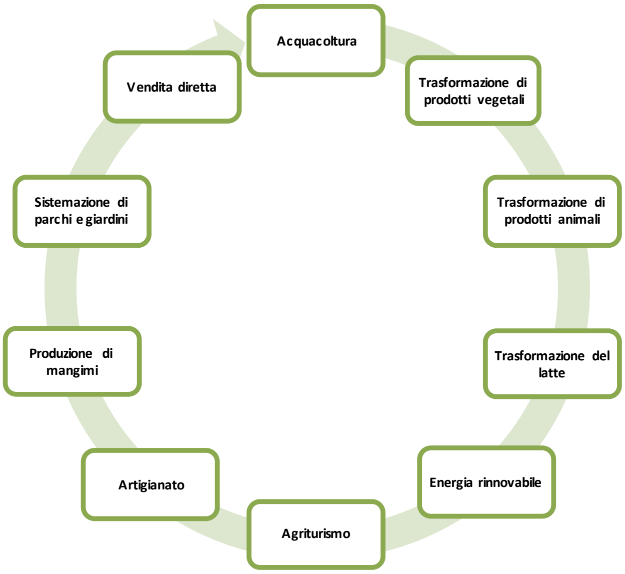
L'evoluzione dei conti economici nazionali degli ultimi anni ha portato con sé un ampliamento della numerosità delle voci che contribuiscono a comporre il fenomeno della diversificazione in Italia. Ciò è avvenuto di pari passo con le modifiche registrate dalle rilevazioni di carattere censuario, che hanno parallelamente rilevato le grandi trasformazioni strutturali e di orientamento produttivo delle aziende agricole, permettendo così di affinare i processi di stima delle variabili di carattere economico. Con l'introduzione di queste modifiche, la diversificazione viene articolata nei due macro aggregati: «attività di supporto» e «attività secondarie» che, insieme alle produzioni vegetali e animali, determinano il valore totale della produzione della branca agricoltura[7]. Le prime rappresentano le attività di supporto alla produzione agricola e similari effettuate per conto terzi (codice ATECO 01.6)[8] e, pertanto, strettamente legate alla fase della produzione primaria. Nella contabilità si presentano articolate in quattro sotto voci di maggiore dettaglio. In ragione della loro stretta connessione con la produzione vegetale e animale, il conteggio relativo alle attività dei servizi prodotti rientra direttamente nella determinazione del cosiddetto valore della "Produzione di beni e servizi dell'agricoltura".

Le attività secondarie restano, invece, identificate come componente autonoma. Esse sono definite come quelle che non intervengono allo stadio della produzione agricola e non costituiscono attività tradizionali dell'agricoltura, pur essendo di fatto non separabili da essa. Si trat-

[7] Il valore della produzione agricola è calcolato facendo riferimento cosiddetto metodo "quantità per prezzo". Pertanto, all'interno della contabilità nazionale sono presenti solo i valori di beni e servizi (in tutto oltre 170 voci) che vengono scambiati sul mercato e per i quali è possibile determinare un prezzo medio unitario. In questo quadro, anche le stime relative alle attività di diversificazione sono contabilizzate secondo questo metodo, se necessario facendo ricorso a collegamenti con soggetti detentori di informazioni specifiche in relazione agli andamenti rilevati.

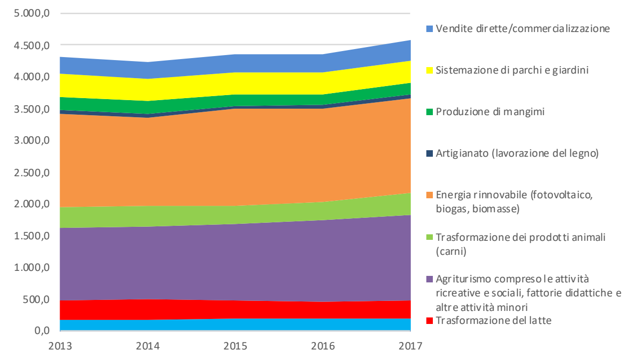
[8] Si tratta di: 01.61 – Attività di supporto alla produzione vegetale; 01.62 – Attività di supporto alla produzione animale; 01.63 – Attività successive alla raccolta; 01.64 – Lavorazione delle sementi per la semina.

Fig. 1. Elenco delle attività secondarie.



Fonte: ISTAT, Contabilità nazionale italiana.

Fig. 2. Evoluzione delle attività secondarie in Italia (media 2013-2017), migliaia di euro.



Fonte: elaborazioni su dati Istat.

ta di attività che si caratterizzano per una natura diversa dalla produzione primaria, ma con la quale si integrano in misura più o meno stretta. Infatti, tra le attività secondarie rientrano, sia quelle che costituiscono un ampliamento dell'attività agricola e che impiegano gli stessi prodotti agricoli (come ad esempio la trasformazione), sia quelle che, invece, utilizzano l'azienda e i suoi mezzi di produzione (terra, strutture, lavoro ecc.) per la loro realizzazione (come ad esempio l'agriturismo). Il loro conteggio si somma a quello della Produzione di beni e servizi dell'agricoltura, portando così alla definizione finale del valore della "Produzione della branca agricoltura"[9].

La Figura 1 riporta la quantificazione delle dieci voci che in Italia vengono prese a riferimento per il calcolo delle attività secondarie che, sulla base dell'approccio della contabilità nazionale, rappresentano la reale diversificazione agricola. La loro identificazione è avvenuta, in gran parte, sulla base alle informazioni derivanti dall'ultimo Censimento dell'agricoltura italiana che ha evidenziato la presenza, all'interno delle aziende agricole, di numerose attività emergenti, in aggiunta a quelle già tradizionalmente considerate come parte della diversificazione agricola (Istat, 2015). Le «Attività secondarie (+)» sono frutto di un processo di riaggregazione effettuato a partire dal più ampio elenco previsto dal Questionario censuario, che ha portato all'identificazione delle voci considerate, in questa sede, come il fulcro del fenomeno della diversificazione. Ciò in conseguenza del contributo, che tali attività hanno dato e continuano a dare, alla produzione della branca agricoltura, permettendo così di stabilizzare il peso relativo del settore agricolo nazionale sul complesso del sistema economico del nostro paese. L'importanza relativa della categoria considerata si è, infatti, progressivamente rafforzata, giungendo a pesare per oltre l'8% sul valore della Produzione della branca agricoltura (2017). Peraltro, salvo l'eccezione di un ristretto numero di anni, nel medio periodo i tassi di crescita più significativi hanno interessato proprio la componente delle attività secondarie (Fig. 2), rispetto a quelle di supporto o a quelle vegetali e zootecniche.

Tra queste dominano per consistenza la produzione di energia rinnovabile (34%) e l'agriturismo (28%), che comprende anche le attività ricreative e sociali, le fattorie didattiche e altre attività minori (Fig. 3). Modesto, invece, è stato lo sviluppo della trasformazione dei prodotti vegetali (4%), a fronte di una rilevanza più significativa della trasformazione di latte (7%) e prodotti animali (7%). Tra le attività più in continuità con quella agricola, si segnala il peso rivestito dalla vendita diretta e commercializzazione, pari al 7% del totale nel periodo e l'artigianato (2%). All'opposto, tra le attività che si collocano del tutto al di fuori del perimetro aziendale, si segnalano le attività di sistemazione di parchi e giardini che, tuttavia, hanno un peso non trascurabile nel periodo (8% del totale). Infine, irrilevante è il peso dell'acquacoltura che rappresenta meno dell'1% del totale.

2.2. La classificazione di Eurostat

Il sistema europeo dei conti, elaborato sulla base del sistema dei conti nazionali riveduto delle Nazioni Uni-

[9] Questa, in realtà, è definita dopo aver sottratto al valore generale le attività agricole condotte in forma di attività secondarie da aziende che appartengono settori produttivi diversi (ad es. imprese del settore commerciale) le quali in contabilità sono identificate con il segno -.

te, ha l'obiettivo di soddisfare i bisogni conoscitivi specifici dell'Unione europea. In particolare, lo scopo dei conti economici riferiti all'agricoltura (CEA) è quello di analizzare il processo di produzione e di formazione del reddito primario in modo comparativo tra i paesi membri. Anche se la relazione tra il CEA e i conti economici nazionali relativi alla branca agricoltura è molto stretta, il CEA è, in realtà, un conto satellite che richiede la definizione di norme e metodi specifici per la sua elaborazione.

Innanzitutto, il conto satellite differisce dal Quadro centrale dei conti, già in relazione alla stessa definizione di produzione agricola, escludendo dalla sua contabilizzazione le attività degli orti familiari, dei piccoli allevamenti e di alcune attività di servizi mentre include la produzione di olio e vino da cooperative. Viceversa, i conti nazionali includono le prime ed escludono le seconde.

In secondo luogo, il conto satellite si basa sull'unità di attività economica a livello locale (UAEL) che è l'unità in rapporto alla quale vengono rilevati e analizzati i flussi che si verificano nel processo di produzione e nell'uso di beni e servizi. L'attività principale dell'unità di attività economica a livello locale è l'attività il cui valore aggiunto supera quello di qualsiasi altra attività esercitata nella stessa unità sebbene, accanto ad essa, si possano esercitare anche una o più attività secondarie. Queste ultime sono definite come attività

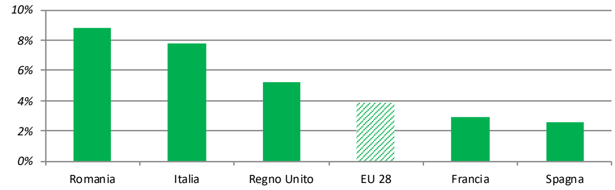
strettamente connesse alla produzione agricola per le quali le informazioni sulla produzione, sui consumi intermedi, sui redditi da lavoro dipendente, sugli input di lavoro dipendente o sugli investimenti fissi lordi non possono essere distinte dalle informazioni sull'attività agricola principale nel corso dell'osservazione statistica (CEA/CES 97).

