Pressures on Prime Agricultural land in Europe

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Introduction

The economic and financial crises are at the centre of the news today. However, there are problems in the world which concern long term issues of global sustainability related to food, water, climate and energy. Leading studies by international organizations sketch a pattern of a growing demand for food production worldwide, shifting consumption patterns and competing claims on available land[1,2].

Will we be able to efficiently produce biomass and provide environmental goods and services on agricultural land, in Europe and in the world? This question has become relevant again after the neglect of agriculture in the past two decades. This publication aims to roughly explore the significance of prime agricultural land in Europe for global food security, based on visions from policy makers, interest groups and scientists on this topic. The visions were gathered in a conference entitled 'Pressures on Prime Agricultural Land in Europe[a].

1. What is Europe's prime agricultural land?

In 2000, 45% of Europe's land mass was covered with agricultural areas (ca 3.9 Mkm^2), forming part of a probably greater variety of landscapes in a small space than anywhere else in the world (Figure 1). Over decades, land users, agri-scientists and soil scientists have discussed ways to define the suitability of land for agriculture, in order to distinguish prime agricultural land. It is impossible to give a univocal definition of prime agricultural land, because the suitability for agriculture depends on many other things than solely the physical, chemical and biological properties of soils. The type of agricultural production and land management determine the suitability, but also the extent to which land owners, land users and societies are prepared to accept harmful effects to the environment[3,4].

Soil scientists and agricultural scientists seem to prefer definitions based on biophysical parameters, like properties of soils, climate and terrain[37]. Social scientists and economists tend to focus on the human factors that determine agricultural production, such as human capital, institutions or farming systems. A third viewpoint is that of environmental scientists, who emphasize the impact of farming on the environment - for instance the need to preserve natural areas.

A definition encompassing these viewpoints could be: prime agricultural land includes land suitable for agriculture due to its physical, chemical and biological properties, which best meets the conditions of providing maximum yields while providing least pressure on the environment, and requiring least inputs[5]. However, putting this definition into practice appears to be difficult due to the lack of information on direct costs of pressures on the environment, and contrasting effects. For example, the use of manure instead of inorganic fertilizer result in higher loads of copper and zinc in soil and associated waters, while manure has positive effects on several soil functions.

[a] This conference was organized in November 2008 by the Dutch Ministry of Agriculture, Nature and Food Quality and Wageningen University & Research Centre, in collaboration with the European organization of farmers and agri-cooperatives (COPA-COGECA).

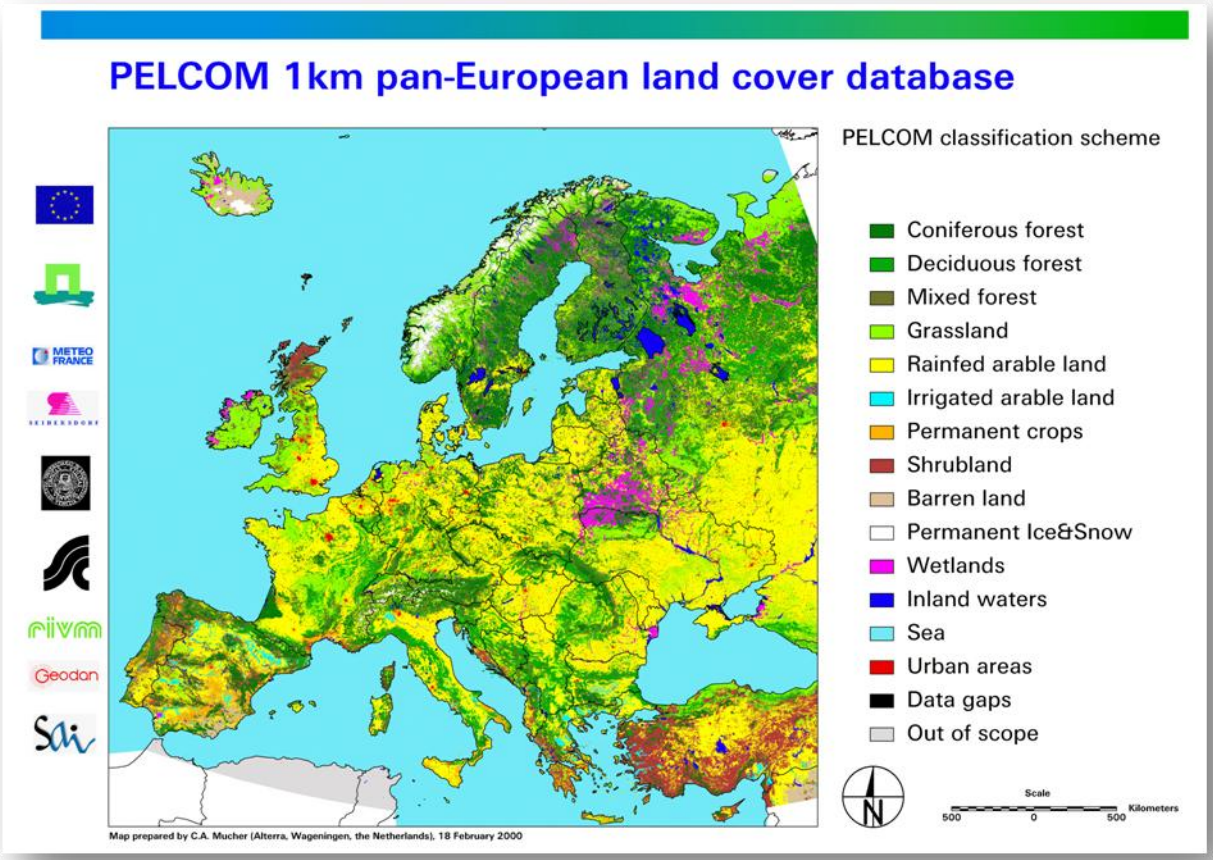

Figure 1 Europe's land cover. Source: PELCOM land cover database, Mücher et al., 2001[6].

