

Chapter 5

Socio-Economic Impacts of Biofuels on Land Use Change

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Abstract The main focus of the current discussion on sustainability of biofuels and bio-products in relation to land use issues is on its environmental impacts of feed-stock production. Thereby, a large emphasis is put on greenhouse gas (GHG) emissions and biodiversity. The impacts on socio-economic issues are far less discussed, although they urgently need to be addressed in policies and legislation. This chapter describes socio-economic impacts related to land use issues of biomass production for biofuels.

Keywords Land use change · Land use · Indirect land use change · Land cover · Land rights

5.1 Introduction

Before analyzing the impacts of biofuels and bio-products value chains on land use aspects and changes, the topic must be addressed in a more holistic approach, as land use changes occurred since ever in parallel with human development.

Land use is the human use of land which involves the management and modification of natural environment or wilderness into built environment such as fields, pastures, and settlements (Watson et al. 2000).

Historically, major shifts from natural and virgin ecosystems and vegetation to “used” land occurred due to the need for agricultural land and for wood. Thus, today, only a small part of Europe’s land surface consists of virgin ecosystems. Most land has been influenced and changed by humans. In other continents, the percentage of virgin land is higher.

In many cases, the land use change had positive impacts, e.g., on biodiversity, as the structures of landscapes were diversified which created new habitats for more species. This happened in Europe, especially during the Medieval period.

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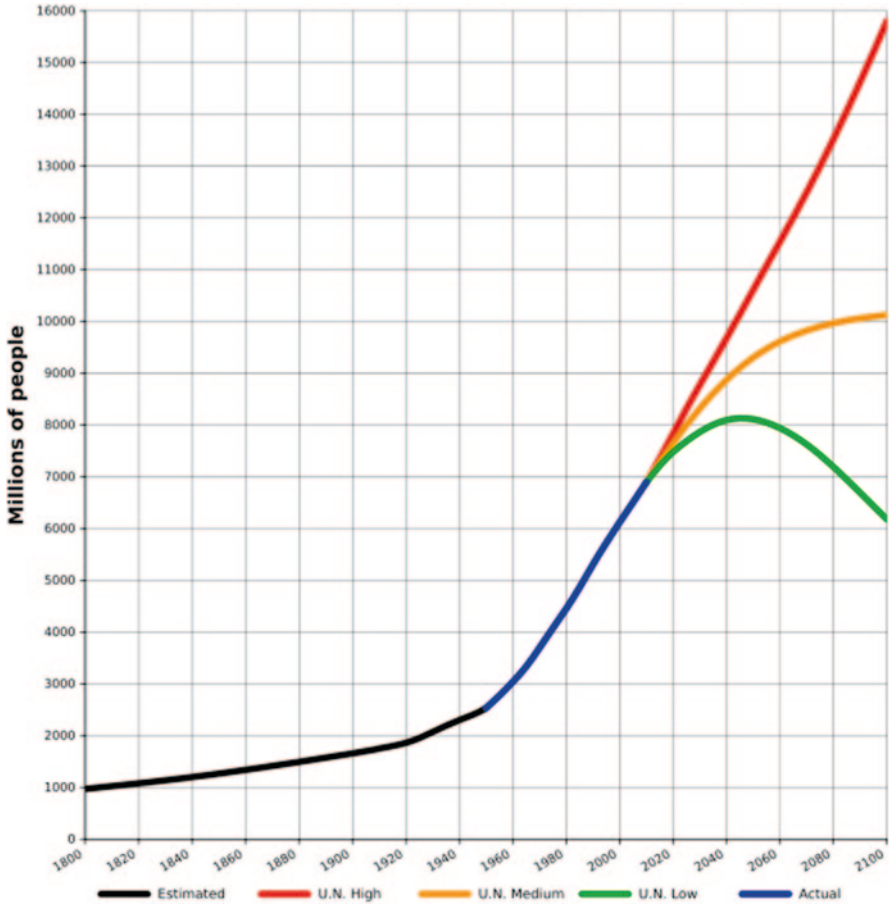


Fig. 5.1 World population from 1800 to 2100 based on UN 2010 projections and US Census Bureau historical estimates. (Source: Jmanrazor 2013)

Today, according to the US Census Bureau (2013), the world population reached more than 7.076 billion people and the growth rate is steadily augmenting (see Fig. 5.1). A larger population requires more food, feed, fuel, and fiber which can be compensated by higher agricultural productivity (EC 2010). However, pressure and competition on land use is increasing. Sustainable land use management practices and land use policies become hence increasingly important.