In generale, le «attività non agricole non separabili» in Eurostat vengono distinte in due tipologie[10] che non corrispondono a quelle previste nei conti nazionali italiani.

La prima di esse è rappresentata dalla «Trasformazione dei prodotti agricoli» che viene bene definita e dettagliata[11], includendo al suo interno la trasformazione di: cereali; ortaggi; frutta; vino; animali; prodotti animali; latte; altri prodotti animali e altro.

La seconda voce «Altre produzioni di beni e servizi», al contrario, riunisce in modo indifferenziato tutte quelle attività che utilizzano l'azienda agricola e i suoi mezzi di produzione. In questa categoria, a seconda del-

Fig. 3. Peso delle attività secondarie non separabili sul valore della produzione agricola (media 2013-2017) in Italia e nell'EU, valori espressi in %.



Fonte: elaborazioni degli autori su dati Eurostat.

le caratteristiche dei diversi paesi, possono rientrare: l'agriturismo, la rivendita di prodotti agricoli, lo sport e le attività ricreative rurali, i servizi prestati a favore di terzi come, ad esempio, il noleggio e riparazione di macchine agricole, la manutenzione di fabbricati agricoli, i servizi paesaggistici, le altre attività utilizzanti i terreni di produzione agricola.

È in particolare quest'ultima voce quella che, ai fini dello studio della diversificazione delle attività agricole, dovrebbe essere deputata a fornire le informazioni di maggiore interesse e dettaglio. Tuttavia, la rilevazione delle informazioni relative a tali attività risulta largamente discrezionale nei diversi paesi membri dell'UE. Inoltre, non è prevista nessuna sottovoce di dettaglio, essendo presentata come un unico aggregato indifferenziato. Ciò rende difficile la comparazione dei percorsi di diversificazione in atto, limitando di molto l'analisi evolutiva del fenomeno.

L'analisi dei dati relativi alla media del periodo 2013-2017[12] mostra come la diversificazione rappresenti un valore pari a circa il 4% per la media della produzione dell'agricoltura nei singoli paesi dell'UE (Fig. 3). Tuttavia, emergono notevoli differenze tra stati, con la Romania e l'Italia che risultano caratterizzate da un peso largamente superiore delle attività secondarie rispetto alla media. Inoltre, nello stesso periodo 2013-2017, le imprese agricole italiane risultano aver realizzato ben il 27% del valore delle attività secondarie dell'intera UE, seguite da quelle di Francia (13%), Regno Unito (10%), Spagna (8%) e Romania (9%). Complessivamente questi cinque paesi spiegano da soli più della metà delle attività secondarie in agricoltura registrate dai paesi membri.

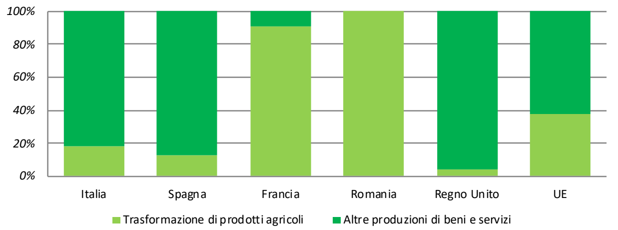
Approfondendo le due tipologie di attività secondarie contemplate per l'Italia, risultano di gran lunga dominanti le attività diverse dalla trasformazione agricola tradizionale (82%); analogamente accade in Spagna e nel Regno Unito, dove tali attività costituiscono rispet-

[10] Per un approfondimento si rimanda a: https://ec.europa.eu/eurostat/documents/3859598/5854389/KS-27-00-782-EN.PDF/

[11] Tali processi di trasformazione possono dar luogo a prodotti molto vari, tra cui il manuale cita: burro, succhi di frutta, conserve, confetture, prodotti alcolici, filatura di tessili, lana e intreccio di materie vegetali, patè, foie gras ecc.

[12] Il dato si riferisce all'insieme delle attività secondarie non separabili: trasformazione e le altre attività non separabili.

Fig. 4. Composizione delle attività secondarie in Italia e nell'UE (media 2013-2017), valori espressi in %.



Fonte: elaborazioni degli autori su dati Eurostat.

tivamente l'88% e il 96% del totale delle attività secondarie (Fig. 4). Al contrario, in Romania e in Francia sono le trasformazioni dei prodotti agricoli, ed in particolare di prodotti animali in Romania e di vino[13] in Francia, a rappresentare la totalità o quasi totalità delle attività secondarie contabilizzate.

3. LA DIVERSIFICAZIONE AGRICOLA NELLA NORMATIVA ITALIANA

Diversamente dalla contabilità nazionale ed europea, nella normativa nazionale il centro delle attività agricole di diversificazione è costituito dalle cosiddette attività connesse. Sulla base dell'articolo 2135 del codice civile, queste ultime vengono definite come quelle direttamente collegate alla produzione agricola o di allevamento e finalizzate alla manipolazione, conservazione, trasformazione, commercializzazione e valorizzazione dei prodotti dell'azienda. Sono considerate attività connesse anche la trasformazione e commercializzazione di prodotti acquistati da terzi, svolte dall'imprenditore agricolo, a condizione che siano prevalenti i prodotti propri e che appartengano al medesimo comparto produttivo di quelli realizzati in azienda. In merito a quest'ultimo aspetto, la normativa è molto precisa, prevedendo che qualora nella trasformazione dei prodotti agricoli ci si avvalga anche di materie acquistate da altri, è necessario che siano rispettate una serie di condizioni per poter rimanere nel novero delle attività connesse. Innanzitutto, i beni e le attività devono essere previsti in un apposito decreto; inoltre, le produzioni proprie devono essere prevalenti rispetto a quelle acquistate da terzi e i prodotti acquistati da terzi devono rientrare nel comparto di quelli realizzati in proprio. Appartengono alle attività connesse anche quelle dirette alla fornitura di beni e servizi, attraverso l'utilizzo predominante di attrezzature o risorse dell'azienda normalmente impiegate nell'attività agricola. Il limite va ricercato nei criteri di prevalenza dei servizi operati sul proprio fondo o sui propri prodotti rispetto a quelli resi a terzi e l'attinenza dell'attività svolta con l'attività agricola principale.

Tuttavia, va precisato che si parla di attività connesse solo in relazione alle aziende agricole, soggette a tassazione catastale, che rappresentano la maggioranza delle aziende del settore (88%), mentre per tutte le altre si parla genericamente di attività secondarie, cioè attività esercitate accanto ad un'attività agricola principale[14]. La definizione di attività agricole connesse viene utilizzata, in questa sede, per fornire un ulteriore contributo per la migliore definizione delle modalità con cui si manifesta la diversificazione in agricoltura, essendo molto dettagliate nell'ambito della normativa di riferimento. Quest'ultima è costituita, innanzitutto, dal decreto del 13 febbraio 2015[15] che individua i beni che possono essere oggetto di attività agricole per connessione[16], integrata da ulteriori norme in materia.

Nella Tabella 1 le attività di diversificazione sono state suddivise in categorie in rapporto alla loro tipologia sulla base della normativa esistente. Si tratta sia attività tradizionalmente legate all'agricoltura quali la trasformazione di prodotti agricoli, che di attività che esulano completamente dal settore quali, ad esempio, la realizzazione di prodotti della chimica verde. Per quanto riguarda la trasformazione, la normativa si è spinta molto avanti, considerando attività agricole per connessione anche quelle finalizzate alla produzione di prodotti alimentari come succhi di frutta, pane, pasta e birra, normalmente appannaggio dell'industria alimentare. Ciò con l'obiettivo di permettere agli agricoltori, soggetti a tassazione catastale, di integrare il proprio reddito, ampliando il novero delle attività considerate come agricole e favorendo così la crescita del settore. Va sottolineato, in proposito, che la normativa fiscale usa quale ele-

[13] In merito alla trasformazione di vino, è bene evidenziare come questa riguardi le attività di elaborazione successive all'ottenimento del prodotto vino, e non la trasformazione di uve in vino. Quest'ultima, insieme all'olio di oliva, è tradizionalmente inclusa all'interno del valore della produzione agricola (componente vegetale), seppure con una differenza tra contabilità nazionale ed europea, relativamente alla cooperazione, che è esclusa dal primo sistema e inclusa dal secondo.

[14] La normativa di rifà al concetto di attività principale definita sulla base dell'appartenenza ad uno dei codici Ateco relativi al settore agricolo. La classificazione Ateco costituisce la versione nazionale della nomenclatura Nace Rev.2.

[15] Il decreto riguarda l'individuazione dei beni che possono essere oggetto delle attività agricole connesse, di cui all'articolo 32, comma 2, lettera c), del testo unico delle imposte sui redditi. (15A02038), (Gu Serie Generale n. 62 del 16-03-201

[16] Il decreto, pubblicato sulla Gazzetta Ufficiale, Serie Generale n. 62 del 16-03-2015, individua i beni che possono essere oggetto delle attività agricole connesse, di cui all'articolo 32, comma 2, lettera c), del testo unico delle imposte sui redditi e rientrare nella tassazione catastale del reddito.

Tab. 1. Il quadro normativo delle attività di diversificazione agricola.