2. Why does prime agricultural land now have renewed relevance in EU countries?

The notion that prime agricultural land should be preserved for agriculture is not new. The shift of focus from soil science to agronomic science in between the World Wars, and the large campaigns of land capability analysis and land evaluations under the direction of FAO in the 1980s following the food crises in Sub Saharan Africa are evidence of the relevance of prime agricultural land to societies. The increase in food prices in the summer of 2008 has revived the interest again, despite the fact that the restricted availability of agricultural land in relation to crop production for energy sources was only one of the causes[7].

Figure 2 Using land for food production. Source: www.estyep.com – royalty free image.

Currently, the agricultural sector in general and prime agricultural land in particular receive more attention from the policy forming community, because agricultural land in Europe is faced with various pressures. These include demands for increased food and biomass production for a growing world population and the need to adapt to climate change. At the same time, societies become aware of the need to conserve or restore biodiversity, and soil and water resources (Figure 2). Finally, most evident to citizens in Europe, urban development, bioenergy cropping and nature development set claims on the available land resources.

Europe's agricultural area is expected to decrease by 20 Mha up till 2030 due to claims from urban development, nature development and bioenergy cropping[8]. Population and prosperity growth are the most important drivers for land take from agricultural areas[9,10]. From experiences in the USA it is well known that the urban land transformation is taking place on the most fertile lands and hence has a disproportionately large overall negative impact on the net primary productivity [34]. The amount of cropland which is lost to urban encroachment coincidences with an equal amount of rangeland conversion to cropland. An important amount of the cropland lost was prime agricultural land, and soils with lower qualities are converted to cropland[35].For historical reasons, urban metropolitan zones are often located in areas with prime agricultural land. The soils with the highest productivity in the USA is also the land with the highest level of urbanization[36]. This implies that more inputs and/or cultivated land are required for obtaining the same agricultural production elsewhere, on less suitable soils, resulting in higher pressures on water, soil and biodiversity. This is called suboptimal land use. Urban areas have been able to, and are still expanding at the expense of rural areas (Figure 3). One of the reasons is that it is often cheaper to develop previously undeveloped land, than to redevelop land previously in use for housing, industrial and commercial use, recreation or transport infrastructure. This phenomenon is also termed the 'rural-urban gap'. Currently, the redevelopment of 'brownfields', as previously developed land is called, is on the political agenda of several EU member states.