The production of biofuels and bio-products requires large amounts of feedstock, which is related to land use. This is obvious for dedicated energy crops; but also feedstock that is currently categorized as “residues” or “wastes” may have impacts on land use in the long term, as the general competition on carbon-based renewable sources is increasing. This is heavily influenced by prices for biofuels and biomass, as well as by prices and availability of fossil based sources.

Factors that are increasingly important in the current sustainability debate are the complexity of the issue and the interrelation of the different sectors. For example, biofuels have been frequently accused for having negative impacts on food security due to land use competition (see Chap. 5.4). It is thereby often neglected that large amounts of energy are also needed to produce food (see Chap. 17 of this book). Historically, horse and animal power was used to cultivate agricultural land for food and feed (= fuel) production. This is still the case for some niche applications and in several developing countries. During industrialization, this energy was steadily replaced by fossil fuels. With depleting fossil fuels and increasing prices of fossil fuels, biofuels and bio-products are gaining more importance again. Bioenergy will be an important future factor which ensures that food can be produced in the future as efficient as today. Thus, land will be always used for both, food and energy production with the need for both sectors to complement each other.

5.2 Definitions

In order to discuss about land use and land use changes, several definitions are needed that are described in the following sections.

5.2.1 *Land Cover*

Land cover is the observed physical and biological cover of the earth's land, as vegetation or man-made features (Watson et al. 2000). The terms "land cover" and "land use" are often confused as land use is "the total of arrangements, activities, and inputs that people undertake in a certain land cover type" (FAO 1997; FAO/UNEP 1999).

National categories of land cover differ. A general classification is given in the following list by the FAO's World Census of Agriculture (FAO 1986; FAO 1995; FAO/UNEP 1999; Watson et al. 2000). The following categories are listed in sequence of increasing intensity of land use:

- **Deserts** (barren land and waste land)
- **Non-forest wooded lands** (scrubland; may include national parks and wilderness recreational areas)
- **Wetlands**, non-forest (marshes)
- **Land under forest** (natural forests and most nonmanaged woodlands)
- **Land under forestry/Silviculture**
- **Land under shifting cultivation** (temporarily abandoned land that is not part of a holding)
- **Land under agroforestry** (permanent use of land at holding level, but with mixed crop growing, animal herding, and tree utilization)
- **Land with temporary fallow** (resting for a period of time, less than 5 years, before it is planted again with annual crops)

- **Land under permanent meadows and pastures** [used for herbaceous forage crops that are either managed/cultivated (pastures) or growing wild (grazing land); trees and shrubs may be present or grown purposely, but foraging is the most important use of the area; grazed woodlands]
- **Land under temporary meadows and pastures** (cultivated temporarily, for less than 5 years, for herbaceous forage crops, mowing, or pasturing, in alternation with arable cropping)
- **Land under permanent crops** (perennials; cultivated with long-term crops that do not have to be replanted for several years after each harvest; harvested components are not timber but fruits, latex, and other products that do not significantly harm the growth of the planted trees or shrubs: orchards, vineyards, rubber and oil palm plantations, coffee, tea, sisal, etc.)
- **Land under temporary crops** (annuals; cultivated with crops with a growing cycle of under 1 year, which must be newly sown or planted for further production after harvesting; not only small grain crops such as beets, wheat, and soybean but also biannuals that are destroyed at harvesting, such as cassava, yams, and sugarcane; bananas are transitional to the permanent crops category)
- **Land under temporary crops requiring wetland conditions** [wet-foot crops such as irrigated rice and jute (dry-foot crops with intermittent irrigation included in other categories)]
- **Land under protective cover** (greenhouses and other urban or peri-urban intensive use, formal or informal; vegetable growing, home gardening, residential parks, golf courses, etc.)
- **Land under residential/industrial/transportation facilities**

5.2.2 *Land Use*

Land use is the human use of land which involves the management and modification of natural environment or wilderness into built environment such as fields, pastures, and settlements (Watson et al. 2000). It also has been defined as “the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it” (FAO 1997; FAO/UNEP 1999; Watson et al. 2000).

5.2.3 *Land Use Change*

Land use change (LUC) is the change from one use to another use. Often, land use change is also referred to the change of nonused land (virgin land, abandoned land, degraded land) to another use. Thereby, distinction is made between direct land use change and indirect land use change.

Direct land use change (dLUC) is referred to the change of a specific land area that is directly converted from one status to another status. In the biofuels sector, dLUC is referred to the production of biofuel feedstock that is produced on land directly converted from another status to agricultural land for feedstock production (EC 2010).

