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Mariusz Maciejczak

Warsaw University of Life Sciences – SGGW, Poland

INNOVATIONS IN VITICULTURAL PRODUCTION IN POLAND UNDER CLIMATE CHANGE CONDITIONS[1]

INNOWACJE W PRODUKCJI WINOGRON W POLSCE W WARUNKACH ZMIAN KLIMATU

Key words: viticulture, innovations, climate change, Poland

Słowa kluczowe: uprawa winogron, innowacje, zmiany klimatu, Polska

JEL codes: Q12, O31

Abstract. The paper aims to identify factors under climate change conditions that could impact innovativeness in grapevine growing in Poland. It is shown that today the viticulture cultivation in Poland is of little economic significance. However, based on primary data applied to econometric model, it is argued that driven by climate changes as well as due to other factors, grapevine growing might become a significant branch of agriculture. The estimates of the model, although randomized, suggest that there is a significant probability that in Polish viticultural farms adaptation measures applied as a respond to these factors will result with implementation of innovations and through overall development.

Introduction

Grapevine production in Polish conditions is much more difficult, more risky – and consequently much more expensive – than in most traditional wine countries. The most obvious reason for these handicaps is the climate, not always conducive to cultivation of the viticulture. Thus the viticulture cultivation in Poland is of little economic importance. It is accompanied however by great social interest and rapid growth of cultivated area. As stressed by Małgorzata Pink [2015] the revival of viticulture production is favored primarily by climatic change, but also by some social phenomena such as consumers preferences, wealth increase, enotouristic or popularity of local food, and movements like „slow food". Today, according to M. Pink and Joanna Ligenzowska [2016], Polish viticultural production became one of the most dynamically growing in Europe, similar to domestic wine production. Developing wine manufacturing branch in the suitable regions, might be a chance for diversification of activities of the farms, which could contribute in overal improving of their economic performance and would help in adapting to changing market conditions.

Such development should be driven by innovations. And it has much broder meaning. As suggested a.a. by Katalin Takácsné György [2015] or Johan Swinnen and Alfons Weersink [2013] the importance of innovations significantly rises with the increase of the need to adjust the whole agri-food sector as well as individual enterprises to challanges connected not only with socio-economic factors but also environmental, incl. climate change.

The objective of the paper is threefold. Firstly, the current environmental conditions for viticultural production in Poland will be presented. Secondly, the state of the art of grapevine growing in Poland will be characterized. Finally, based on primary data applied to an econometric model, the factors influencing innovativeness at the filed level, incl. those resulted from climate change, will be described.

[1] This paper was prepared based on the first results of the project VITISMART (Toward a sustainable viticulture: Improved grapevine productivity and tolerance to abiotic and biotic stresses by combining resistant cultivars and beneficial microorganisms). The financing of this project by Polish National Centre of Research and Development (NCBiR) in the framework of ERA-NET CO-FUND FACCE SURPLUS program is acknowledged.

Material and methods

Based on the literature review there were different contexts and conditions identified and analysed that influence the viticultural production in Poland. There were selected 50 farms out of 155 that have been officially registered as wine producers in 2016. Respondents were randomly selected to represent various wine producers from different wine regions of Poland. Using the structured questionnaire, which draft form was piloted, two main methods of data collection were applied: CATI and CAPI. There were used open and closed questions. The category in questionnaire "others" was included in case something important was missed in the cafeteria lists. There were obtained 21 full questionnaires, which represents ca. 14% of all officially registered wine farms in Poland. The interviews were executed in February and March 2017.

Due to dichotomous nature of obtained results as suggested by Scott J. Long [1997] out of models of binary choices the linear probability model (LPM) was used in order to determine the factors influencing innovations in viticultural production. The LPM is an application of ordinary least squares to binary outcomes instead of continuous outcomes [Greene, 1993]. The dependent variable explained in the model is a qualitative variable of binary nature. On contrary, the independent variables can be both qualitative and quantitative. The form of the dependency can be different, in particular it can be non-linear. The empirical values of the dependent variable are equal to 0 or 1, but the theoretical values (resulting from the model) of independent variables do not have such limitations. Interpretation of structural parameters of linear probability model refers to the change in probability in response to a unitary change of the independent variable with other factors unchanged. For calculation the SAS software was used and the GENMODE procedure was applied [SAS 2015]. The model was validated using procedures proposed by David L. Debertin et al. [1980]. The error term in the model is heteroskedastic as the variance is not constant and depends on the value of the independent variables. The functional for of the applied LMP is used after James J. Heckman and James M. Snyder [1996] and presented in the quotation below:

$$p_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + ... + \beta_k x_{ki}$$