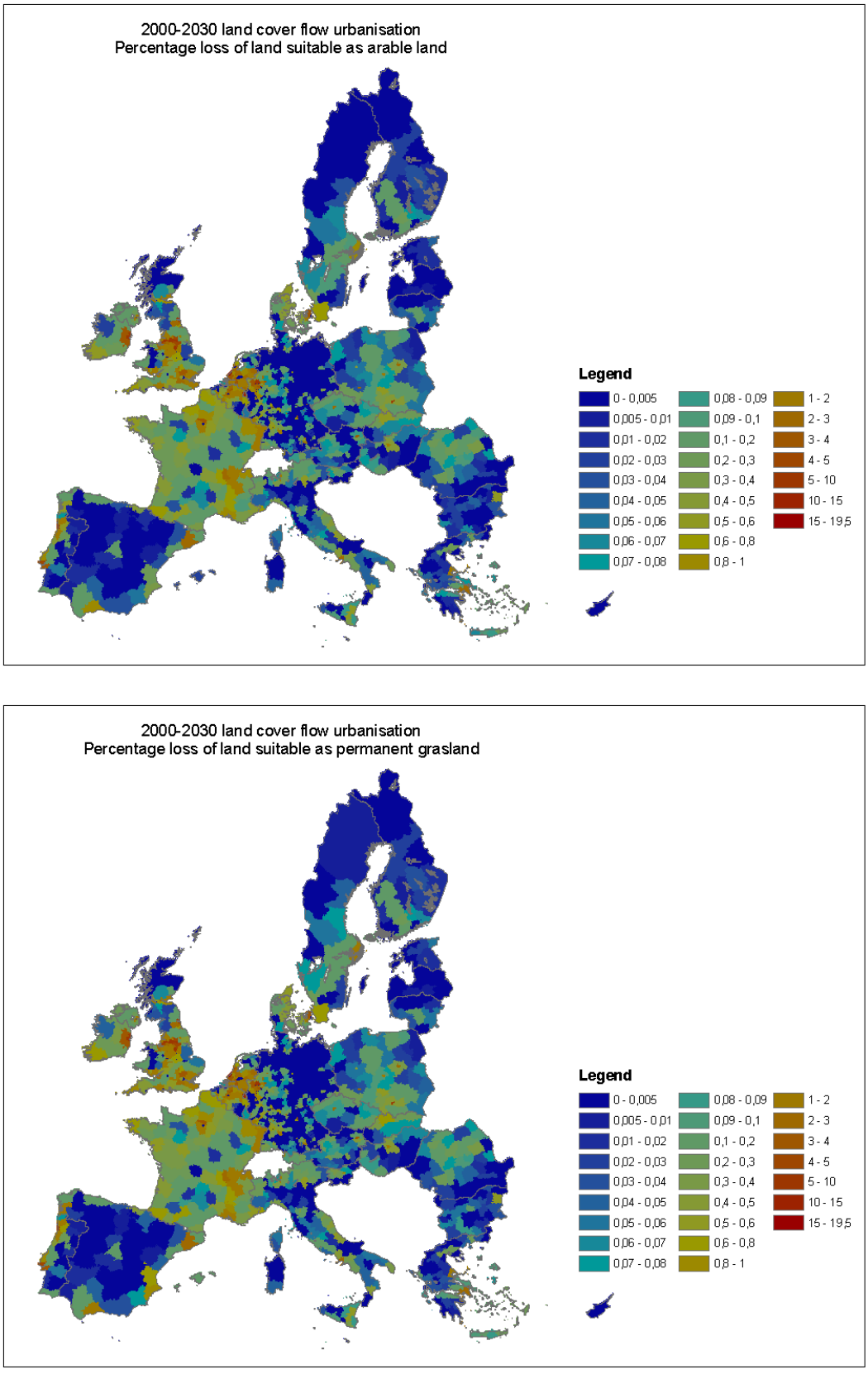

Figure 3 Expected land take from suitable agricultural land for artificial surfaces between 2000 and 2030 following the Global Cooperation scenario of global change (B1) (in % of NUTS3 regions). Top: land take of suitable land for arable cropping; bottom: land take of suitable land for permanent grassland[11]

3. Can we deliver enough food, feed, fibre and fuel from our land, given expected impacts of climate change?

Food insecurity is one of the main current threats to people and societies in many parts of the world[1]. A recent evaluation of the Millennium Development Goal to eradicate hunger shows that with recent increases in food prices, it is estimated that 1 billion people go hungry, while another 2 billion are undernourished.

Changing consumption patterns towards more meat and dairy products raise the demand on the global cereal markets in the long term, especially due to expanding urban areas in Asia. The production of primary biomass for food and stock feed must double to feed the world population by 2050[19]. Europe will have an increasing role to play in food production for other parts of the world.

According to global simulations for different socio-economic scenarios[12], by 2080, 100 to 250 M ha of additional cultivated land will be required compared to the situation in 1990, even as demographic growth flattens. This refers to food and feed purposes only. The demand for additional cultivated land for food and feedstock comes mainly from population growth and shifts in lifestyle[23]. Following the scenario most demanding for additional cultivated land (A2r, Figure 4), the share in growth of agricultural production from 2000 to 2050 will be met for 12% from an increase in the land area used for agricultural production. The remaining growth in agricultural production comes from an increase in crop yield (75%) and more products per hectare (13%)[13].
Although there is consensus that it is possible to produce enough food in the next 50 years, and to decrease the number of people who go hungry, there is not much consensus how on to achieve this by sustainable means[38]. In Europe for example, it is unknown if the projected increase in agricultural production can be done within the current European regulations. To increase the agricultural production it is necessary to use more inorganic fertilizers and pesticides, while the use is limited by the Nitrates Directive and the Water Framework Directive. Land consolidation will also be necessary in Eastern European countries and this can be in conflict with EU targets for biodiversity.

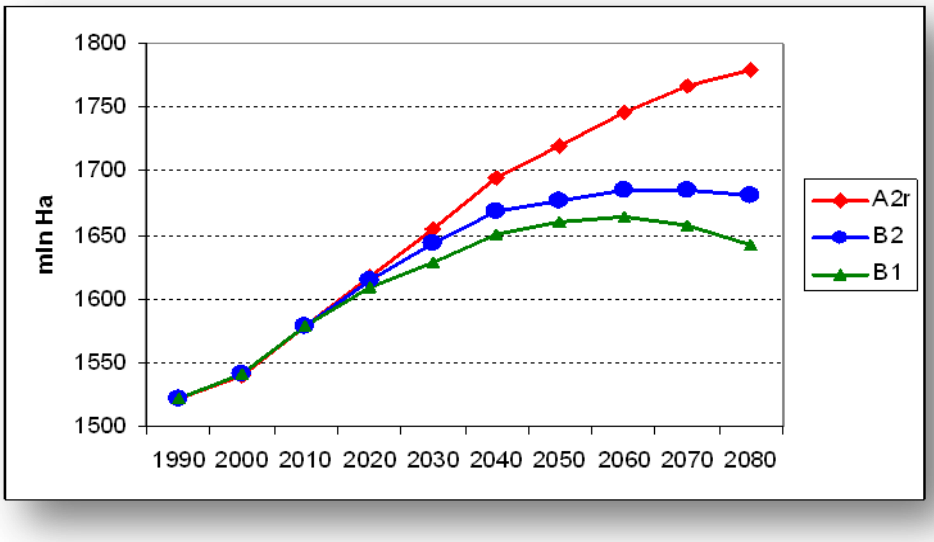

Figure 4 Development of the area of cultivated land, projected for different socioeconomic path-ways, from 1990 to 2080. Source: Fischer (2008). The scenarios A2r, B2 and B1 respectively lead to high, intermediary and low emissions of greenhouse gases and hence magnitude of future climate change. The A2r is the A2 scenario, revised for the most recent long-term demographic outlook with a corresponding lowering of future world population growth[14]

Climate change

Climate change has effects on the availability and productivity of prime agricultural land[15]. Due to rising temperatures and precipitation, the productivity of soils in Northern Europe will increase in the first half of this century, with positive effects on the production of wheat, potatoes and dairy products[16]. Additional positive effects come from the 'fertilization effect' by increased CO2 content in the atmosphere[23]. It is predicted that up to 2050, agriculture will be able to adapt to climate change by changing crop varieties, planting dates, moisture conservation tillage, efficient irrigation (autonomous adaptation), but in the second half of the century, climate change will have a clearly negative impact[23].

