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Implications of agricultural bioenergy crop production and prices in changing the land use paradigm—The case of Romania

Andrei Jean Vasile[a,*], Ion Raluca Andreea[b], Gheorghe H. Popescu[c], Nica Elvira[b], Zaharia Marian[a]

[a] Petroleum-Gas University of Ploiesti, Faculty of Economic Sciences, B-dul Bucuresti, No. 39, 100680, Romania
[b] Bucharest University of Economic Studies, Piata Romana, No. 6, 010374 Bucharest, Romania
[c] Dimitrie Cantemir Christian University, Splaiul Unirii 176, 030134 Bucharest, Romania

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ABSTRACT

The article starts from the premise that agricultural bioenergy crop production has massive influence in changing the land use paradigm in Romania, due the fact that important land surface areas are cultivated with such crops because of the increasing demand of biofuels. The main aim of the paper is to answer a research question: are there any changes in arable land use patterns determined by the increasing of the agricultural bioenergy crop production and what is the pressure on food consumption? The results show that the competition agricultural vs. energy crops has a considerable impact on land use pattern changes and food security.

1. Introduction

Land requirements for food are determined, among other factors, by population size, demand or the types and amounts of specific foods consumed (Zaharia and Zaharia, 2015) and land requirements for other uses than food. According to the scenario of the United Nations, the world population will grow from 7.2 billion in 2014, to 9.5 billion in 2050 (United Nations, 2014; p. 2). Technological developments and increased global food trade (Popescu, 2015a,b,c) have been the reasons that the agricultural sector is so far capable to keep up with population growth (Ivens et al., 1992). Simulations of agricultural production potentials for the year 2040 indicated that future world populations can be fed (Penning de Vries et al., 1995). As regards the second factor mentioned above, the food consumption patterns involve an efficient land allotment policy in order to fulfill the food demand requirements, taking into account the cultural determinants, the land availability, the weather conditions and the population growth trends.

Numerous studies (Azarhoushang and Rukavina, 2015; Ciutacu et al., 2015; Coyle, 2007; Cobb et al. 1999; Gerbens-Leenes et al., 2002; Schomann, 2015) show that they are probably in the same order of magnitude that changing production levels or the growth of the world population is. The correlation between those two mentioned variables is already proved in literature.

In this paper, the influence of the third factor is analyzed, trying to identify the ways in which the land used for food is affected by land requirements for non-food crops, such as crops used for energy purposes. The issue food vs. biofuels becomes a field of debate because agricultural land is in our days a scarce resource, which should be wisely used, due to the ongoing and dramatic process as industrialization, urbanization or land degradation and desertification which shapes irremediable the old land use paradigms. As (Oldeman, 1992) remarks in this study, since 1945, about 2 billion of the world's 8.7 billion hectares of agricultural land, permanent pastures, and forest and woodlands have been degraded (Oldeman, 1992).

The debates food vs. biofuels reveal wide-ranging views and controversial approaches, in literature (Fletcher et al., 2011; Hussain, 2015; Howe, 2015), which include and it is not limited to some aspects as: the effect of oil price trends on economic development, evolution of the energy balance and energy efficiency usage,

* Corresponding author. Tel.: +40 721146587.
E-mail addresses: andrei.jeanvasile@yahoo.com, ajvasile@upg-ploiesti.ro (A. Jean Vasile).

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poverty reduction mechanism, carbon emissions reduction, sustainable biofuel production, soil erosion, biodiversity loss, impact on water resources, food supply shortage, etc. (Fletcher et al., 2011).

There is an increased interest in modeling the effects of biofuels expansion on land use. Mosnier et al. (2013) reveals that renewable fuel standard would substantially increase the portion of agricultural land needed for biofuel feedstock production. Affuso and Hite (2013) developed a mathematical model that simulates a voluntary agricultural program to increase land use efficiency in the production of first generation biofuels in Alabama. Baker et al. (2010) examine environmental and economic implications of carbon reduction policies and the impact of these policies on land use change.

Other discussions go around food prices that were supposed to increase as a result of lower food supply. The influences of the energy crops cultivation on the food products' prices represent a very actual research subject in the context of the actual debate related to the food security and energy independence (Börzel, 2016; Ashford, 2015; Fox and Kenagy, 2015). As it is already shown in recent studies (Kretschmer et al., 2012), the biofuel production has increased the agricultural prices, and a reduction or even abolition of bioefuel demand will reduce the agricultural commodity market price index. Globally, the FAO Food Price Index averaged 208.1 points in February 2014, 195.8 points for cereals, 197.8 points for vegetable oil, 275.4 points for dairy, 182.6 points meat, and 235.4 points for sugar. For example, in 2011 the agricultural prices went up to 230% of its level of 2002–2004 (FAO, 2014).