Descrizione delle attività di diversificazione	Tipologia di attività
Produzione di carni e prodotti della loro macellazione Produzione di carne essiccata, salata o affumicata, salsicce e salami Lavorazione e conservazione delle patate, escluse le produzioni di purè di patate disidratato, di snack a base di patate, di patatine fritte e la sbucciatura industriale delle patate Produzione di succhi di frutta e di ortaggi Lavorazione e conservazione di frutta e di ortaggi Produzione di olio di oliva e di semi oleosi Produzione di olio di semi di granturco (olio di mais) Trattamento igienico del latte e produzione dei derivati del latte Lavorazione delle granaglie Produzione di farina o sfarinati di legumi da granella secchi, di radici o tuberi o di frutta in guscio commestibile Produzione di pane Produzione di paste alimentari fresche e secche Produzione di vini Produzione di grappa Produzione di aceto Produzione di sidro e di altri vini a base di frutta Produzione di malto Disidratazione di erba medica Lavorazione, raffinazione e confezionamento del miele Produzione di sciroppi di frutta Produzione e conservazione di pesce, crostacei e molluschi, mediante congelamento, surgelamento, essiccazione, affumicatura, salatura, immersione in salamoia, inscatolamento, e produzione di filetti di pesce Manipolazione dei prodotti derivanti dalle coltivazioni di cui alle classi 01.11, 01.12, 01.13, 01.15, 01.16, 01.19, 01.21, 01.23, 01.24, 01.25, 01.26, 01.27, 01.28 e 01.30, nonché di quelli derivanti dalle attività di cui ai sopraelencati gruppi e classi.	Trasformazione di prodotti agricoli e della pesca
Servizi di ricezione e ospitalità resi mediante l'utilizzazione prevalente di attrezzature o risorse dell'azienda normalmente impiegate nell'attività agricola esercitata. Rientrano tra le attività agrituristiche anche l'organizzazione di attività ricreative, culturali, didattiche, di pratica sportiva, escursionistiche, di ippoturismo finalizzate a una migliore fruizione e conoscenza del territorio nonché la degustazione dei prodotti aziendali, ivi inclusa la mescita del vino.	Agriturismo
Produzione di energia da fonti "rinnovabili agroforestali": s'intendono le biomasse, ovvero, la parte biodegradabile dei prodotti, rifiuti e residui provenienti dall'agricoltura (comprendente sostanze vegetali ed animali) e dalla silvicoltura (es. biomasse legnose che si ottengono da legna da ardere, cippato di origine agroforestale, o pellet derivante dalla segatura di legno); Produzione di energia da fonti "rinnovabili fotovoltaiche": s'intendono i moduli o pannelli fotovoltaici, in grado di convertire l'energia solare in energia elettrica.	Produzione di energia rinnovabile
Produzione di "carburanti derivanti da produzioni vegetali": s'intendono prodotti quali il bioetanolo (etanolo ricavato dalla biomassa ovvero dalla parte biodegradabile dei rifiuti, destinato ad essere usato come carburante); il biodiesel (etere metilico ricavato da un olioil biodiesel (etere metilico ricavato da un olio vegetale o animale, destinato ad essere usato come carburante); il biogas carburante ed altri carburanti simili	Produzione di biocarburante
Produzione di "prodotti chimici derivanti da prodotti agricoli": s'intendono prodotti quali biopolimeri, bioplastiche ecc. che si ottengono per esempio da amido e miscele di amido (prodotti della c.d. chimica verde).	Produzione di prodotti della chimica verde
Servizi resi mediante l'utilizzazione prevalente di attrezzature dell'azienda quali il noleggio di macchine aziendali; rientra in questa categoria anche la manutenzione di parchi e giardini esercitata con personale/attrezzature dell'azienda.	Altre attività di servizi

Fonte: elaborazione degli autori.

mento identificativo dell'attività di trasformazione, considerata come connessa, il prodotto finale (ad es. pane, grappa, aceto ecc.), anziché fare riferimento ai prodotti agricoli utilizzati come materia prima o prodotto intermedio all'interno del processo di trasformazione (latte, frutta, cereali ecc.). Ciò consente di fare luce sulla reale portata delle attività di diversificazione, considerando che molti dei prodotti alimentari inclusi tra tali attività, sono ottenuti con processi di trasformazione che si allontanano, spesso in misura notevole, dalla fase di produzione agricola.

Tra le attività di diversificazione un posto a parte merita l'agriturismo che è tra esse quello più sviluppato e variegato. Infatti, la normativa in materia prevede che rientrino nel novero delle attività agrituristiche, oltre alla ricezione e ospitalità, la somministrazione di pasti e bevande costituiti prevalentemente da prodotti propri e da prodotti di aziende agricole della zona in cui è ubicata l'azienda, l'organizzazione di degustazioni di prodotti aziendali e di altre attività anche all'esterno dei beni fondiari nella disponibilità dell'impresa quali: attività ricreative, culturali, didattiche, di pratica sportiva, nonché escursionistiche e di ippoturismo, anche per mezzo di convenzioni con gli enti locali, finalizzate alla valorizzazione del territorio e del patrimonio rurale.

A seguire, i più recenti aggiornamenti introdotti dalla normativa fiscale annoverano come afferenti al campo delle attività connesse un gruppo di attività innovative. Si tratta della produzione di energia rinnovabile, sia a partire dalla biomassa agricola e forestale, che quella prodotta con l'installazione di pannelli fotovoltaici. In questi casi la normativa fissa alcuni limiti legati, innanzitutto, alla potenza degli impianti[17].

Ulteriori attività considerate agricole per connessione sono la produzione di biocarburanti e di prodotti della chimica verde. Anche in questo caso, la normativa, fissa dei paletti: per i biocarburanti è previsto che debbano essere ottenuti da produzioni vegetali provenienti prevalentemente dal fondo mentre, per i prodotti chimici, stabilisce che debbano derivare da prodotti agricoli provenienti prevalentemente dal fondo effettuati dagli imprenditori agricoli.

In sintesi, i progressivi adeguamenti della normativa hanno determinato la costituzione di un elenco piuttosto esteso delle attività di diversificazione, che presentano spesso indicazioni di dettaglio (come nel caso della trasformazione e dell'agriturismo), al fianco di una visione molto spesso «avveniristica» delle attività agricole, che forse è ancora lontana dal produrre effetti concreti.

4. RISULTATI

Il confronto tra i due diversi sistemi di classificazione in uso per la rilevazione del fenomeno della diversificazione, unitamente all'analisi della normativa nazionale in vigore, evidenziano la presenza di significative differenze negli approcci impiegati, nel livello di dettaglio delle voci di attività individuate e nella loro organizzazione interna. Da tutte queste differenze emergono, inevitabilmente, alcune rilevanti lacune informative che sarebbe opportuno colmare, affinché si possa disporre di informazioni in grado di catturare la complessità della «mappa» della diversificazione agricola e valutarne la reale dimensione, unitamente alle sue dinamiche, consentendo altresì di realizzare delle idonee analisi comparative tra i paesi membri dell'Unione (Tab. 2).

Il più rilevante tratto in comune, tra tutti i sistemi fini qui analizzati, che costituisce un'ottima base di lavoro per un percorso di riavvicinamento, è rappresentato dalle attività di trasformazione, che sono quelle che si pongono più immediatamente in continuità con la fase agricola. Queste, seppure con un diverso grado di approfondimento, sono rappresentate in maniera bene evidente in tutti i tre sistemi di classificazione osservati. Tuttavia, si possono notare alcune differenze di approccio: la normativa nazionale ha definito queste attività ricorrendo ad un dettaglio molto spinto, basato sui prodotti finali; la contabilità nazionale, invece, ha dato particolare enfasi ad alcune tipologie di trasformazione quali il latte, i prodotti vegetali e la carne, per le quali vengono raccolte le relative informazioni statistiche. Infine, Eurostat, ha organizzato la raccolta delle informazioni tenendo conto dell'ampia varietà di prodotti agricoli di partenza che possono costituire la materia prima dei processi di trasformazione in seno all'azienda agricola.

Quando, invece, si passa ad analizzare le altre voci della diversificazione, il livello della corrispondenza tra i sistemi classificatori si indebolisce in maniera significativa, facendo emergere un diverso livello di attenzione e sensibilità ai fenomeni in atto. Nel caso dell'agriturismo, che da più parti è considerata una voce tradizionale di diversificazione, si segnala come la normativa nazionale abbia saputo descrivere con estrema precisione la complessità dell'offerta di servizi agrituristici, che si è andata sempre più ampliando nel tempo, fino ad includere una molteplicità di attività e di servizi che non hanno quasi nessun collegamento funzionale con l'attività agricola

[17] La produzione di energia fotovoltaica derivante dai primi 200 Kw di potenza nominale complessiva si considera in ogni caso connessa all'attività agricola; mentre la produzione di energia fotovoltaica eccedente i primi 200 Kw di potenza nominale complessiva può essere considerata connessa all'attività agricola solo se sussistono specifici seguenti requisiti.

Tab. 2. Tavola di corrispondenza della classificazione delle attività di diversificazione.