In Southern Europe, negative impacts from climate change are already showing up[17] (Figure 5). Higher temperatures and decreasing precipitation will result in agricultural land being taken out of production[16]. Rain-fed agriculture will be less viable here[23].

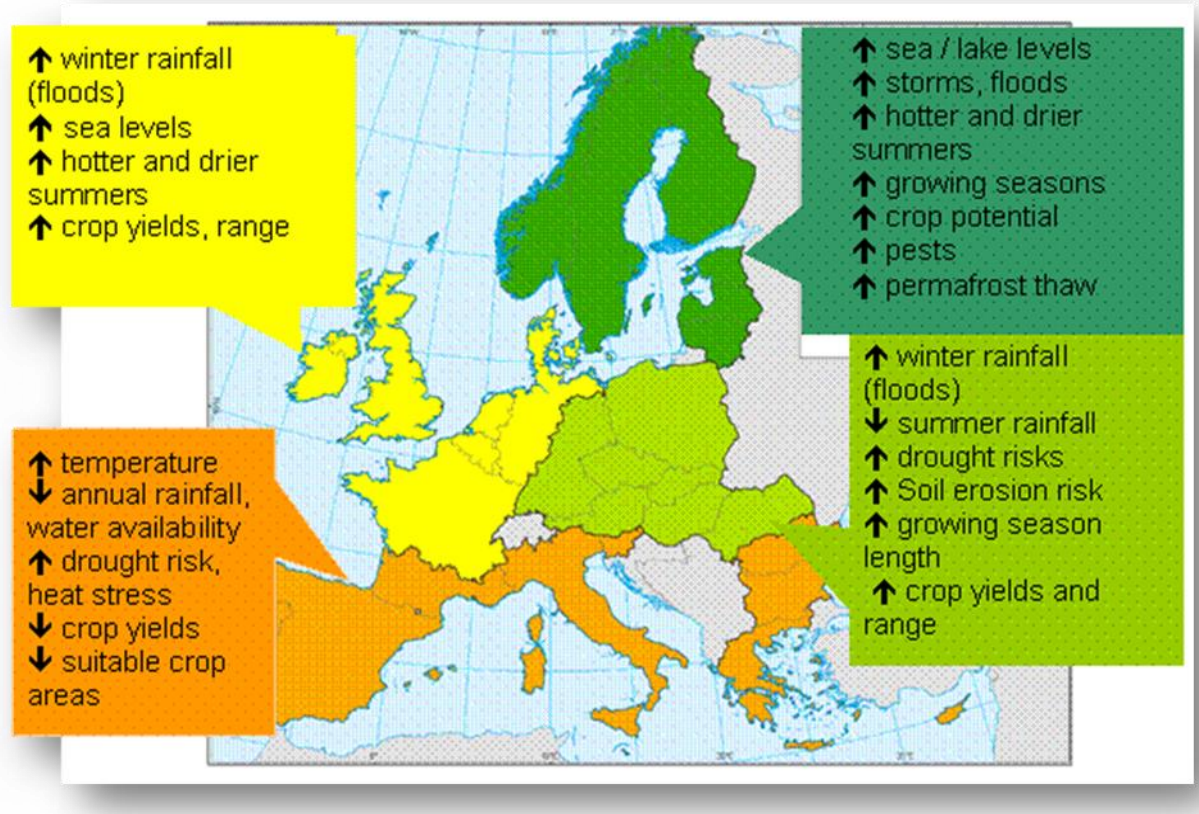

Figure 5 Projected impacts from climate change in different EU regions. Source: http://ec.europa.eu/agriculture/climate_change/index_en.htm.

Overall, international food security problems do not necessitate Europe to change its policy with regard to food production. This may change in the future, depending on a variety of socio-economic driving forces and the land use for biofuel production. We should also realize that increasing food production in Europe is not without costs[23].

Globally, the impacts of climate change on crop production are geographically unevenly distributed. Aggregate impacts of the predicted climate change on the global food system are relatively small. The global balance of food demand and supply is not likely to be challenged until the middle of the century, and many food security problems have nothing to do with climate change[23]. However, in

the future, climate change will lead to more costs because of necessary adaptations, and the costs of adaptation will increase with time. Among the elements of climate change, changes in frequencies of extreme events (droughts, heat waves, severe storms) will have more risks for damage of agricultural yields in the near term than gradual changes in average temperature and precipitation[23].

4. Which consequences may agricultural biomass production for energy sources have for (prime) agricultural land?

The production of agricultural biomass for energy sources has been suggested for several goals: to provide an alternative source for energy to fossil sources, to accomplish greenhouse gas savings, and to improve the ecological quality of degraded land[23].

