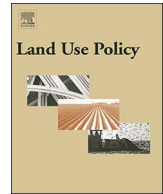




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# Food and environmental function in world agriculture—Interdependence or competition?

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## ABSTRACT

The paper discusses the implementation of the food and environmental function in agriculture. The author's method to determine the amount of energy produced by agriculture was used. In 1961–2009 the amount of energy generated by agriculture all over the world increased more than the population, which means that the sector fulfilled the food function. Conducted research leads to the conclusion that on all continents the production of 1000 kcal was accompanied by decreasing emission of greenhouse gases. There are relatively high ecological costs of agricultural energy production in less economically developed regions. This fact points to the need to diffuse progress both in terms of intensified production and pro-environmental activities.

## 1. Introduction

The essential goal of world agriculture is to provide sufficient amount of food to satisfy the nutritional demand of the current population. In the last fifty years the population has doubled, which has posed a challenge to agriculture (Food security, 2010). It was necessary to increase amount of production in this sector what can be achieved by enlarging the area of agricultural production or increasing the intensity of land cultivation. Because it was difficult to acquire new land for agricultural production due to limited possibilities, the only solution was to increase intensity, which was possible due to technological, biological and chemical progress. At the same time, it is necessary to note the interdependence between agricultural development and population growth. Progress enables demographic growth, which causes the need to adjust efficiency to the current population. In consequence, the influence of agriculture on the environment increased significantly. In recent years the influence of agriculture on the environment has been widely discussed. For example Gliessman (2014) shows the need to adapt present agriculture and food system to reduce the emission of the greenhouse gases. Parry (2000) presented a wide evaluation of the impact of climate changes in Europe. Dockerty et al. (2006) showed the influence of climate on agricultural landscapes while Cole et al. (1997) and Johnson et al. (2007) estimated the potential mitigation of greenhouse gas emissions by agriculture. Furthermore Lawrence et al.

(2013), Sundstrom et al. (2013) drew attention to the impact of climate change on food security.

Apart from the food function, agriculture must implement the environmental function, which chiefly consists in protection of agricultural production space in order to continue production in the long perspective. However, it is noteworthy that despite of the obligatory character of both goals they stand in opposition to each other, at least in the short perspective. On the one hand, the need for higher volume of production causes the necessity to increase the intensity and area of cultivation. On the other hand, the need to protect the environment points to extensification of production and using marginal land for non-nutritional purposes. Usually conducting environmental-friendly production involves limitation of chemical and technical means of production. The increasing demographic pressure and the expected growth of population in the next decades considerably complicate the search for an optimal solution because it is necessary both to increase production mainly by improvement of efficiency and intensify environment-friendly actions. This means that the choice between these two purposes will be increasingly limited (Fig. 1). Moreover, the environmental pressure is also increasing because of changes in the diet of a large number of people and due to the growing consumption of meat. Meat production consumes much more resources than crop production.<sup>1</sup> It requires taking intentional actions to combine both tasks of contemporary agriculture, what should be based on sustainable

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<sup>1</sup> As results from research by Barilla Centre for Food and Nutrition, production of animal products (mainly beef) has the greatest influence on the environment. The following indicators were used to determine the influence of production on the environment: greenhouse gas emission (*Carbon Footprint*), water consumption (*Water Footprint*) and *Ecological Footprint* which measures the quantity of biologically productive land and water required both to provide the resources consumed and absorb the waste produced by population or by a single human activity (Poli, 2010).

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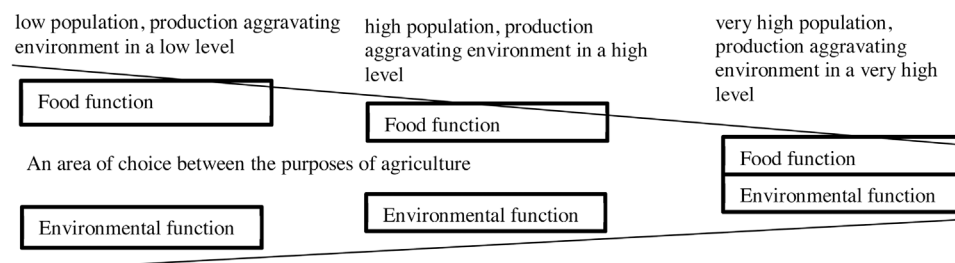


Fig. 1. The increasing demographic and environmental pressure on agriculture.  
Source: Own elaboration

development. According to [Buckwell et al. \(2014\)](#), it consists in simultaneous improvement of productivity and environmental management of agricultural land. In this context it is important to investigate interrelations in the implementation of the food function and environmental function of agriculture in different regions of the world, which is the main aim of this paper.

The paper is organised as follows. First, there is a conceptual framework and description of the methods used in analyses. It is followed by presentation of the parameters determining the amount of energy produced by agriculture and the accompanying emission of greenhouse gases. The paper concludes with a discussion.