Normativa nazionale relativa alle attività connesse	Classificazione ISTAT	Classificazione Eurostat
Trasformazione di prodotti dell'agricoltura, della silvicoltura e della pesca	Trasformazione dei prodotti vegetali, del latte e dei prodotti animali Produzione di mangimi	Trasformazione ortaggi, frutta, prodotti animali, animali, cereali
Attività agrituristiche	Agriturismo compreso le attività ricreative, sociali e altre attività minori	Altre attività secondarie di produzione e servizi
Produzione di energia rinnovabile	Produzione di energia rinnovabile (fotovoltaico, biogas, biomasse)	
Produzione di biocarburanti	Non rilevata	
Produzione di prodotti della chimica verde	Non rilevata	
Altre attività connesse	Vendite dirette e commercializzazione Sistemazione di parchi e giardini Artigianato	

Fonte: elaborazione degli autori

(ISTAT, 2018a; ISMEA, 2018)[18]. La contabilità nazionale si pone, invece, in una posizione intermedia, associando all'agriturismo anche altre attività minori (fattorie didattiche, attività ricreative ecc.); mentre, Eurostat non esplicita neppure questa storica voce di diversificazione all'interno del suo database, inserendola in un aggregato indifferenziato «Altre produzioni di beni e servizi». È proprio su questa voce indifferenziata della classificazione di Eurostat che si rietine opportuno focalizzare l'attenzione. Tale aggregato, infatti, soffre di due importanti limiti. Il più evidente riguarda la mancanza di un'adeguata articolazione interna, che consenta di pesare e dare significatività ai suoi elementi costituenti. Il secondo, dal quale in realtà discende il precedente, riguarda invece la voluta indeterminatezza di questa voce, argomentata all'interno del Manuale CEA/CES97 come rispondente alla necessità di tenere conto delle specificità dei percorsi di diversificazione in ciascun paese membro. Questo aspetto, in particolare, se da un lato consente di garantire una giusta elasticità a ciascuno Stato membro, dall'altro finisce con il mascherare le caratteristiche specifiche della diversificazione e rende opaca la reale dimensione del fenomeno nel confronto tra le diverse agricolture nazionali dell'UE.

Infine, l'analisi comparativa pone in evidenza una serie di voci di diversificazione, particolarmente innovative (come la produzione di biocarburanti, o la chimica verde), che certamente non sono contemplate dalla contabilità nazionale curata dall'Istat, e che con ogni probabilità sfuggono anche alla contabilizzazione di Eurostat, la quale non fornisce indicazioni in merito e discende dalle comunicazioni ricevute dai diversi paesi membri.

In sintesi, tutti i sistemi presi a riferimento hanno saputo cogliere e valorizzare solo in parte la complessità del percorso di sviluppo che ha investito il mondo agricolo nella direzione della diversificazione. Peraltro, ciascuno dei tre sistemi osservati si caratterizza per finalità diverse, che determinano delle fisiologiche differenze. Queste, tuttavia, potrebbero essere almeno in parte attenuate con uno sforzo di minima armonizzazione, teso ad assicurare un miglior grado di comparabilità tra sistemi e a paesi. Ciò è particolarmente importante nel contesto di una politica agricola comune, che si va sviluppando nella direzione di un'agricoltura che tenga sempre più conto del raggiungimento di obiettivi in campo economico, ambientale e sociale, come dimostrano le proposte in discussione per il periodo post 2020.

Nel tentativo di cogliere questa estrema varietà, le classificazioni nazionali in uso in Italia (conti economici e normativa) sono state interessate da significativi tentativi di innovazione, che però si sono manifestati con intensità e velocità diverse. Mentre, va rilevato come la classificazione Eurostat sia rimasta ferma nel tempo e basata su un approccio che appare oggi inadeguato a rappresentare i fenomeni in atto, non essendo stata oggetto di un aggiornamento o di un processo di revisione nel corso degli ultimi venti anni, durante i quali l'agricoltura europea si invece è profondamente modificata, anche sotto la spinta delle politiche comuni, progressivamente indirizzate a ridisegnarne i ruoli e le funzioni tradizionali (De Filippis, 2007).

Infine, va segnalato il fatto che nessuna delle tre classificazioni ufficiali qui osservate appare pienamente coerente con gli approcci impiegati in prevalenza dalla

[18] È questo il caso, ad esempio, dell'affitto di attrezzature non agricole per l'esercizio di alcune attività sportive (bicicletta, tiro con l'arco, trekking, osservazioni naturalistiche ecc.).

letteratura scientifica per la descrizione dei fenomeni di diversificazione, richiamati in apertura di questo contributo.

5. DISCUSSIONE FINALE

L'analisi delle informazioni disponibili sulla diversificazione ha messo in evidenza come tale fenomeno abbia conosciuto dei tassi di sviluppo sostenuti negli ultimi anni, così da dare oggi un contributo di primo piano alla formazione della produzione settoriale, soprattutto in Italia, rispetto al complesso dell'UE. In alcuni casi, come per la trasformazione di prodotti agricoli e l'agriturismo, tali processi si sono basati su attività consolidate e ormai abbastanza radicate nel tessuto delle aziende agricole, mentre in altri presentano elementi di assoluta novità. Al contempo, all'interno delle attività storicamente esercitate dalle aziende agricole, si vanno evidenziando continui processi di ampliamento del campo di azione o di recupero di attività un tempo diffuse e poi abbandonate, quali ad esempio la trasformazione in azienda di alcuni prodotti agro-alimentari, che nella fase di industrializzazione del paese erano comunemente divenuti appannaggio dell'industria alimentare (Fanfani, 2001). Ciò mostra come il concetto di diversificazione risulti in costante evoluzione e necessiti di progressivi adeguamenti nei sistemi classificatori deputati alla loro misurazione.

Questa dinamicità, peraltro, si combina anche con una forte differenziazione territoriale del fenomeno, resa evidente sia dall'analisi regionale dei dati di contabilità nazionale (CREA, 2018; Fanfani, Sardone, 2017), che da quella per paese desumibile da Eurostat (ISTAT, 2018b; Lo Surdo, 2018).

In un contesto così mutevole, la disponibilità di regole e modalità di rilevazione comuni, definite all'interno di Manuali aggiornati, rappresenta un elemento di base essenziale per la corretta costruzione dei conti economici dell'agricoltura e per una più chiara definizione della dimensione della diversificazione agricola. Pertanto, sembra innanzitutto utile richiamare l'attenzione sul fatto che il sistema di rilevazione dei conti Eurostat, attualmente in uso, è rimasto purtroppo fermo al 1997; mentre, sarebbero auspicabili alcune modifiche, soprattutto in vista delle opportunità connesse alla realizzazione della prossima rilevazione censuaria, programmata al 2020 per tutti i paesi dell'UE.

La necessità prioritaria che si pone in evidenza riguarda anche l'adozione di una metodologia maggiormente uniforme per la determinazione delle voci da includere tra le attività di diversificazione. Come già sottolineato, nella contabilità europea tra le attività secondarie sono previste, con un livello di dettaglio piuttosto spinto, numerose voci di trasformazione di prodotti agricoli, che però non sono rilevate in maniera omogenea da tutti i paesi membri. Anzi, in molti casi tali processi di trasformazione risultano del tutto inattuati, con la conseguente mancata compilazione dei corrispondenti campi di contabilità[19]. Allo stesso tempo, la flessibilità finora riconosciuta ai paesi membri dal manuale CEA/CES97, relativamente all'individuazione delle altre attività di diversificazione da rilevare (agriturismo, produzione di energia rinnovabile, artigianato e altre attività minori) ha, di fatto, reso opaca la rilevazione stessa, determinando l'impossibilità di determinare con esattezza i fattori trainanti di questo fenomeno. Tale identificazione resta possibile ricorrendo alle singole contabilità nazionali, ma solo laddove queste ultime siano state sviluppate in misura più dettagliata di quanto richiesto da Eurostat, come nel caso dell'Italia, la quale possiede un sistema di contabilità piuttosto avanzato, che costituisce un'eccezione nel panorama europeo.

In sintesi, una lettura non deformata della diversificazione agricola nei paesi europei non può prescindere da un profondo processo di revisione e aggiornamento delle regole di rilevazione di Eurostat. Inoltre, un quadro contabile più preciso, coerente e uniforme a livello europeo, permetterebbe di rispondere meglio ai bisogni emergenti degli stakeholder, tenuto conto del fatto che queste informazioni rappresentano la base di partenza per la definizione delle politiche pubbliche, decise e attuate in agricoltura, su scala europea e nazionale. Quanto detto vale, in particolare, nell'ottica della PAC post 2020, per la quale una conoscenza più approfondita del fenomeno della diversificazione consentirebbe di effettuare scelte più consapevoli per il settore primario e più coerenti con la necessità di raggiungere la pluralità degli obiettivi individuati quali: la garanzia del reddito degli agricoltori, l'uso sostenibile delle risorse naturali, la mitigazione dei cambiamenti climatici, il ricambio generazionale (Commissione Europea, 2018). Infine, va anche ricordato come molte delle misure già attuate nell'ambito del secondo pilastro della PAC, hanno tra le proprie finalità quella di fornire supporto per lo sviluppo delle attività secondarie, in ragione del loro potenziale di impatto per la crescita delle aree rurali.

In proposito, va considerato che a livello europeo è in corso il processo di revisione delle statistiche sull'agricoltura che ha, tra i suoi principali obiettivi, proprio il miglioramento della qualità delle statistiche agricole, ivi inclusa la chiarificazione delle definizioni impiega-

[19] Come esempio eclatante si può citare la trasformazione dei cereali, che risulta presente in pochissimi casi.

te (Eurostat, 2018). In tale ambito, un approfondimento delle informazioni sulla diversificazione agricola nei singoli paesi membri, che non sembra ancora aver trovato spazio, potrebbe rivelarsi particolarmente utile, al fine di individuare quelle da riportare, in modo stabile, nei sistemi di contabilità. A quest'ultimo riguardo, l'impiego della FADN (*Farm Accountancy Data Network*)[20] potrebbe facilitare il lavoro, essendo basata su un sistema di raccolta armonizzato delle informazioni sulle imprese agricole, svolto annualmente da tutti i paesi europei. Il principale limite di questa fonte è costituito dal fatto che la classificazione adottata è basata ancora sul concetto di orientamento tecnico economico (OTE), che ne rende difficile l'integrazione con le classificazioni organizzate sulle nomenclature NACE/ATECO, come quelle di contabilità. Nella stessa direzione, il Censimento dell'agricoltura 2020 potrebbe costituire l'occasione per rilevare ulteriori elementi in grado di meglio definire il quadro della diversificazione agricola, a condizione di raccogliere, in modo omogeneo, informazioni su aspetti della diversificazione agricola meritevoli di approfondimento. Tra questi per esempio, almeno nel caso italiano, ci sono quelli legati alla produzione di prodotti atipici per il settore agricolo (chimica verde), che potrebbero svilupparsi nei prossimi anni. Quanto detto, consentirebbe di far luce sulla direzione dell'attuale processo di diversificazione e sull'opportunità di dare spazio ad un'agricoltura, forse meno agricola e più orientata al territorio, a discapito una più tradizionale, legata alla produzione primaria in senso stretto.