Currently, 2% of the agricultural area worldwide is used for bioenergy cropping. 5% of the global oil seed production is being processed into biofuel, or directly used for transport, and 4.5% of the global cereal production is used to produce ethanol[18]. The upper limit of land required for bioenergy cropping depends on political ambitions, but based on the use of 1st generation bioenergy crops, even the use of the total area of agricultural land will not be sufficient to meet global energy demands[19].With the recent increase in food prices and the projected demand for additional food and feed production, the use of agricultural land for bioenergy cropping at the expense of food or feed cropping has become the subject of an ethical debate.

In order to avoid the competition for land from bioenergy cropping with agricultural production of food and feedstock, suggestions have been made that part of the near future demand for biofuels can be met by growing biofuel crops on degraded land[20,21]. The key aspect of degraded land is that there is no current cultivation for crop production. Making use of such land would therefore seem a chance for sustainable bioenergy cropping.

How much land is available for bioenergy cropping? Calculations by IIASA and LUC[23] show the following picture (Figure 6, Figure 7, Figure 8):

- Excluding from a total land area (excl. Antarctica & Greenland) of 13.1 billion hectares current cultivated land, forests, built-up land, water and unvegetated land (desert, rocks, etc,) results in some 4.5 billion hectare.
- Excluding from these lands the very low and unproductive areas (e.g. tundra, arid land) a remaining area of 2.1 billion hectares is estimated (currently grassland & pastures, shrubs and woodland).
- Constructing detailed country-level livestock feed balances, we estimate that in year 2000 about 60-70 percent of the available biomass was needed for animal feeding.
- Hence with current use, the land potentially available for bioenergy production is 600–800 million hectare, with a wide range of natural productivity.

Figure 6 Calculation of available land for bioenergy cropping. Source: Fischer, 2008.

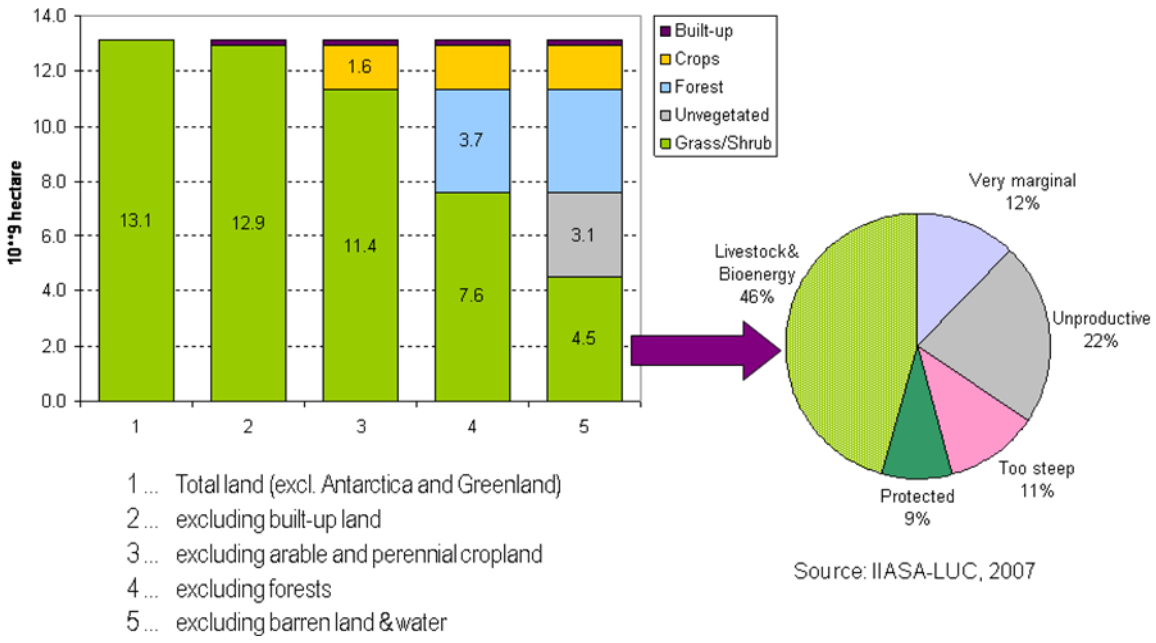

Figure 7 Calculation of available land for bioenergy cropping. Source: IIASA-LUC, 2007.