If the feedstock for biofuels or bio-products is instead cultivated on existing agricultural land, it may then displace other crop production some of which ultimately may lead to the conversion of land into agricultural land. Through this route, the extra biofuel demand can lead *indirectly* to land use change, from which the term indirect land use change (iLUC) is derived (EC 2010). This indirect effect manifests itself through a change in demand for agricultural commodities, and their substitutes, in global markets.

In general, land use changes are always referred to a baseline status which needs to be defined. Depending on this baseline, land use changes can be determined and described, e.g., by using maps and images. Using data of the baseline and of the current or future situation, it is generally possible to determine the dLUC, whereas the iLUC can be, if at all, determined only in an abstract way, e.g., by using global land use models. However, also in models a distinction between dLUC and iLUC is often not made (Edwards et al. 2010; Laborde 2011).

Any land use change has impacts not only on the environment but also on socio-economic aspects. These impacts can be positive or negative. Impacts affected by land use changes may include biodiversity, water quality, soil properties, food prices and supply, land tenure, worker migration, rural development, income generation, and community and cultural stability, etc. iLUC usually has negative environmental impacts, whereas its socio-economic impacts are often negative and positive (mainly due to new income generation opportunities).

5.2.4 Land Use Rights, Land Tenure, and Ownership

An important factor for the determination of social impacts of land use change is the status of the ownership of the land (real property, real estate, realty, immovable property), often also called land tenure, and the associated land use rights (property rights). In general, land use rights and ownership must be respected; otherwise the setup of new cultivation areas is per se not sustainable. The following definitions for land access, land rights, property rights, land tenure, land tenure systems, and land tenure security can be given (UN-HABITAT 2008; UN-HABITAT 2003; Ciparisse 2003):

- **Land access** is the opportunity for temporary or permanent use and occupation of land for purposes of shelter, productive activity, or the enjoyment of recreation and rest. Land access is obtained by direct occupation, exchange (purchase or rental), though membership in family and kin groups, or by allocation by government, other landowners or management authorities.
- **Land rights** are socially or legally recognized entitlements to access, use, and control areas of land and related natural resources.
- **Property rights** are recognized interests in land or property vested in an individual or group and can apply separately to land or development on it. Rights may apply separately to land and to property on it (e.g., houses, apartments, or offices). A recognized interest may include customary, statutory, or informal social practices which enjoy social legitimacy at a given time and place.

- **Land tenure** is the way land is held or owned by individuals and groups, or the set of relationships legally or customarily defined among people with respect to land. In other words, tenure reflects relationships between people and land directly and between individuals and groups of people in their dealings in land.
- **Land tenure systems** are sets of formal or informal rules and institutions which determine access to, and control over, land and natural resources.
- **Land tenure security** is the (1) degree of confidence that land users will not be arbitrarily deprived of the rights they enjoy over land and the economic benefits that flow from it, (2) the certainty that an individual's rights to land will be recognized by others and protected in cases of specific challenges, or specifically, (3) the right of all individuals and groups to effective government protection against forced evictions.
- **Land titles** are official records of who owns a piece of land. They can also include information about mortgages, covenants, caveats, and easements.

There exist a great variety of land tenure and ownership systems that are influenced by historical, cultural, and economic factors. Some are very specific or outdated (allodial title, feudal land tenure, life estate, fee tail) and thus not considered here. Land tenure and ownership systems that are relevant for the bioenergy sector are described below, whereby the definitions are adapted from Kuhnen (1982), UN-HABITAT (2008), and Wikipedia (2013):

- **Fee simple, freehold, or private ownership of land:** This is the most complete ownership interest one can have in real property. It is ownership in perpetuity. The holder can typically freely sell or otherwise transfer that interest or use it to secure a mortgage loan. This picture of "complete ownership" is limited in most places by the obligation to pay a property tax and by the fact that if the land is mortgaged, there will be a claim on it in the form of a lien. In modern societies, this is the most common form of landownership. Land can also be owned by more than one party and there are various concurrent estate rules.
- **State ownership of land:** As a consequence of conquest, purchasing, gifts, and seizure, land belongs to the state in many countries in the same way as other areas belong to private people. In socialist countries, land has been turned into state property. State ownership plays a large role if public interests cannot be satisfied by private ownership, or if the land is not of interest to private people from an economic standpoint (catchment areas, wasteland, forest, frontiers, experimental farms, etc.). The state partially cultivates its own land (government farms and government forests) and also partially leases it out.
- **Government collectives:** Found in communist states, whereby government ownership of most agricultural land is combined in various ways with tenure for farming collectives.
- **Collective and communal ownership:** In this type of ownership, the right of disposition is in the hands of kinship or political groups that are larger than a single family, but not necessarily the whole state. In the forms of communal ownership found in Africa (a widespread phenomenon in sub-Saharan Africa), the land rights are generally controlled by the tribe, and the use of the land is regulated

by the chieftain or priest serving the land and earth deities. Every member that is born into the group has a lifelong right to a piece of land for his own usage. The tribes regard themselves as custodians of the land for future generations rather than proprietors.