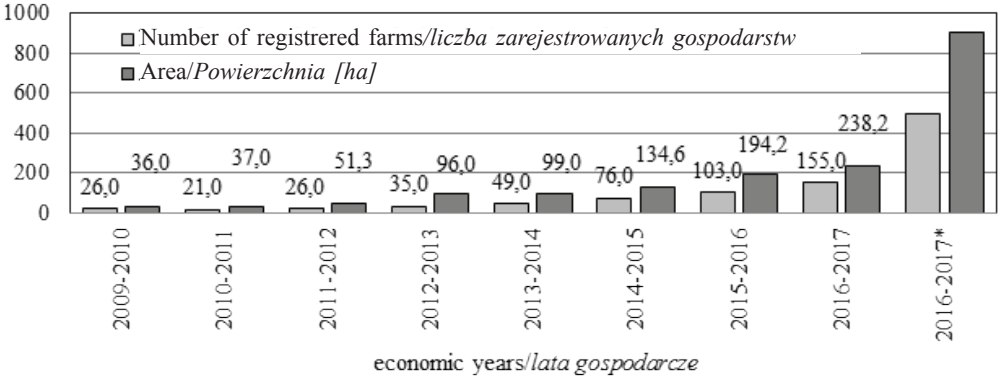
As dependent variable the farmers' opinion confronted with the expert's view about innovativeness of particular viticultural production was used. There were selected 13 independent variables, which after estimations were limited to 8. These variables described today's farm situation as well as future possible impact due to climate change. There were characterized main cultivated varieties, soil quality, landform, impact of biotic factors (plants' diseases and pests), impact of abiotic factors (overheating, cooling) and the innovativeness in the complementary activities such as farm organization and market actions (sale through internet channels and enotouristic). The future impact of the climate change was characterized using approach proposed by Frans Berkhout and Michiel Van Drunen [2007]. There were taken into account possible fluctuations of weather conditions during vegetation period, possible impact of biotic factors (plants' diseases and pests), possible impact of abiotic factors (overheating, cooling).

Results and disccusion

There are several factors conditioning the possibility to conduct viticultural production. Among environmental characteristics the importance play a.a. climate, soil and landform. Climate favorable for viticulture is characterized by an average annual temperature not less than 8°C, the average temperature of the hottest month not less than 17°C and the total active annual temperature 25°C. Some areas of Poland are also characterized by these conditions. Alina Kunicka-Styczyńska et al. [2016] reported that Poland extends from the parallel 49°00′ N (south) to 54°50′ N (north), so about half of the country is situated in this area. At the latitudes between 49°00′ N and 52°00′ N, there are many regions in Europe known for their excellent

wines, including some appellations in the region of Champagne (e.g. Reims) or German appellation Rhine. According to Jerzy Lisek [2008] the current climate changes are conducive to the development of Polish winemaking. The average annual temperature showed an upward trend (about 0.3°C per decade), transitional periods have been shortened, warm periods have been prolonged, the course of winters became milder, allowing the cultivation of early and very early varieties. J. Lisek [2008] stressed out that out of all the climatic changes noticed in the past several dozen years the most favorable for grapevine growing, is increased annual air temperature during the growing season, expressed as the so-called sum of active temperatures. This consists of the daily temperature averages above 10oC. On average, beginning of the phenological stages such as bud swelling, blooming and fruit ripening of researched grapevine cultivars in the years 2005-2007 on average occurred 12 days earlier than in the period 1987-1989. Climate fluctuations, especially increase of temperature during the growing season, has presented in the past few years new issues concerning plant protection against pests and diseases. Some of the most important problems are more and more frequent grapevine infections with the fungus. Additionally new threats pose solar injuries of grapevine leaves and fruit caused by thermal (infrared) and ultraviolet (UV-B) radiation.

In the European Union's classification of climate for viticulture [Council Regulation (EC) No 479/2008, OJL 148/1] Poland was classified in the coldest wine-growing region and officially acknowledged as a wine-producing country, altogether with, among others, Germany (except for Baden), the Czech Republic (except for Moravia), Belgium and the Great Britain. Due to the thermal conditions, Polish territory was divided into three regions: Region I – the west and southwest of the country, namely provinces of Lubusz, Lower Silesia, Opole, Silesian and southern parts of the provinces Wielkopolska and Lódź; Region II –threatened with greater extent of cold winters, covers the south and southeast of the country, i.e. the provinces of Małopolska, Podkarpackie, Świętokrzyskie and southern parts of the provinces of Lublin and Warsaw; and Region III – the other areas, where viticulture is impossible or very difficult.



