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European dietary patterns and their associated land use: Variation between and within countries

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ABSTRACT

This paper determines the cropland use associated with the dietary patterns of 16 European countries and investigates sources of variation in land use between and within these countries. The analysis combines food availability data at the household level with country-specific land use data for food items. The household food availability data is obtained from a standardized and post-harmonized databank, developed in the Data Food Networking Project (DAFNE). The results show large differences between the land use of the 16 European countries, ranging from ±1500 m^2 (Ireland) to ±3000 m^2 (Malta) to supply an average person's food demand. Major reasons for this divergence include disparities in total caloric food availability and in national yields. The composition of the diet is only a minor source of variation. Using food consumption data at the household level makes it also possible to look for sources of variation within countries. This paper investigates sources of variation within countries by examining the influence of education of the household head on land use associated with food consumption. The analysis shows that diets of people with only elementary education need on average 20% more land than diets of people with a higher education (2302 m^2 and 1948 m^2, respectively). The basis of this difference is the higher caloric availability for people with only an elementary education; the influence of differences in the composition of the diet is negligible. Variation in land use between countries is thus caused by the different agricultural productivities and caloric availabilities, and the major source of variation within countries is the caloric availability. The composition of the diet is only a minor source of variation, both between and within countries. The results implicate that highly educated people have a lower demand for land.

Introduction

In the last decade, research on the environmental impact of food consumption patterns has increased. This is caused by the rising awareness that the consumption of food has major environmental consequences. For instance, it is estimated that 20–30% of the environmental impacts of final household consumption is due to our food (Tukker et al., 2011). Land use has been one of the main indicators of environmental impact, as there is an increasing debate about whether there will be enough suitable land for the production of food. It is estimated that agriculture occupies 38% of total land area and it is expected that this will increase in the upcoming decades (FAOSTAT, 2011). Therefore, the relation between food consumption patterns and land use has become increasingly important as a topic for research. Land use is calculated for past and current situations for different regions (e.g. Geeraert, 2012; Zhen et al., 2010) and for future projections (e.g. Wirsenius et al., 2010).

There are large differences in the use of land among individual food items (e.g. Gerbens-Leenes et al., 2002). For example, the production of meat in particular is inherently inefficient compared to plant-based food items, so the role of animal products in the use of land has been a prominent focus of research (e.g. Baroni et al., 2007; Nijdam et al., 2012). Identifying variations in the land use requirements of different food items leads to proposals for more sustainable diets.

However, diets of people are more than the sum of individual food items. They are complex combinations of different food items, influenced by cultural and regional preferences. As a result, it might prove difficult to exclude individual land-intensive food items from a specific diet. Moreover, the land use impact of food items depends also on the productivity of a specific agricultural system.

To investigate the influence of dietary patterns on land use, the combination of different dietary patterns and associated agricultural systems are analyzed here, to investigate sources of variation

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between European countries. This analysis can produce insights into the relation between dietary patterns and land use. The analysis is carried out by calculating the land use of the dietary patterns of 16 European countries. The food consumption data are obtained at the household level and thus represent a different scale than studies which use FAO data for their analyses. This finer spatial resolution of data for food consumption also allows the identification of sources of variation within countries. For the current analysis, education of the household head is investigated as a possible socio-economic variable associated with variation in land use. Identifying variations in land use of dietary patterns between, and within, countries leads to a better understanding of the relation between dietary patterns, the agricultural system and land use.

Variation in land use between different dietary patterns

There are differences in dietary patterns between and within European countries, resulting mostly from their different cultural norms (Naska et al., 2006). An early study on land use and dietary patterns, conducted by Gerbens-Leenes et al. (2002), developed a methodology for the assessment of land required for food and showed, in combination with household data, the land use for the Dutch consumption pattern in 1990. A follow-up study assessed the relative land use for 14 European countries, compared to the Dutch consumption pattern and land use in 1990 (Gerbens-Leenes and Nonhebel, 2005). This study showed large differences in land use for the existing dietary patterns in Europe.