- **Cooperative tenure:** Ownership is vested in the cooperative or group of which residents are co-owners.
- **Land grants:** In Islamic countries, land is granted to schools, mosques, orphanages, and similar institutions. This type of grant is often called a “waqf”. The beneficiary receives an irrevocable right of use that is carried out by government organizations, generally in the form of being leased out. The institution that is granted the right of use receives the profit. Such lands are frequently in very bad condition as hardly any investments are made.
- **Farm tenancy:** Agricultural land that people can rent from someone for their usage for a period of time. In densely settled countries with private landownership, in some cases more than half of the land is cropped by tenants. One can differentiate between various forms of renting the land according to the type of payment that is demanded (occupational tenancy, cash tenancy, rent in kind, share tenancy).
- **Occupational tenancy:** The tenant works for a specific number of days on the landlord’s farm in order to pay for the land he rents. In some cases, he uses his own draught animals and implements. This form is particularly found in Latin America where it is called a “colonate.”
- **Cash tenancy:** The tenant pays a fixed rent for the land he rents and, thus, bears the full cropping and marketing risk himself; however, he also receives all the proceeds growing out of his labors. This form demands the ability to face a risk and is, thus, found in the case of tenants who are economically sound.
- **Rent in kind:** The tenant pays a fixed quantity of produce and, therefore, does not have to take the marketing risk himself. This form is found especially among landowners who rent out small parcels of land and who consume the rent in their own household.
- **Share tenancy or sharecropping:** This refers to a specific form of rent in kind that is widely spread, particularly in developing countries. In this case, the gross output is divided between the landlord and tenant. While the original size of the share was determined by the reciprocal obligations and the productivity of the land, the great demand for land has led increasingly to shares equaling 50/50. Under these conditions, each side receives only half of any proceeds resulting from additional inputs. There is little incentive, therefore, to increase productivity by means of working harder or making larger investments. Moreover, the contract is often drawn up for only 1 year. Even though it is often prolonged by tacit agreement, it leads to insecurity and a state of dependence. This has, along with the normally extremely small size of the plots under tenancy, resulted in many farmers being indebted and living in very poor economic and social conditions.
- **Traditional land tenure:** For example, most of the indigenous nations or tribes of North America had no formal notion of landownership. When Europeans first came to North America, they sometimes disregarded traditional land tenure and simply

seized land; or, they accommodated traditional land tenure by recognizing it as aboriginal title. This theory formed the basis for treaties with indigenous peoples.

- **Ownership of land by swearing to make productive use of it:** In several developing countries (e.g., in Egypt, Senegal), this method is still presently in use.
- **Leasehold, registered leasehold, or rental:** Land may be leased or rented by its owner to another party; a wide range of arrangements are possible, ranging from very short terms to 99-year leases and allowing various degrees of freedom in the use of the property.
- **Rights to use a common:** This includes rights such as the use of a road or the right to graze one's animals on commonly owned land.
- **Easements:** This allows somebody to make certain specific uses of land that is owned by someone else. The most classic easement is right-of-way, but it could also include (for example) the right to run an electrical power line across someone else's land.
- **Agricultural labor:** Someone works the land in exchange for money, payment in kind, or some combination of the two.
- **Customary ownership:** Ownership is vested in the tribe, group, community, or family. Land is allocated by customary authorities such as chiefs.
- **Nonformal tenure systems:** These include many categories with varying degrees of legality or illegality. They include regularized and unregularized squatting, unauthorized subdivisions on legally owned land, and various forms of unofficial rental arrangements. In some cases, several forms of tenure may coexist on the same plot, (e.g., tenants and subtenants), with each party entitled to certain rights.

Furthermore, a frequently used term of land use and agricultural system in the bioenergy sector, especially in developing countries, is **Smallholdings**. According to Kuhnen (1982), this is a widespread form of family farms throughout the world. It is the target of many agrarian reforms. In order to guarantee the continuation of yields of family farms from their land, it is necessary for them to observe the preservation of the ecological balance. As soon as the precondition of sufficient farm size no longer exists, the situation becomes less favorable and the living standard of the farm families drops.