Also, Glauber (2008) remarks several factors with determinant influence on changing the production paradigm during the translation to the energy crops production, among the most important mentioned are the growing demand for organic food diets, organic agricultural production, the reduction of the cultivated yields due the weather changing conditions, drought, flooding of the agricultural land, lack of the irrigation facilities, increased production costs from energy and fuels. In this context, (Baier et al., 2009) draw attention about the increased production of biofuels, especially of ethanol production which has nearly doubled and biodiesel production which has increased nearly three-fold. This situation reviles a massive shift of the agricultural production toward energy crops, which in the majority of the countries is state subsided and stimulated. For example, in the EU-28 the agricultural land cultivated with energy crops as wheat, barley, and soybeans for biofuels production has constantly increased during the last period as part of the strategy for increasing the European energy independence.

In another study, (Babcock et al., 2010; Babcock, 2011) referring to the influence of the biofuel production on prices mechanism appreciate that it is indisputable that "biofuels contribute to higher agricultural commodity prices because the biofuel industry represents a large and growing share of demand for maize, vegetable oil and sugarcane." (Babcock et al., 2010). On the other side, Kocar and Civas (2013) argue that agricultural lands offer an alternative to the agriculture which is referred to as energy farming.

The biofuel production has been increased and diversified during the years in the majority of the countries, especially in US, Brazil and EU-28. As for example in EU-28, the production of biodiesel was 789,100 tons of oil equivalent in 2001, and few producers decided to convert land from agriculture to energy crops use. It sharply increased in 2012 to 9187,900 tons of oil equivalent (Eurostat, 2014).

Romanian production of biodiesel accounts for almost 1% of European Union production. Still, it increased from 19,600 tons of oil equivalent in 2007 to 88,700 tons of oil equivalent in 2012 (4.5 times). In modern economies, some commodities like maize, sugar cane or vegetable oil (distillated from sunflower, rapeseeds and soybeans) have an wider usage staring as food resources for peoples, feed, or in energy industry for biofuel production.

The idea of studying the biofuels influence on agricultural and food products' prices issued from empirical observations of the fact that, since early 2000, the areas cultivated with energy crops such as rape, sunflower and soybean have continually increased, in Romania, in competition with areas cultivated with cereals. This leads to the question whether changes in land use in the direction of smaller surfaces cultivated with wheat, barley and corn and, as such, lower supply of cereals on the market, influenced the prices of agricultural products and further of food products. The specific objectives of this study are to identify the changes in land use in those regarding the shift from food crops to energy crops and the influence of energy crops' production on agricultural and food products' prices. In order to validate the results, furthermore, the research aims to clarify how strong the correlations are between agricultural and food products' prices and biofuels production.

Starting from the assumption already expressed in literature (Baier et al., 2009) that biofuels have had a massive impact on individual crop prices, and a much smaller impact on global food prices (Baier et al., 2009) we have checked this hypothesis in this paper, considering the case study of Romania (2008–2012). The study analyzes cross-sectional and time series relationships, revealing general trends of agricultural and food products' prices, agricultural land use and agricultural, food and biofuels productions, expressed as econometric functions. These trends provide a better understanding of the connection between agricultural and food prices, and biofuels production. It starts from the assumption that food prices increased as a result of a decreasing supply in the agricultural market, because farmers are responsive to prices (Angus et al., 2009) and so fewer areas are cultivated with wheat, corn, rye, barley for food and feed, and more and more areas are cultivated with energy crops such as rape, sunflower, soybean, for biodiesel, to the detriment of the food supply (climate change is crucial in crop adjustments, having thus a significant impact on biodiversity and food security—considerable alterations in agricultural systems are required in the areas subjected to decisive modifications in climate).

The reasoning of the research goes further to identify the land use implications on food security. The Food and Agricultural Organization (FAO) of the United Nations considers that "food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life" (FAO website, 2015). This definition has two approaches: quantitative and qualitative. The quantitative one refers to the quantities of food intake needed for a person to have an active and healthy life. Considering that more and more areas are cultivated with energy crops in competition to food, the agricultural supply decreases and, as such, the quantities of food needed to feed the people. The qualitative one refers to the economic access to food, meaning the food is affordable for all people. The recent increases of food prices due to different factors, including competition food vs. biofuels, put pressure on people's economic access to buy the food needed for an active and healthy life, and therefore on food security.

The level to which the advancement of biofuels participates in contest with food production, bringing about aspects of food security, relies on a diversity of elements: selection of feedstock; natural resources (chiefly land and water) entailed; relative efficiencies (GHG releases, yields, expenditures) of various feedstocks; and processing technologies chosen. The demand to adapt biofuel schemes to their consistency with food security as a main policy goal, in addition to environmental interests and the requirement to indicate adequate GHG savings, functions as powerful determinants for a fast shift to second-generation biofuels. Governments alter biofuel schemes, design and systematize buffering mechanisms lest biofuel need does not pose a menace to food security from price increases. Biofuel development brings out the demand for more