The total land use related to food consumption is determined by both consumption (type and amount of food products consumed) and production (high yields lead to a lower use of land) of food. The studies conducted by Gerbens-Leenes et al. (2002) and Gerbens-Leenes and Nonhebel (2005) used one production system (the Dutch system) for the calculation of the use of land; they were designed to show the relevance of specific dietary patterns for the use of land. A recent advancement in the methodology made it possible to also include other national production systems. Kastner et al. (2012) use an updated methodology and FAO data from 1961 to 2007 for a consistent comparison of land use in different subcontinents at different points in time. They show that variations in per-capita food supply are large and linked to income levels, especially qualitatively. On the other hand, variations in land use were less pronounced, and not clearly linked to income levels. This latter finding can be explained by large differences in output per unit land (production system). This emphasizes the importance of the production system in analyses about land use. We use the methodology from Kastner et al. (2012) to investigate whether differences in agricultural systems are a possible source of variation for the land use of European dietary patterns.

A challenging issue in comparative studies on land use for food is the difference in collection methodology for food consumption data, since different definitions and methods exist for the recording of food consumption. To compensate for this, most comparative studies use food supply data obtained from the FAO food balance sheets (FBS). Because these data are harmonized as much as possible, using FAO data for inter-country comparisons is a common practice. Nevertheless, these data represent the national supply level, and information about consumption within the household is lost. On the other hand, analyses from single-country studies which use household data cannot be used for comparisons with other countries, as the methodology for the collection of household food data differs substantially between countries. Hence they cannot be used for the purpose of the current paper.

In this paper, we use a standardized and post-harmonized databank, developed in the Data Food Networking Project (DAFNE). This dataset allows the assessment of land use associated with dietary patterns on the household level, without risking flaws because of differences in the collection methods. Minimizing the effects of differences in collection methods is essential for the purpose of our analysis, to exclude methodological differences as a source of variation. The DAFNE project exploits food and socio-demographic data collected in the household budget surveys (HBS), aiming at the development of a cost-effective food databank that allows monitoring of food availability both within and between European populations (Trichopoulou and Naska, 2003). Currently, 24 European countries are included in the database (DAFNE, 2005). The initiative is intended to be used as a cost-effective nutrition monitoring tool in a European context. The databank allows for comparison between countries and within countries. This latter fact makes it also possible to investigate the influences of socio-economic variables on land use. Since it is known that dietary patterns are also influenced by socio-economic factors, this represents a major advantage compared to the use of FAO national supply data. For instance, Hulshof et al. (2003) show that people with a high socio-economic status (SES) in The Netherlands consume more vegetables, cheese and alcohol, whereas people with a low SES consume more potatoes, meat and meat products, visible fats and coffee. Education is studied as a possible source of variation in this paper, since epidemiological studies show that it represents the strongest and most important social predictor in Western countries for a healthy diet (Johansson et al., 1999; Roos et al., 1996). People with a higher level of education generally have a healthier diet, characterized by a higher consumption of fruit and vegetables. For that reason, education is chosen as most likely source of variation for dietary patterns within European countries.

Thus, this analysis uses the method by Kastner et al. (2012) and data obtained from the DAFNE databank to assess the land use related to the dietary patterns in Europe. We are able to incorporate both the influence of differences in consumption patterns as well as differences in the agricultural systems on total land use. The paper assesses both the cropland use of the European dietary patterns, as well as the effect of education on this land use. In doing so, this paper contributes to the body of knowledge on the relation between dietary patterns and land use. This is accomplished by using food consumption data on the household level instead of using data on a national supply level.

Methodology

Collection of household budget survey data

The used food consumption data are freely available at the Dafnesoft website (DAFNE, 2005). The methodology for the collection of these data consists of several steps and is described in detail by Trichopoulou and Naska (2003). A brief overview is given in this section. First, the data are collected from several European countries through household budget surveys (HBS). These surveys collect data on food availability at the household level. Hereafter, the raw HBS data are incorporated in a central database. The next step involves the post-harmonization of the food, demographic and socio-economic information. The final step comprises the calculation of the average, daily individual food availability. The average daily individual food availability is expressed in grams per day. The data obtained from this databank can be used for comparisons between and within countries.

For comparisons within countries, food availability in the DAFNE databank can be obtained for different socioeconomic variables: education, occupation, locality and household composition. Education is chosen as socioeconomic indicator in the current study. The variable differentiates three categories in the data bank: ‘primary education/illiterate’, ‘secondary education’ and ‘higher