BIBLIOGRAFIA

Aguglia L., Henke R., Salvioni C. (2008). *Agricoltura multifunzionale. Comportamenti e strategie imprenditoriali alla ricerca della diversificazione.* INEA, Studi & Ricerche, ESI, Napoli.

Belletti G., Brunori G., Marescotti A., Rossi A. (2003). *Multifunctionality and rural development: a multilevel approach.* in Van Huylenbroeck G., Durand G., a cura di Multifunctional Agriculture. A new paradigm for European agriculture and Rural Development, Ashgate, Burlington, VT (USA) e Aldershot (UK).

Ciaccia D., Moro R. (2014). Produttività dei fattori e distribuzione del valore aggiunto: un confronto europeo. *Agriregionieuropa,* 36(10).

Ciaccia D., Moro R. (2017). I conti economici dell'agricoltura, in Cristofaro A., a cura di Fisco e agricoltura: una difficile convivenza. *Collana di Economia Applicata*, Vol. 5: 15-27.

Commissione Europea (2018). *COM (2018) 392 final.* Bruxelles, 1.6.2018.

Cooper T., Hart K., Baldock D. (2009). The Provision of Public Goods Through Agriculture in the European Union. Report Prepared for DG Agriculture and Rural Development, Contract No 30-CE-0233091/00-28, Institute for European Environmental Policy: London.

Crea (2019). *Annuario dell'agricoltura italiana*, 2017. Volume LXXI, Roma.

Cristofaro A. (2014). Produzione e produttori nel settore agricolo: definizioni e fonti statistiche. *Agriregionieuropa,* 36(10).

Cristofaro A. (2011) Le statistiche tributarie: una lente deformata ma necessaria per l'analisi del mondo agricolo. *Agriregionieuropa,* 26(7).

De Benedictis M., a cura di (1990). Trasformazioni agrarie e pluriattività in Italia. *Inea Studi & Ricerche*, Il Mulino, Bologna.

De Filippis F., a cura di (2007). *Oltre 2013. Il futuro delle politiche dell'Unione Europea per l'agricoltura e le aree rurali.* Atti del Workshop tenuto a Palazzo Rospigliosi, Roma 11 luglio 2007, Quaderni Gruppo 2013, Tellus, Roma, 2007.

Durand G., Van Huylenbroeck G. (2003). *Multifunctionality and Rural Development: a general framework*. in Van Huylenbroeck G., Durand G., eds.: Multifunctional Agriculture. A new paradigm for European agriculture and Rural Development, Ashgate, Burlington, VT (USA) e Aldershot (UK).

European Commission (2018). *Strategy for agricultural statistics for 2020 and beyond*. ESSC meeting, November 2015

European Commission and Eurostat (2008). *Statistical classification of economic activities in the European Community (Nace, Rev.2).* European Communities.

Eurostat (2000). *Manual on the economic accounts for agriculture and forestry.* EAA/EAF 97, Luxemburg.

Fanfani R. (2001). *L'agricoltura in Italia. Dalla riforma agraria alle quote latte. Come era e come è la nostra agricoltura*, Farsi un'idea, Il Mulino, Bologna.

Fanfani R., Sardone R. (2017). *La diversificazione delle attività in agricoltura: opportunità, sviluppo dei redditi e nuove sfide della società.* in Annali dell'Accademia Nazionale di Agricoltura, Volume CXXXVI, anno 2016, Bologna.

Finocchio R. (2008). *Processi di diversificazione multifunzionale nelle imprese agricolo marchigiane.* Associazione Alessandro Bartola, PhD Studies Series, Vol. 3.

[20] Si tratta della rete europea di contabilità delle aziende agricole, che raccoglie in modo armonizzato i dati su un campione di aziende agricole rappresentativo delle realtà agricole dei paesi membri dell'UE, ciò con l'obiettivo di monitorare l'attuazione della politica agricola comune.

Floreani A. (2004). *La valutazione dei rischi e le decisioni di risk management*. Pubblicazioni dell'I.S.U. Università Cattolica, Milano.

Henke R., a cura di (2004). Verso il riconoscimento di una agricoltura multifunzionale. Teorie, politiche, strumenti. INEA, *Collana Studi & Ricerche*. Fabiani G. (1991), Letture territoriali dello sviluppo agricolo, Franco Angeli, Milano

Henke R., Salvioni C. (2008). Multifunzionalità in Agricoltura: sviluppi teorici ed evidenze empiriche. *Rivista di Economia Agraria* LXIII, 1: 5-34.

Henke R., Salvioni C. (2011). La diversificazione dei redditi nelle aziende agricole italiane. *QA – Rivista dell'Associazione Rossi-Doria*, 3: 25-56.

Henke R., Povellato A. (2012). La diversificazione nelle aziende agricole italiane. *Agriregionieuropa*, 31(8).

Henke R., Salvioni C., a cura di (2014). *I redditi in agricoltura. Processi di diversificazione e politiche di sostegno.* INEA.

ISMEA (2018). *Agriturismo e multifunzionalità. Scenario e prospettive.* Rapporto 2018, RRN.

ISTAT (2018b). *Le aziende agrituristiche in Italia.* Report, 26.09.2018.

ISTAT (2018b). *L'andamento dell'economia agricola.* Report, 17.05.2018.

Jongeneel R.A. (2018). Research for AGRI Committee – *The CAP support beyond 2020: assessing the future structure of direct payments and the rural developments interventions in the light of the EU agricultural and environmental challenges*. European Parliament, Policy Department for Structural and Cohesion Policies, Brussels

JRC (2013). Feasibility Study on the Valuation of Public Goods and Externalities in EU Agriculture

Lo Surdo G. (2018). Il "Km zero" moltiplica il valore dei prodotti agricoli. *L'Informatore agrario*, N. 30, 30.08.2018

Nazzaro C. (2008). *Sviluppo rurale, multifunzionalità e diversificazione in agricoltura. Nuovi percorsi di creazione di valore per le aziende agricole delle aree interne del Mezzogiorno d'Italia*. Franco Angeli, Milano.

OCSE (1998). *Multifunctionality: A Framework for Policy Analysis.* OCSE, Parigi.

OCSE (2001). *Multifunctionality: Towards an Analytical Framework.* OCSE, Parigi.

OCSE (2003). *Multifunctionality: The Policy Implications*. OCSE, Parigi.

OCSE (2005). *Multifunctionality in Agriculture. What Role for Private Initiatives?*. OCSE, Parigi.

Renting H., Oostindie H., Laurent C., Brunori G., Barjolle D., Jervell A.M., Granberg L., Heinonen M. (2008), Multifunctionality of agricultural activities, changing rural identities and new institutional arrangements', *Int. J. Agricultural Resources, Governance and Ecology,* Vol. 7, Nos. 4/5: 361–385

Van der Ploeg J.D., Long A., Banks J. (2002). *Living Countrysides: Rural Development Processes in Europe: the State of the Art.* Elsevier, EBI.

Van der Ploeg J.D., Roep D. (2003). *Multifunctionality and rural development: the actual situation in Europe*, in Van Huylenbroeck G. - Durand G., eds., Multifunctional Agriculture. A new paradigm for European agriculture and Rural Development, Ashgate, Burlington, VT (USA) e Aldershot (UK).

Velazquez B.E. (2001). Il concetto di multifunzionalità in agricoltura: una rassegna. *QA-La Questione Agraria*, 3: 75-112.

Wilson G.A. (2008). From 'weak' to 'strong' multifunctionality: Conceptualising farm-level multifunctional transitional pathways. *Journal of Rural Studies* 24: 367–383.

Wilson G.A. (2007). *Multifunctional agriculture. A transition theory perspective.* Cabi Publishing, Cambridge MA (USA) e Wallingford (UK).

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Short Notes

Social Farming and inclusion in EU ESI Funds programming

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Abstract. EU Europe 2020 Strategy identifies fighting against poverty and marginalization as a key objective, with an attention to active inclusion in society and in the labor market of the most vulnerable groups. The paper aims at outlining the evolutionary framework of EU policies in the field of social inclusion and at analyzing the novelties introduced by the European Structural and Investment (ESI) Funds 2014-20. A specific focus is dedicated to social agriculture (SF) interventions, which generate social inclusion and innovation with benefits in rural and peri-urban areas and in society as a whole. It is still too early to assess the impact of RDP-funded interventions, as the investments are still ongoing. The analysis of the SF resources highlights a wide range of policy and programming choices.

Keywords: social inclusion, social farming, multifunctional agriculture, EU policies, ESI Funds, rural development.
JEL codes: O20, I31, I38, O35.

1. INTRODUCTION AND METHODOLOGY

One of the 5 objectives of the EU Europe 2020 Strategy is fighting against poverty and marginalization, with a special attention to active inclusion of the most vulnerable groups in society and in the labour market and overcoming of discriminations and integration of people with disabilities, ethnical minorities, immigrants and other vulnerable groups. In this policy context, social farming (SF) has been explicitly pointed out in the 2014-2020 programming documents as a tool for addressing social inclusion and achieving the abovementioned goal.