* Estimates for all viticultural farms in Poland, both registered and non-registered/*Szacunki obejmujące wszystkie gospodarstwa uprawiające winogrona, zarówno zarejestrowane jak i niereje-strowane;*

Estimated number of all farms = 500/*szacowana liczba wszystkich gospodarstw = 500;* estimated total area = 900 ha/*szacowana powierzchnia całkowita = 900 ha*

Figure 1. Registered viticultural production in Poland (economic years 2009/2010-2015/2016, data as at 31.03.2017)

Rysunek 1. Rejestrowana uprawa winogron w Polsce (lata gospodarcze 2009/2010-2015/2016, dane na dzień 31.03.2017)

Source: own calculations based on [AMA 2017] and interviews with experts for estimates

Źródło: obliczenia własne na podstawie [AMA 2017] i wywiadów z ekspertami w odniesieniu do szacunków

Table 1. Results of the linear probability model – estimation of parameters influencing the innovations in viticultural production in Poland
Tabela 1. Wyniki liniowego modelu prawdopodobieństwa – oszacowanie parametrów wpływających na innowacje w uprawie winogron w Polsce

Parameter/*Parametr*	DF	Estimate/ *Ocena*	St. Error/ *Błąd stand.*	Wald confidence limits/*Przedział ufności Walda 95%*		Wald Chi-Sq/*Chi-kwadrat Walda*	Pr>ChiSq *Pr>chi-kw.*
Intercept/*Stała*	1	0,0023	0,3499	-0,6834	0,6881	0	0,9947
Variety/*Odmiana*	1	-0,066	0,0981	-0,2584	0,1264	0,45	0,5013
Occurrence of diseases/ *Występowanie chorób*	1	0,4521	0,2615	-0,0604	0,9646	2,99	***0,0838
Cooling stress/*Wyziębienie*	1	0,3776	0,2033	-0,0209	0,776	3,45	**0,0498
Overheating stress/*Przegrzanie*	1	0,0426	0,1723	-0,2951	0,3802	0,06	0,8049
Change of the weather cond. during veg.period due to climate change/*Zmiana warunków pogodowych w okr. wegetacji w wyniku zmian klimatu*	1	0,2667	0,1561	-0,0394	0,5727	2,92	***0,0877
Change of occurance of pests due to climate change/*Zmiana występowania szkodników w wyniku zmian klimatu*	1	0,1650	0,2327	-0,2912	0,6211	0,5	**0,0385
Introduction of innovations in farm organization/*Wdrożenie innowacji w zakresie organizacji gospodarstwa*	1	0,6302	0,2157	-1,053	-0,2074	3,53	**0,0035
Introduction of innovations in marketing/*Wdrożenie innowacji w zakresie marketingu*	1	-0,4521	0,2845	-0,875	-0,6487	3,25	***0,0554
Scale/*Skala**	1	0,33	0,0509	0,2439	0,4465		

* the scale parameter was estimated by maximum likelihood, ** p < 0.05, *** p < 0.1/*Parametr skali oszacowano na podstawie maksymalnego prawdopodobieństwa; ** p <0,05; *** p < 0,1*
Source: own calculations
Źródło: obliczenia własne

Wine production in Poland is linked to the obligation to report to the Agricultural Market Agency (AMA) on production volumes and stocks of wine. Under the Common Agricultural Policy, AMA implements measures related to determining the production potential of vines and wine in Poland. The purpose of these activities is to assess the volume of grape harvest and the production of wines and vine crops, and to monitor the market. AMA performs its task in the wine market under the mechanism «Administration of the production potential of grapevines and wine». There are however producers that owns vineyards and do not produce wine for market purposes, thus, are not oblige to register in AMA. At present there are about 500 vineyards, with estimated area of ca. 700 ha (see graph 1). Out of this number 155 farms are registered by AMA, with total area of 238,2 ha. The size of already existing vineyards, which are included in the records, ranges from less than 1 ha to over a dozen of hectares. Most of the farms have however 1 or less (ca. 75%) [AMA 2017].

There is significant dynamic of growth both number of registered farms and registered area of vineyards for wine production in Poland. Comparing economic years 2009/2010 to 2016/2017

it is over 20 times growth. Most of the vineyards could be found in the belt of south-eastern, south-western and southern provinces, where are favored climatic conditions. In recent years, however, vineyards have also been created in Central and Eastern Poland, although it seems that both land formation and climatic conditions are not conducive to this.

The conducted research among 21 registered grapevine producers made possible to state that during the last few years they adapted changes of innovative nature in the scope of the production in order to strengthen the farms' profitability. It was done by increase natural fertilization (86%), introduction of varieties resistant to the stresses (76%), modernization of the machinery park (67%) and equipment (43%), implementation new training systems (33%), and protection schemes (19%). Changes in the scale of farm organization have been concentrated mostly by adaptation new areas for grapevine cultivation (90%), purchase of new equipment (81%), application irrigation systems (57%) and at construction of new meteorological stations (29%). Wine producers also observed that marketing activities i.e. active promotion in media, internet, trade journals as well as complementary activities such as agritourism have great impact to strengthen the farm profitability and through ensure conditions both financial and market for innovations' development.