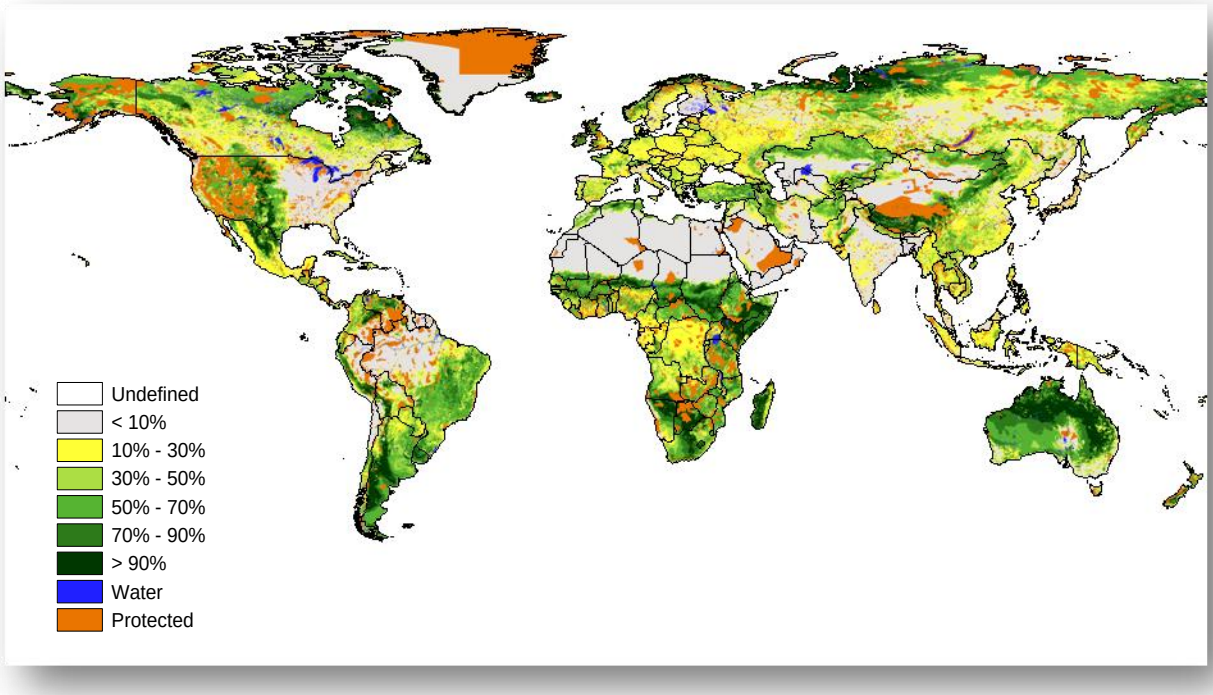

Figure 8 Available land for bioenergy cropping according to calculations by IIASA-LUC (2007). Source: GAEZ 2007, IIASA-LUC/FAO[22].

In the EU27, sufficient extents of agricultural land could become available for biomass production while satisfying food and feed demand. Land use scenarios show that by 2030, some 22 to 30 Mha cultivated land will be available in EU27, and another 20 Mha in Ukraine. In addition some 15 Mha of pasture could be used for energy crops (Fischer, 2008). By 2030, with large areas to be used for bio-energy feedstock production, the efficiency and sustainability of production will be crucial for public

acceptance[23]. The competition for land to produce biomass is expected to cause an increasing integration of the agricultural, forestry and energy sectors[23].

From the calculations of available land for bioenergy cropping it can be concluded that at the global scale, there is limited additional high-quality land available for this purpose, and that there is uncertainty regarding the use of marginal land. In order to achieve the goals of agricultural biomass production, the current area of agricultural land would need to be preserved, and a focus on increased but sustainable production on the current agricultural land would be required[23]. In addition, non-forested land currently not or extensively used for agriculture would need to be considered for agricultural production. Finally, a rapid development of 2nd generation feedstocks and conversion routes would be required[23].

5. Which are the challenges for the sustainable use of soil?

Until recently, soil has predominantly been perceived in the context of its agricultural production function. Over the last decades, the awareness has grown that soils provide goods and services which are vital for land and aquatic ecosystems, and that soils have many other important societal functions[24]. These functions have been clearly expressed in the soil functions developed in the framework of the Soil Protection Strategy of the Commission of the European Union[25] (Box 1). The use of soils for agriculture draws upon all soil functions.

The seven main functions of soil

F1: food and other biomass production
F2: storing, filtering and transformation of compounds
F3: habitat and gene pool of living organisms
F4: physical and cultural environment for humankind
F5: source of raw materials
F6: acting as a carbon pool
F7: archive of geological and archeological heritage

Box 1 The seven main functions of soil, as defined in the Soil Protection Strategy of the Commission of the European Union[25].

In order to safeguard these functions, soils must be used in a sustainable way. What this means, is determined by our current knowledge of the effects of soil use on soil functions, and the thresholds set by societies. However, soil limitations and suitability are often not determining factors for land use planning, for example where urban sprawl takes place on prime agricultural land. These situations, where 'soil follows use' are increasingly common[26]. This is partly explained by the fact that soil is always owned by someone in the EU, which complicates the adoption of regulations similar to those in force to protect air, water and wild flora and fauna.

At the same time, there is an increasing demand for agricultural products, and a loss of agricultural land due to sealing and land abandonment[8]. On the remaining agricultural land, a segregation into high tech farming and extensive farming is taking place[27]. If agricultural production also decreases, the volumes produced by European farmers will have to be met by an increase in production in Third Countries[27]. This may have positive effects on the economies in these countries, but negative effects on soil, water and biota resources with possibly global implications (e.g. in case of the release of organic C).

Farmers' organizations pronounce that European farmers are committed to maintain soil functions. However, they are faced with several constraints. Safeguarding soil functions on agricultural farms in situ ('on farm') and in areas influenced by the agricultural practice on the farms (e.g. by groundwater contamination; 'off farm') implies protecting public goods (soil, water, atmosphere) and providing public services (the soil functions) far beyond the farm. Farmers are expected to act as managers of landscape and rural areas. These activities are partly remunerated by farm support and agri-environment schemes in the Common Agricultural Policy, but not by the operation of the market, especially not when farmers do not have secure land ownership or tenure.