Starting from a definition of SF as innovative opportunity of services delivery, able to address the need of services coming from individuals and communities, and of diversification of agricultural activity, enabling farmers both to integrate their income and broaden their role in local communities and society as a whole, in the framework of the theoretical context of multifunctionality of agriculture, we assume that the adoption at EU level of a cross-cutting approach to social inclusion policies represents a policy innovation generating social innovation. Coordination of different policies relevant to SF at EU, national and regional level has been recently recommended by the European Economic and Social Committee (EESC).

The paper will outline, through a desk analysis, the evolutionary framework of EU policies on social inclusion and analyze both the novelties introduced by the 2014-2020 programming with reference to the European Structural and Investment (ESI) Funds and their implementation in Italian programming documents. In this framework, in order to better define the political framework for SF in Europe and Italy, the paper reports the results of an analysis carried out in 2016 on 2014-2020 Italian RDPs, highlighting the political choices made in the planning phase, and comparing them with the partial results emerging by calls released at June 2019 by the Italian Regions. The analysis, focusing on the EU programming in the field of social inclusion, will start with the exam of Partnership Agreement (PA) for Italy, acknowledging the intimate link between economic and social policies and defining thematic Objective 9 "Promoting social inclusion, fighting poverty and discrimination". A specific focus will be devoted to the Italian case, with the outcomes of an analysis of 2014-2020 Rural Development Programmes (RDPs) and of a LAG experience; the latter represents a best practice in the integration of EU Funds for social inclusion. Social inclusion generated by SF expands its effects both in rural and peri-urban areas interested by SF initiatives and in society as a whole.

2. RESULTS: SOCIAL INCLUSION AND SOCIAL FARMING (SF) IN EU POLICY

2.1. Policy context and theoretical framework

Social inclusion is on the EU and Member States agenda since the 1990s, with Maastricht Treaty and the Structural Funds and the establishment of the European Observatory on policies to combat social exclusion. The historical EU approach to social inclusion is one of «cohabitation» and balance between competitiveness and social in the broad sense. Social inclusion, in the predominant sense of participation, of integration into society, is also at the base of many policies' design: core elements of rural development policy are participation, networks, partnerships and multi-level governance. It is also very much related to the logic of cohesion at the base of EU Structural Funds (Shortall S., 2008; Shortall S., Warner M.E., 2010), now EU Structural and Investment Funds (ESI). In 2014-2020, the approach to economic, social and territorial cohesion in the EU is reinforced, coherently with Europe 2020 Strategy, by setting common rules for ESI Funds, in order to better coordinate and harmonize the implementation of cohesion policy. The EU Regulation 1303/2013 defined «Common provisions regulation» (CPR)[1], foresees the organization of partnerships for each Member State and for each Programme, in order to ensure respect for the principles of multi-level governance; these partnerships are open to all public, private and third sector components, including bodies responsible for promoting social inclusion.

The theme of social inclusion and fight against poverty is then addressed in the single Funds: ESF supports, among others, disadvantaged people, people facing poverty and social exclusion, actors in the social economy; ERDF, among other, finances social infrastructures; EAFRD focuses on social farming.

SF is a complex body of practices integrating various activities (social, care, educational, etc.) into farming and promoting, among other goals, social inclusion. SF uses agricultural farms and their components as landscape, animal, plants, as a base for promoting human mental and physical health, as well as quality of life, for a variety of client groups (Lanfranchi M. *et al.*, 2015; Scuderi A. *et al.*, 2014; Steigen A.M. *et al.*, 2016). People with disabilities, also intellectual ones, benefit from the practice of SF, becoming part of a social community, working in a farm and establishing relationships with farmers. All these aspects confirm the role played by SF in the development of relational and professional skills in adults with cognitive disorders (Torquati B. *et al.*, 2019).

SF represents an innovative, multi-actor and multidisciplinary approach to different levels (social, economic) of problems in EU territories; it can contribute to the definition and implementation of new pathways of change in rural and peri-urban areas, being an alternative way for delivering innovative and effective social services, with effects on individuals, farmers, local communities (Lanfranchi M. *et al.*, 2015).

In terms of inclusive effects, apart from «direct» inclusion towards service-users, SF can become an element of inclusive development for the whole society due to its characteristics: it uses a community-based development approach, it is based on networking and collaboration between different stakeholder groups, as farmers, disadvantaged people, social/health professionals, local communities, policy makers and administrators (Di Iacovo F., O'Connor D., 2009). The propensity for inclusive development can be found in consumers positive attitude in terms of willingness to pay a higher price for SF products. The aim is to ensure firms economic sustainability, to reinforce positive social externalities generated by agriculture, to bring advantage to the whole society (Torquati B. *et al.*, 2019).

[1] Reg. (EU) 1303/2013 of the European Parliament and of the Council of 17 December 2013.

The emergence of this phenomenon has originated a broad variety of practices and definitions: social farming, green care, care farming, farming for health, etc., involving both different type of farms (institutional/public, ordinary, care farms, etc.) and different specific target groups as youth, children, disabled, prisoners, refugees, elderly people, unemployed, but also the broad population living in rural and urban areas (Dessein J. *et al.*, 2013; Leck C. *et al.*, 2015; Scuderi A. *et al.*, 2014, Steigen A.M. *et al.*, 2016).

From a theoretical point of view, the relatively new social function recognized to agriculture is closely related to the acknowledgement of the multifunctional role of agricultural activity (Dessein J. *et al.* 2013; Lanfranchi M. *et al.*, 2015; Scuderi A. *et al.*, 2014; Zasada I., 2011). SF can potentially further broaden, diversify and add value to multifunctional agriculture, by interlacing farming with welfare services and creating both new markets for farmers (Di Iacovo F., O'Connor D., eds., 2009).

SF originates in a context of changes in lifestyles and economic crisis and generates benefits in terms of inclusion, going beyond the borders of rural territories and reaching European peri-urban and urban areas. With austerity measures and partial shift of responsibility from public actors and governmental support to private business and citizens, new opportunities in terms of social innovation are offered by collaboration and new alliances, new governance approaches towards public-private partnerships promoting social inclusion (Bock B., 2016; García-Llorente M. *et al.*, 2016; Shortall S., Warner M.E., 2010). Social innovation is thus related to self-organization and bottom-up initiatives, partly originating from the need for viable alternatives to poor public services in the EU; expectations on social innovation in particular are based on the idea that public-private forms of partnerships and development of community-based services can help overcoming the existing limits of EU welfare systems (Bock B., 2016; Hassink J. *et al.*, 2010; Maino F., 2014).

SF shows many features involving social innovation: it is a form of diversification of agriculture into social activities and functions, able to deliver services both to direct beneficiaries and to support rural and urban inhabitants and community in general. Also, social innovation transcends the boundaries of specific places and involves actors and networks going beyond the local and the rural, including urban and peri-urban.

The role of social farming as innovative opportunity for the farm of diversification of agricultural activity and providing services and benefits to individuals with specific needs, local community and broad population, territories and their development is recognized both by literature and policy (Dessein J. *et al.*, 2013; Lanfranchi M. *et al.*, 2015; Tulla F. *et al.*, 2014).

2.2. Social farming in the framework of the EU 2014-2020 cohesion policy

The theme of SF in Europe has emerged in the last two decades, starting with the institution of «Farming for Health», a community of practices of researchers and scholars from 14 European Countries, whose outcomes have influenced the Opinion of the EU Economic and Social Committee (EESC) on the topic «Social Farming: green care and social and health policies»[2]. The EESC, stating the need of «a definition at European level in order to identify the activities that comprise it and to define a framework and criteria, including quality criteria…» believes that «EU institutions and various regional and national authorities should support social farming putting in place an appropriate regulatory framework».

SF represents an opportunity in Europe to affirm a sustainable and innovative model of agriculture and of participated welfare; it is an integral part of the Europe 2020 Strategy, identifying social integration as one out of the 5 objectives for an intelligent, sustainable and inclusive growth.

The 2014-2020 Partnership Agreement (PA) for Italy[3], national programming instrument of European Structural and Investment (ESI) Funds, including the European Agricultural Fund for Rural Development (EAFRD), defines strategy and priorities for pursuing the goals of Europe 2020. With thematic objective 9 «Promoting social inclusion, fighting poverty and discrimination», PA acknowledges the intimate link between economic and social policies, also identifying strategic lines of interventions pertinent to each Fund. According to identified priorities and needs, PA foresees some particularly interesting actions: promotion of social inclusion through active inclusion and job placement, reinforcing offer and improving quality of territorial social and health services, reinforcing social economy. The abovementioned principles are outlined in the EU Regulations setting rules for ESI Funds; in particular, EAFRD Regulation[4] sets as one of the 6 Priorities to

[2] European Economic and Social Committee, Opinion of the European Economic and Social Committee on «Social Farming: green care and social and health policies», (2013/C 44/07).

[3] Commissione Europea, «Accordo di partenariato» con l'Italia sull'uso dei fondi strutturali e di investimento per la crescita e l'occupazione nel 2014-2020, C(2014) 8021 final «Decisione di Esecuzione della Commissione del 29/10/2014 che approva determinati elementi dell'accordo di partnenariato con l'Italia».

[4] Reg. (EU) 1305/2013 of the European Parliament and of the Council of 17 December 2013 on support for rural development by the Euro-

be pursued in 2014-2020 «social inclusion, reduction of poverty and economic development in rural areas».

In the intention of European policy makers, agricultural firms are increasingly called to implement and provide services for civil society; these services are both environmental, focused on territories and their management, and social.