## 2. Food security and environmental care as equivalent goals of contemporary agriculture

The issue of food security<sup>2</sup> is a regular subject discussed at forums of numerous international organisations. It encompasses a wide scope of problems ranging from global food security to health-promoting diet. The importance of this issue is due to the fact that almost every eighth man in the world suffers from hunger. Nevertheless, the scale of this phenomenon is decreasing. The number of malnourished people in the world decreased from 1015.3 million in 1990–1992 to 792 million in 2014–2016. It should be noted that the reduction occurred with an increasing population. Most undernourished people live in the least developed and developing countries, and taking into account the geographical regions of the world – in sub-Saharan Africa where the share of undernourished population is about 23%.

In the second half of 2014 the discussion on global food security after 2015 became even more intense. 2015 was the deadline for accomplishment of the goals which were formulated at the World Food Summit in 1996. The main goal was to reduce global famine by half compared to 1990. This challenge was difficult to achieve, so in 2001, the UN Millennium Development Goals (MDGs) undertook, among other, the task of reducing hunger by half (in 2015 compared to 1990), but measured by the share of hungry people in the global population of the world.<sup>3</sup> According to the FAO data, the percentage of malnourished in 2014–2016 was 10.9%, so it can be said that the target was achieved, but of course the problem still exist. In 2015 seventeen new goals were assumed to transform our world named Sustainable Development Goals (SDGs). They were supposed to continue the Millennium Development Goals.<sup>4</sup> It could be said that the first two goals are related with the implementation of the first Millennium Development Goal, because these goals are to end poverty, hunger, achieve food security and additionally promote sustainable agriculture.

<sup>2</sup> Food security is a holistic concept that addresses a wide range of dimensions, including availability, access, utilisation and stability of food (Food security, Food security...2010). According to FAO food security is, when all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". This phenomenon can be examined on the micro (individual, household) and macro (national, regional, world) scale (Food Security Indicators, [The State...2015](#)).

<sup>3</sup> The implementation of the Millennium Development Goals (MDGs) was described in detail in [The Millennium Development Goals Report 2015](#), United Nations.

<sup>4</sup> Different aspects of the SDGs are discussed in publications by [Gore \(2015\)](#), [Koehler \(2015\)](#) and [Scott and Lucci \(2015\)](#).

Conducted analyse proved that the long implementation of the unilateral food function by agriculture caused the per capita food supply to rise from about 2200 kcal/day in the early 1960s to more than 2800 kcal/day in 2009. As [Gilland \(2002\)](#) proves, 'food production has outpaced population, chiefly as a result of the development and use of improved plant varieties, major increases in the use of nitrogen, potassium and phosphorus fertilisers, a doubling of the irrigated area, more effective control of insects and diseases, improved strains of livestock and poultry, and wider use of nutritionally balanced feeds. A half century ago few, if any, would have considered this possible'. However, this did not result in food security in all world regions. Moreover the implementation possibilities of the food function of agriculture in respective states are diametrically different. It is a result of both environmental conditions, like a kind and quality of soil, and socioeconomic ones, including, among others, the quality of human resources and social capital, the level of economic development and resources of agricultural capital.

As [Richards et al. \(2016\)](#) argue, '(...) the decades of policies for intensive agriculture have not alleviated hunger and malnutrition, with an absence of food security featuring in both economically developing and developed nations'. So the main challenges remain that food security needs to be addressed through social, economic and distributive justice.

As [Rockström et al. \(2009\)](#) and [Griggs et al. \(2014\)](#) note, so far the scale and intensity of production have caused the situation where the Earth boundaries, defining safe space for humankind, have been reached. As many authors indicate, in many countries in the longer perspective it is impossible to continue the industrial model of agricultural development. The world needs to search for opportunities to start building and implementing a new food production system. The system should be based on a new paradigm of management of natural resources, where agricultural production is integrated with the natural environment. It is defined as sustainable intensification ([Giovannucci et al., 2012](#)). The main assumption is that it is possible to achieve global production growth by increasing land productivity and simultaneous reduction of the negative influence of agriculture on the environment. It can be achieved by increasing environment-friendly agricultural production. [Buckwell et al. \(2014\)](#) express this idea in the postulate 'more knowledge per hectare'. Increasing the 'knowledge per hectare' depends on the diffusion and implementation of knowledge into economic practice among as wide a group of entities in the agri-food sector as possible.

The designation of trends in the development of agriculture according to the rules of sustainable development, taking into accounts sustainable intensification is a very complex issue. On the one hand, it requires extending the range of technical and organisational solutions in order to develop and implement environment-friendly technologies, which do not stand in opposition to the food function. On the other hand, it is necessary to engage political instruments to correct market failure in the form of external effects. Both trends of actions require funds, high innovation potential, effective public administration and social acceptance. All these aspects are achievable in highly developed countries. However, the demographic pressure is particularly strong in poor countries, which struggle with the problem of hunger and malnutrition ([Achieving zero hunger, 2015](#); [Caparrós 2014](#); [Ziegler, 2011](#)). Usually these countries are neither motivated nor do they have

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