The results of the linear probability model estimations show that there are important factors that could influence the innovations in viticultural production in Poland, including those which result from the climate change conditions. It was estimated that under ceteris paribus the likelihood of implementing the innovation at the field level increases by 37% due to cooling stress. The more grapevines are liable to damage due to frost or low temperatures the higher risk of decreasing the profitability and that results with the probability that at one out of three cases farmers will implement measures protecting against loses which could be considered as innovations. Similar situation, nevertheless higher significance level, could be observed in case of disease occurrence. The diseases increases by 45% the probability that the farm will be innovative in production.

The impact of climate change factors on innovations at the filed level in Polish viticultural farms can be observed with regard to the change of weather conditions during vegetation period as well as occurrence of pests. The model results suggest that there is 26% probability that due to long term fluctuations of the weather farmers will undertake appropriate measures to minimize the associated risk. Another climate change connected factor is the occurrence of pests. Should climate change conditions influence increase of pests occurrence ie. mites or aphids there is 16% probability that the viticultural production will be innovative.

The results of the model estimates also suggest that the overall innovativeness of the farm has an impact on the innovations at the filed level. There is 63% probability that if there will be implemented innovations in farm organization i.e. new equipment also the innovativeness at the grapevine growing will increase. On contrary, the model results suggest that the probability that the grapevine growing will be innovative is decreasing by 45% in case the farm will implement innovations connected with the market and marketing of its products or services. This is connected with the availability of two influencing scare resources: time and money.

In the literature there are no other researches that analyzes the factors influencing innovations at the filed level in Polish viticultural farms. That does not mean that such estimates are not needed. According to US researchers [Hannah at al. 2013], as a result of climate warming, in the next decades (up to 2050) the most important European wine regions such as Tuscany and Bordeaux will lose between 19 and 73 percent of production capacity. Rising temperatures will make vineyards growth in places that so far are considered as economically unessential. According to forecasts for the production of wines will be suitable mountain slopes and river valleys in central China, Canada and central Europe - including most of Poland.

Additionally Iacopo Bernetti et al. [2012] have shown that adaptation actions undertaken to adjust to climate change, which can be considered as innovations at the farm level, lead to a 61% probability of maintaining current levels of income. The most important result of their

research, however, is that farms tend to respond to climate change without stopping the production. They are adapting innovations as a respond to climate changes. Based on that conclusion it could be stated that the climate change factors will impact economic performance of viticultural production and will strengthen the innovativeness level.

Conclusions

Based on the conducted research the following can be stated. Although viticulture cultivation in Poland is today of little economic significance, which remain for short and probably medium term perspective, in long term run, driven by climate changes associated with technological and socio-economic transformations it might become a significant branch of agri-business sector.

It should be recognized as rational economic behavior that the abiotic and biotic unfavorable production conditions resulted from climate change will force farmers to undertake the adaptation strategies to limit the risk of lowering productivity and through increase the level of innovativeness. The estimates of the model, although randomized, suggest that there is a significant probability that in Polish viticultural farms adaptation measures and strategies applied as a respond to climate changes will result with overall progress and development of the grapevine and wine sector. This can be considered as an example of schumpeterian creative destruction.

One should agree with Sandro Sacchelli et al. [2012] that the study of climate change impacts on the viticulture and wine sector is a recently emerging research topic. Adaptation strategies have not yet been explored and further analysis are needed. Also in case of growing viticultural sector as in Poland.

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Streszczenie

Celem artykułu jest określenie czynników, w tym tych związanych ze zmianami klimatu, które będą miały wpływ na wdrażanie innowacji w produkcji winogron w Polsce. Badanie przeprowadzono z wykorzystaniem danych pozyskanych z gospodarstw winiarskich, na podstawie których oszacowano model ekonometryczny. Dodatkowo, na podstawie danych wtórnych zaprezentowano obecne uwarunkowania środowiskowo-klimatyczne oraz poziom rozwoju uprawy winorośli w Polsce. Stwierdzono, że uprawa winorośli w Polsce ma obecnie niewielkie znaczenie ekonomiczne, które nie ulegnie znaczącej zmianie w perspektywie średniookresowej. Jednak czynniki związane ze zmianami klimatu i wynikające z nich działania adaptacyjne zapobiegające stresom biotycznym i abiotycznym, mogą ze znacznym prawdopodobieństwem wpłynąć na wdrażanie innowacji w uprawie winorośli i tym samym prowadzić do rozwoju tego sektora w dłuższej perspektywie.

Correspondence address
Mariusz Maciejczak, Ph.D.
Warsaw University of Life Sciences – SGGW
Faculty of Economic Sciences
Nowoursynowska Str. 166
02-787 Warsaw, Poland
phone: +48 (22) 593 42 35
e-mail: mariusz_maciejczak@sggw.pl