Also, the Social Investment Package (SIP), adopted by the European Commission (EC) on 20th February 2013, aims at stimulating Member States (MS) to maintain investments in social policy areas, as the enhancement of people's capacities and the support to their participation in society and in the labour market. Following a network logic, connecting agricultural sector, social and health services and training sector, The European Social Fund (ESF) also devotes attention to the theme of SF. The Inclusion National Operational Programme[5] (20% of ESF financial resources), among the actions foreseen against poverty and social exclusion, considers coordination with EAFRD to be relevant, with specific reference to SF interventions; similar coordination and collaboration possibilities are present in ERDF.

Finally, considerable importance is attached to social inclusion in the EU rural development policy since 2007-2013 (Shortall S., 2008), with EAFRD addressing SF as instrument of diversification of farms also into social activities, mostly in Axis 3 measures dealing with quality of life in rural areas and diversification of rural economy. In the period 2014-2020 the theme of the social functions of agriculture becomes more relevant, putting a stronger accent on policies for social inclusion and in particular on the role of agricultural activities.

In conclusion, SF, following a logic of cooperation with social and health institutions and with the synergic support of EU Funds, can represent a model of social and organization innovation. This path is supported by the EU 2014-2020 Regulations, that have created the conditions to foster SF practices and better define SF activities in European territories.

2.3. Social inclusion in Italian 2014-2020 Rural Development Programmes

As reported in literature (cfr. 2.1.), the context of SF in Italy, confirmed by an analysis carried out on the 21 Italian Rural Development Programmes (RDPs) in 2016[6], is that of the increasing demand for services and functions related to agriculture and of the growing potential for the offer of socio-educational and welfare services in agricultural firms. Many RDPs underline the social role of agriculture and express the specific need of supporting the diversification of farm activities towards the offer of welfare services, giving SF the role of stimulating inclusive development (Di Iacovo F., O'Connor D., 2009).

Interventions affecting SF are programmed in various RDPs Measures. Italian Regions, with only one exception, have foreseen SF among the interventions that can be financed, with a relevant variability among programmes, devoting to the theme a more specific attention with respect to the 2007-2013 period, coherently with the current EU cohesion policy framework.

SF is described as: opportunity of social inclusion, innovation and instrument of social and economic development in rural areas, with benefit for rural communities; creation of networks between farmers and social cooperation operators; expansion of diversification and opportunity for farmers to deliver complementary services related to agriculture; opportunity of income and employment both for firms and new operators. SF is perceived as a social innovation that can enable agriculture to become instrument of welfare for the benefit of rural communities.

SF is predominantly programmed within rural development Priorities 2A[7] and 6A[8] . Measures giving a major contribution to SF are: M16 «Co-operation», with sub measure 16.9 «Diversification of farming activities into activities concerning health care, social integration, community-supported agriculture and education about the environment and food», specifically addressed to SF; M6 «Farm and business development», in particular with sub measure 6.4 «Investments in creation and development of non-agricultural activities», dedicated to diversification. The last has been activated by all the Italian regions, apart from the Province of Bolzano, showing the political relevance given by regional authorities to diversification of agricultural activity for the territorial development of rural areas. In Valle d'Aosta sub measure 6.4 is activated but dedicated to agritourism.

Among the possibilities of intervention for SF and

pean Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005.

[5] Ministero del lavoro e delle politiche sociali «Programma Operativo Nazionale Inclusione 2014-2020» Decisione della Commissione C(2014)10130.

[6] Ascani M., De Vivo C. (2016), «L'agricoltura sociale nella nuova programmazione 2014/2020», CREA, Centro Politiche e Bioeconomia. Document published in www.reterurale.it, April 2016, Roma, in the framework of the project «Promozione e supporto alla diffusione dell'Agricoltura sociale», Italian National Rural Network 2014-2020. The 21 Italian RDPs have been fully analyzed with specific focus on SF, starting from Swot analysis, and continuing with Priorities and Focus Areas and Strategy.

[7] «Improving the economic performance of all farms and facilitating farm restructuring and modernization, notably with a view to increasing market participation and orientation as well as agricultural diversification».

[8] «Facilitating diversification, creation and development of small enterprises, as well as job creation».

Tab. 1. Implementation of sub measures 16.9 and 6.4 in Italian RDPs to 30 June 2019.

Regions	Sub measures					
	16.9			6.4		
	Programmed	Nr. Calls	% of 16.9 resources on M. 16 total	Programmed	Nr. Calls	% of 6.4 resources on M. 6 total
Piedmont	X	1	*2,1*	X	1	*9,2*
Valle d'Aosta	--			--		
Lombardy	X			X	1	*11,1*
Trento	--			X		
Bolzano	--			X		
Veneto	X	2	*5,0*	X	5	*15,4*
Friuli Venezia Giulia	--			X	1	*7,8*
Liguria	X	1	*14,9*	X	1	*8,8*
Emilia-Romagna	X	2	*7,3*	X	1	*16,0*
Tuscany	X	1	*3,3*	X	1	*3,5*
Umbria	X			X	1	*9,1*
Marche	X	1	*1,4*	X	3	*2,6*
Lazio	X			X	1	*9,9*
Abruzzo	--			X		
Molise	--			X	1	*10,0*
Campania	X	1	*5,1*	X	2	*36,4*
Apulia	--			X	1	*11,8*
Basilicata	X			X		
Calabria	X	1	*8,5*	X	1	*7,1*
Sicily	X	1	*5,3*	X	1	*11,1*
Sardinia	X	1	*3,3*	X	1	*10,0*

Source: our elaboration on Italian RDPs calls, 30/6/19, in www.reterurale.it.

related services for social inclusion, the most innovative and targeted is sub measure 16.9, foreseen by 14 RDPs, that can be seen as a cooperative form of diversification of agricultural firms; it is also a specific support to different actors involved into providing social services, implemented through a form of cooperation for SF. It specifically addresses the promotion and implementation of social and welfare services by a variety of forms of partnerships. In particular, the sub measure foresees the cooperation among agricultural firms and public, private, third sector entities for the development of social welfare, therapeutic, educational and training, recreational, job placement activities.

In June 2019, 10 Regions issued calls for sub measure 16.9, with differences and peculiarities related to the territories and their characteristics and to the degree of experience on the subject of SF: 16 Regions issued calls for sub measure 6.4, with specific interventions on SF.

It is early for verifying the impacts of the financial resources granted, being investments not yet concluded. The following table highlights the implementation of 16.9 and 6.4 in Italian Rural Development Programmes: all the Regions planned in their RDPs at least 16.9 or 6.4. Calls have been issued on both sub measures, but 16.9 until now has found a minor implementation,

The financial weight of both 16.9 and 6.4 on the whole 16 and 6, with reference to the calls, strongly varies between Regions, highlighting different strategic and planning choices.

Furthermore, within M7 «Basic services and village renewal in rural areas», in some cases investments of sub measure 7.4 «investments in the setting up, improvement or expansion of local basic services for the rural population, including leisure and culture, and the related infrastructure» aim at establishing or enhancing the offer of welfare services, creating a possible link with social farming. A space for growth of SF in RDPs 2014-2020 can finally be traced in transversal measures 1 «Knowledge transfer and information actions» and 2 «Advisory services, farm management and farm relief services», referring to diversification and/or multifunctionality in many cases, and to socio-cultural aspects of agriculture, services to the population in rural areas and social farming in some cases.

2.4. A Leader best practice on agriculture for social inclusion: the Sulcis LAG

Social farming is a complex of practices integrating social, care, educational and other activities into agriculture, with several aims and recipients: cooperation between different actors, sectors and areas is therefore fundamental; the same cooperation is a peculiarity representing an innovative, multi-actor and interdisciplinary approach to several orders of problems.

The Italian LAG Sulcis Iglesiente Capoterra e Campidano (SULCIS), in Cagliari, Sardinia, is an example of networks created for supporting SF and an interesting experience of use of EU Funds for social inclusion and of promotion of territorial cohesion for answering to a part of population expressing a growing need of citizenship and inclusion.

The project «Agrisociale: Coltiviamo Cittadinanza» started in 2011 various participatory paths at transnational, regional and local level. SULCIS LAG, in particular, created a local network of actors dealing with SF. Setting up a participatory process, together with specific training seminars, have been fundamental aspects of the project. In order to facilitate interaction between the actors involved, specific methodologies have been adopted, allowing mapping actors and skills operating on the territory, knowing the needs expressed by local communities and possibilities offered by the RDP, activating a network between SF operators.

At the beginning, 5 municipalities have been selected with a LAG public call, in order to manage financial resources aimed at creating social farms. Then, agricultural firms and social cooperatives have been selected, with a second call issued by municipalities, in order to offer SF services to population. This process started the local project «Serenamente», involving 5 municipalities, 3 social cooperatives and 4 agricultural firms.

The participatory process resulted in the identification of the focus on social inclusion of people with disabilities, in particular mental ones. The project allowed the construction of paths of social inclusion, both through training sessions and specific workshops directly related to agricultural firms and activities; this local experience was based on the creation of an active space for subjects who were forced to live predominantly between the home walls, giving them and their families, a new perspective made of dignity and participation.

The project has moreover developed other local and transnational activities: at local level, thanks to an agreement with the Ministry of Justice, activities had detainees as target group; at transnational level, in collaboration with other Italian and Finnish LAGs, a document was developed, defining the social farming principles underlying actions of inclusion in social farms.

The end of 2007-2013 programming period did not conclude the local social farming experience, since other projects were launched in the territory, as a social garden (ST'ORTO) created by Giba municipality, where young people carry out agricultural activities with the support of some local farms.