Apart from soil resources, the sustainable use of water resources by agriculture also stands for challenges. According to the EEA, water use in agriculture is becoming unsustainable in some parts of Europe[28,29]. Agriculture accounts for 24 % of water abstraction in Europe as a whole, whereas most of the water abstracted for agriculture is not returned to water bodies. In southern European regions, abstractions for agriculture amount up to 80%, typically occurring in summer, when water is least available, thus maximizing negative effects. Climate change aggravates this situation, as hotter and drier summers are expected to enhance demands for water resources. The impacts of climate change on the increasing net demand for irrigation water could be as large as changes projected due to socio-economic development between 2000 and 2080[23]. Also, agricultural water use will grow if growing demand for bioenergy is met using first generation energy crops[28,29].

6. How do we value soil functions for an optimal use of agricultural land?

The value of the production function of soils for agriculture is debated. Environmental scientists and farmers' organizations tend to attribute a large value to this function, whereas agricultural economists do not reward soil as an important production factor, stating that social organization is much more important for agricultural production, at least in Europe. Indeed the availability of prime agricultural land alone is not enough for food, feed and biomass production. Soil science was invented in Russia, and most prime agricultural land can be found in Southern Ukraine. However, the availability of farms, farmers and knowledge has been limiting agricultural production in this region. The economic profitability of the Dutch agricultural sector proves that these factors are more important than the availability of prime agricultural land: part of the Dutch soils had to be made suitable for agriculture with intensive management[30].

When looking at the full spectrum of soil functions for an optimal use of agricultural land (Box 1), the question needs to be posed if we wish to distinguish between key land functions, and if so, to which to give priority. Agricultural use of land, like any other land use, may benefit some soil functions, while at the same time endangering others. Among the functions competing for priority positions we could imagine the production of food and biomass, but given the current focus on environmental pressures and climate change effects on societies, organic carbon sequestration may also obtain a high score of interest. We also need to consider that biomass production is not limited to soil resources: glasshouses for example produce large shares of food production[31]. In recent years, appreciation has grown for agricultural land use as 'carrier' of landscape quality, and its value for tourism, biodiversity and food safety. These contributions are based on the combined operation of different soil functions.

The (economic) valuation of soil functions is related to the view on the importance of soil protection. For a long period, soil has not received attention from an economic viewpoint due to the possibility to maintain the production function by using inorganic inputs. Another reason is that findings from the scientific community were only gradually interpreted and accepted by the policy-forming

community in wider themes of environmental sustainability. The awareness of the need to protect soils is now increasing slowly. However, whereas the food production function will receive the support from all politicians, the organic carbon sequestration function from only a few[31]. On the other hand, if a soil performs this function well, it will help to mitigate effects from climate change, while improving the performance of other functions.

7. What is the perspective of farmers and land owners to the protection of prime agricultural land?

The agricultural sector is asked to deliver simultaneously commodities in a good quality and produced in a sustainable way, and also to deliver public goods and services (environmental services, rural services). On the other hand, the demand for food, feed and biomass products is increasing. Farmers' organizations, farmers and land owners struggle in finding the right balance to fulfill these demands while keeping a competitive position in the market. The European Commission is working on sustainable production and consumption[32]. In this process, retailers are involved, but farmers are not. Farmers organizations feel that farmers should be at the heart of such discussions[27].

The Common Agricultural Policy grants support to farmers for environmental services, animal welfare and food quality standards. In the 'Health Check' of the Common Agricultural Policy, this so-called cross-compliance was proposed to be simplified by withdrawing standards that are not relevant or linked to farmer responsibility. On the other hand, new requirements were proposed in the CAP reform to retain the environmental benefits of set-aside and improve water management.

European farmers generally are well aware of the importance of soils as a production factor, and as a vital element in rural development. Farmers' organizations recognize that the continuous development of technology is necessary, and that they should be open to innovation, including biotechnology[27]. But often farmers have limited access to up to date knowledge, technology and guidelines on soil use and land management. Governments, agribusiness and interest groups in several EU member states currently join efforts to bridge the gap between scientific research and the uptake by land managers, focusing on agrobiodiversity and sustainable soil and land management (SLM). An example is the Dutch portal for farmers SPADE (www.spade.nl), which puts practical knowledge on soils and SLM at the service of farmers in the form of hands-on guidelines.

8. What is the main relevant legislation to prime agricultural land?

At the European level, existing legislation dealing with prime agricultural land is included in the Common Agricultural Policy (CAP) and various legislation related to water, soil, biodiversity, climate change and landscape and environmental assessment.

The CAP has an enormous influence on land use. Its latest reform has resulted in a decoupling of subsidy from its original goal of increasing food production. There is now a stronger focus on rural development and environmental objectives, for instance through the cross compliance in the Good Agricultural Environmental Practice. The CAP also includes voluntary instruments for environmental objectives, such as the agri-environmental measures. Extensive farming is supported by the CAP. Also under the CAP, since 1975, areas with physical, climatic and topographical constrains could be classified in the EU as Less Favored Areas (LFA) and farmers could get compensatory allowances to compensate for negative effects on agricultural production. A new classification of agricultural areas with natural handicaps has been adopted by the European Commission[33], showing that it is possible to incorporate some kind of differentiation in land qualities in important EU legislation.

Legislation related to water which influences the use of agricultural land includes the Nitrates Directive, the Water Framework Directive and the Pesticides Directive. These set limitations to the intensity of agricultural land use.