The project «Agrisociale: Coltiviamo Cittadinanza», through a participatory approach, has led to the following results:

- 3 participatory paths (local, at LAG level, regional and transnational);
- 1 transnational SF principles chart;
- 35 boys in social inclusion laboratories;
- 19 boys in pet therapy laboratories;
- 1 social garden;
- 1 enterprise network, «Bio rete terra sarda»;
- 2 internships for mentally disabled boys in farms of the network.

In the current period SULCIS LAG has foreseen in its Local Development Plan measure 16.9 dedicated to social farming; the objective is to develop the past experience, overcoming some critical issues and with the aim of involving a greater number of actors, first of all local authorities, farms and cooperatives.

In LAG's intentions, there is the will to pay a particular attention to other weak components of local community, as women and workers over 40, who could find work placement thanks to SF activities.

The Sulcis LAG experience shows the start-up and development, with a bottom-up process, of a participatory path based on the inclusive nature of agricultural activities. It also highlights that SF in rural areas, especially in marginal ones, can stimulate local economy and play a role of «relational catalyst» among community members. Furthermore, policies for inclusion play a propulsive role in starting participatory processes and in building networks that answer to needs expressed by local communities and in particular by weak groups of population.

3. CONCLUSIONS

In the European political and scientific debate, the theme of social inclusion has gained a primary role and this attention has been translated into a EU regulatory framework identifying objectives, tools and modes of intervention.

Social farming (SF), incorporated into EU Regulations, Partnership Agreement and national and regional programmes, represents one of the instruments contributing to active inclusion. SF activities can therefore represent a social innovation laboratory, where network logic and interconnection among Funds allow the implementation of complex interventions, requiring synergies among policies, actors and territories.

An integrated use of policies and Funds and their proper coordination, also recommended by the European Economic and Social Committee, represents a policy innovation generating social innovation. Public policies and support aimed at enhancing social and territorial cohesion processes are crucial both to answer the growing need of weak components of society and to create virtuous development paths for local economic systems. It is therefore essential to intervene with a network logic among Funds, in order to implement an integrated and multidisciplinary approach.

The analysis carried out on the policy and regulatory framework descending by Europe 2020 Strategy shows the opportunities provided by specific lines of intervention for social inclusion in ESI Funds and their implementing programmes. Italian RDPs extensively recognize the requirement of increasing the diversification and the multifunctionality of firms and of improving services to population in rural territories; many RDPs explicitly underline the social role of agriculture and express the specific need of supporting the diversification of farm activities towards providing welfare services and creating synergies between agriculture and social, as welfare instrument in rural areas. Nevertheless, up to now, a substantial delay in the implementation of programmes has to be pointed out; with specific reference to EAFRD, there is a weak correspondence between targeted provisions for social inclusion in RDPs (mainly within sub measures 16.9 and 6.4) and in related public calls, devoting poor specific funding to SF. Almost all of the Regions that have planned interventions for SF have issued the related calls, with specific aspects depending on the territory and on existing SF realities. It is still too early to evaluate the impact of the resources provided by RDPs, being investments still ongoing. From the analysis of the resources for SF, delivered under sub measures 16.9 and 6.4, with reference to the total financial amount of measures 16 and 6, a wide range of strategic and programming choices does emerge.

Given the importance of interdisciplinarity in SF actions, a negative element that can be found in the current implementing phase is the lack of a multi-fund approach, with a few exceptions in the management of regional funding to Leader projects. In the case of Leader, this critical issue is indeed partially overcome by the possibility given to LAGs of participating in other Funds and their measures, activating the necessary synergies, as in the case of Sulcin LAG.

In conclusion, despite its spreading in Europe in terms of practices, the attention devoted to it by researchers and the policy and regulatory framework outlined by the EU, SF is still partially supported by an adequate legislative and operative definition. A development and consolidation opportunity for SF experiences in Italy is represented by the issue of a specific National Law in 2015, whose implementing regulation has been issued in December 2018, creating the conditions for its implementation.

REFERENCES

Ascani M., De Vivo C. (2019). L'attuazione dell'agricoltura sociale (AS) nella programmazione 2014-2020 della politica di sviluppo rurale – Situazione al 30 giugno 2019. CREA, Centro Politiche e Bioeconomia. Document in the process of being published in www.reterurale.it, Roma.

Ascani M., De Vivo C. (2016). L'agricoltura sociale nella nuova programmazione 2014/2020. CREA, Centro Politiche e Bioeconomia. Document published in www.reterurale.it, April 2016, Roma, in the framework of the Project «Promozione e supporto alla diffusione dell'Agricoltura sociale», Rete Rurale Nazionale 2014-2020.

Bock B. (2016). Rural marginalisation and the role of social innovation; a turn towards nexogenous development and rural reconnection. *Sociologia Ruralis*, 56(4): 552 -573. http://dx.doi.org/10.1111/soru.12119.

Dessein J., Bock B., de Krom Michiel P.M.M. (2013). Investigating the limits of multifunctional agriculture as the dominant frame for Green Care in agriculture in Flanders and the Netherlands. *Journal of Rural Studies*, 32: 50-59. https://doi.org/10.1016/j.jrurstud.2013.04.011.

Di Iacovo F., O'Connor D., eds. (2009). *Supporting policies for Social Farming in Europe – Progressing Multifunctionality in Responsive Rural Areas*. ARSIA, Firenze. Available at: http://sofar.unipi.it/index_file/arsia_So.Far-EU_def.pdf, (accessed 08 May 2019). ISBN 978-88-8295-107-8.

European Economic and Social Committee, Opinion of the European Economic and Social Committee on «Social Farming: green care and social and health policies», (2013/C 44/07).

García-Llorente M., Rossignoli C.M., Di Iacovo F., Moruzzo R. (2016). Social Farming in the Promotion of Socio-Ecological Sustainability in Rural and Periurban Areas. *Sustainability*, 8(12): 1238. https://doi.org/10.3390/su8121238

Hassink J., Elings M., Zweekhorst M., van den Nieuwenhuizen N., Smit A. (2010). Care farms in the Netherlands: Attractive empowerment-oriented and strengths-based practices in the community. *Health & Place*, 16: 423-430. http://dx.doi.org/10.1016/j.healthplace.2009.10.016

Lanfranchi M., Giannetto C., Abbate T., Dimitrova V. (2015). Agriculture and the social farm: expression of the multifunctional model of agriculture as a solution to the economic crisis in rural areas. *Bulgarian Journal of Agricultural Science*, 21(4): 711-718. https://www.agrojournal.org/21/04-01.html, 08/05/2019.

Leck C., Upton D., Evans N. (2015). Growing well-beings: The positive experience of care farms. *British Journal of Health Psycology*, 20: 745-762. https://doi.org/10.1111/bjhp.12138.

Maino F. (2014). L'innovazione sociale nell'Unione Europea: uno stimolo per il rinnovamento del welfare. *Quaderni di Economia Sociale*, 1: 10-15. Available at: http://www.sr-m.it/quaderni-di-economia-sociale/, https://www.sr-m.it/wp-content/uploads/2015/09/qes_2014.pdf, (accessed 08 May 2019).

O'Connor D., Lai M., Watson S. (2010). Overview of Social Farming and Rural Development Policy in Selected EU Member States. European Network for Rural Development, NRN Thematic Initiative on Social Farming, European Communities, December 2010. Available at: https://enrd.ec.europa.eu/enrd-static/fms/pdf/1884A840-F38F-4BEE-C23D-8B78E3A6917F.pdf, (accessed 08 May 2019).

Scuderi A., Timpanaro G., Cacciola S. (2014). Development policies for social farming in the EU-2020 Strategy. *Quality - Access to Success*, 15(139): 76-82. Available at: https://www.srac.ro/calitatea/en/arhiva_journal.html, (accessed 08 May 2019).

Shortall S., Warner M.E. (2010). Social inclusion or Market Competitiveness? A Comparison of Rural Development Policies in the European Union and the United States. *Social Policy & Administration*, 44(5): 575-597. https://doi.org/10.1111/j.1467-9515.2010.00730.x.

Shortall S. (2008). Are rural development programmes socially inclusive? Social inclusion, civic engagement, participation and social capital: Exploring the differences. *Journal of Rural Studies*, 24: 450-457. doi:10.1016/j.jrurstud.2008.01.001.

Steigen A.M., Kogstad R., Hummelvoll J.K. (2016). Green Care Services in the Nordic countries: an integrative literature review. *European Journal of Social Work*, 19(5): 692-715. https://doi.org/10.1080/13691457.2015.1082983.

Torquati B., Stefani G., Massini G., Cecchini L., Chiorri M., Paffarini C. (2019). Social farming and work inclusion initiatives for adults with autism spectrum disorders: A pilot study. *NJAS-Wageningen Journal of Life Sciences*, 88: 10-20, https://doi.org/10.1016/j.njas.2019.02.001.

Torquati B., Paffarini C., Tempesta T., Vecchiato D. (2019). Evaluating consumer perceptions of social farming through choice modelling. *Sustainable Production and Consumption,* 19: 238-246

Tulla A.F., Vera A., Badia A., Guirado C., Valldeperas N. (2014). Rural and regional development policies in Europe: social farming in the Common Strategic Framework (Horizon 2020). *Journal of Urban and Regional Analysis*, VI(1): 35-52. Available at: http://www.jurareview.ro/volumes/get_issue_by_id/13, (accessed 08 May 2019). ISSN: 2067-4082 (Print); 2068-9969 (Online).

Zasada I. (2011). Multifunctional peri-urban agriculture – A review of societal demands and the provision of goods and services by farming. *Land Use Policy*, 28(4): 639-648. doi:10.1016/j.landusepol.2011.01.008.

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