From the perspective of soils, the proposed Soil Framework Directive has implications for the use of agricultural land. This directive is currently developed by the European Commission in response to several soil threats. The emphasis is on research on soil protection. The basis of the proposal is to enable member states to take action where problems are identified.

Existing legislation at the European level to protect biodiversity and landscape also influences the use of (prime) agricultural land. The Natura Directives and elements of the GAEC (CAP) provide limitations on land use which are consistent with a higher regard for biodiversity.

Legislation on climate change is partly directed to the agricultural sector. At the European level, climate change legislation comes under the EU Climate Change Policy and the Kyoto Protocol. Both legislative frameworks have the reduction of greenhouse gas emissions as priority objective. The EU Climate Change Policy has a mechanism for monitoring greenhouse gas emissions, and a greenhouse gas emission allowance trading scheme. Under the Kyoto Protocol, EU Member States have two means of achieving reductions in these greenhouses gases, while addressing agricultural land use: stepping up or introducing national policies to promote sustainable forms of agriculture, and cooperation with the other Contracting Parties through emission permits.

The use of agricultural land is also steered by the Environmental Impact Assessment (EIA) and Strategic Environmental Assessment Directives (SEA). These Directives ensure that environmental consequences of projects are identified and assessed during their preparation before authorization is given. According to the EIA Directive an environmental impact assessment must identify, describe, assess likely direct and indirect environmental effects of activities. For prime agricultural land the relevant objects are fauna, flora, soil, water, air, climate, landscape, material assets and cultural heritage. The SEA Directive prescribes that the likely significant environmental effects are evaluated of implementing plans or programs, including effects on biodiversity, soil, water, air, climatic factors, population, human health, architectural and archeological heritage and landscape.

At the national level, in many European countries some form of protection of agricultural area is already present in existing legislation for spatial planning (against land take and fragmentation) and soil and water protection (mostly against pollution). Examples of legislation for spatial planning are the target in the UK to build 60% of new houses in already built up areas (brownfield redevelopment) by 2007. In Germany, there is a national target to reduce soil sealing from 120 ha/day to 30 ha/day in 2020. Also, farmers are compensated for land lost to sealing. In the Czech Republic, the price for the conversion of fertile land to urban land has been multiplied by 20 in a recent amendment to the Soil Law[31]. Most often however, this type of legislation does not differentiate agricultural land with regard to its suitability for certain types of agriculture. This is one of the causes of the 'rural-urban gap' referred to in Chapter 2.[34]

This overview of available legislation shows that there is a complex interplay between legislation at the European and the national level for different sectors, which influences the use of prime agricultural land. There is no overarching legislation to protect prime agricultural land from combined pressures of economic demands for biomass production, land take and the surpassing of targets for environmental sustainability.

9. Conclusions

There is a renewed interest for agricultural land in Europe, and especially prime agricultural land. This derives from demands for increased food and biomass production from a growing world population. Producing enough food for 8 to 10 thousand million people in a sustainable way is one of the great current challenges of mankind[38]. At the same time there is a need to adapt agriculture to climate change. Also, claims on the available land from urban development, bioenergy cropping and nature development are directed towards land currently in use for agriculture. Finally, there is a growing awareness of the need to protect biodiversity, soil and water resources from pressures due to various land uses.

Prospects of the required biomass production to feed the world population indicate that additional cultivated land will be required globally up till 2080. From 2050 onwards, climate change will have a clearly negative impact on the productivity of existing agricultural land globally, and also in Europe.

Due to the increased demand for food and feed production, the use of land for bioenergy cropping has become debated. At the global scale, there is limited additional high-quality land available for bioenergy cropping, and there is uncertainty regarding the use of marginal land. In order to achieve the goals of agricultural biomass production for energy, the current area of agricultural land would need to be preserved, and a focus on increased but sustainable production on the current agricultural land would be required. In addition, non-forested land currently not or extensively used for agriculture would need to be considered for agricultural production. Finally, a rapid development of 2nd generation feedstocks and conversion routes would be required. In the EU27, sufficient extents of agricultural land are expected to become available for bioenergy production while satisfying the food and feed demand up till 2030. Yet, the efficiency and sustainability of production will be crucial for public acceptance.

Given the trend of declining agricultural area in Europe up till 2030, challenges for the sustainable use of land include safeguarding the balance between the increased agricultural production inside and outside Europe and managing the adverse effects on soils, water and biotic resources, with possibly global implications. Within Europe, farmers are constrained by the demand for commodities in good quality and produced in a sustainable way, while complying with obligations to deliver environmental and rural services. Often the latter are not remunerated by the market. Farmers' organizations indicate that farmers have troubles in keeping a competitive position due to this constraint, and indicate to need better access to innovative knowledge and technology.

There is no univocal definition of prime agricultural land, as it is seen differently by scientists from biophysical, social and economic disciplines. Also, the importance of different soil functions for agricultural production is debated. At the same time, it is increasingly recognized in the policy-forming community that agriculture can provide multiple services to societies beyond the food production function, like rural development and organic carbon sequestration.

Given the identified pressures and opportunities to agricultural land in Europe, it is clear that the interest in agricultural land has increased in recent years. However, there are no overarching strategies or legislation at the European level to strengthen the position of agricultural land in order to guide its optimal use. A renewed debate on prime agricultural land may help this endeavor.

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