5.3 The Use of Marginal and Degraded Land

In discussions about bioenergy, often the terms marginal land and degraded land are used. This is due to that fact that on this land usually no other crops, especially no food crops, are cultivated. It is therefore argued that the cultivation of feedstock for bioenergy on such areas has less negative socio-economic and environmental impacts. This applies e.g., for the cultivation of *Jatropha*, as this shrub can survive easily on such land.

The problem is that the yield on this land is usually also low for feedstock for bioenergy production. Therefore, higher inputs are required, such as fertilization and irrigation. Furthermore, this land is often used in developing countries by subsistence agriculture for grazing or for the collection of non-purposely grown food.

In the report of FAO (2000), four definitions on favored land, marginal land, fragile land, and degraded land, are given as shown below:

- **Favored land:** Land having no, or moderate, limitations to sustained application under a given use. Moderate limitations will reduce benefits but an overall advantage will be gained from the use of inputs. Wide options exist for diversification. With proper management, risk of irreversible damage is low. There exist no or moderate constraints related to soil, climatic, and terrain conditions. Soil fertility, if adequately maintained, is favorable. Relatively reliable rainfall and/or irrigation water is available. The level of yields depends not only on favorable biophysical conditions but on accessibility to inputs, market and credit facilities, and beneficial output/input ratios.
- **Marginal land:** Land having limitations which in aggregate are severe for sustained application of a given use. Increased inputs to maintain productivity or benefits will be only marginally justified. Limited options for diversification without the use of inputs. With inappropriate management, risks of irreversible degradation. The soil constraints are low fertility, poor drainage, shallowness, salinity, steepness of terrain, and unfavorable climatic conditions. Absence of markets creates difficult accessibility, restrictive land tenure, smallholdings, poor infrastructure, and unfavorable output/input ratios.
- **Fragile land:** Land that is sensitive to land degradation, as a result of inappropriate human intervention. Sustained production requires specific management practices. Land use is limited to a narrow choice of options. Soils are of low fertility, erodible, steep terrain high groundwater levels, and flood prone. Population pressure, food deficits, competition for land from other sectors, unavailability or high cost of inputs are the socio-economic constraints.
- **Degraded land:** Land that has lost part or all of its productive capacity as a result of inappropriate human intervention. Various forms and degrees of degradation, both reversible and irreversible, may occur. Rehabilitation of reversible forms of degradation requires investment. Biophysiological constraints are erosion, salinization, fertility depletion, lack of adequate drainage on soils, and terrain prone to deterioration. Socio-economic constraints are population pressure, land shortage, inadequate support for agriculture, lack of institutional framework, high cost of rehabilitation, and lack of investment.

5.4 Land Use Issues in Developing Countries

According to Kuhnen (1982), private ownership of land is historically a Western concept that was first introduced into many developing countries by Europeans. It arose under a specific legal order by original acquisition of land (occupying and making the land arable) or changes in ownership (conquest, contract, inheritance). Until today, some societies still have not developed any forms of personal, private rights to land that would grant a right of disposition. The question of private land-ownership is strongly affected by ideological points of view. Practical experience

has shown that agricultural and social developments are possible with or without private ownership of land (Kuhnen 1982).

Due to the historical development of the landownership system in many developing countries, today, these countries often face socio-economic problems in the implementation and enforcement of proper legislation on land rights. Disadvantaged people are often women, smallholders, pastoralists, and small ethnic groups.

These often fragile landownership systems pose serious risks in developing countries, as often large amounts of feedstock are needed for the production of bioenergy which can be grown well in many developing countries due to favorable climatic conditions. This fact poses a serious risk on land use issues. Thus, much public criticism against bioenergy, and especially biofuels, was related to negative land use impacts in developing countries.

However, the main problems and negative impacts are not related to the characteristics of bioenergy value chains, but rather to agricultural systems in general. The cultivation of feedstock for biofuels is not per se different from the cultivation of other crops, be it for luxury goods (tobacco, coffee, cocoa, flowers), bulk commodities for the chemical industry (palm oil, soy oil), or even for food production.

Therefore, the main challenge in developing countries is not related to biofuels but to the agricultural sector in general. This challenge may be addressed by land reforms, but many developing countries face long-term problems in the implementation and enforcement of such reforms. An attempt is to grant land titles to farmers, but Ngaido (2004) mentions that land titling is not a panacea for reforming land tenure systems. Land reforms must consider environmental risks, the level of demand for agricultural land, the performance of existing tenure systems, the legacy of colonial and postcolonial reforms, and other socio-economic factors.

Irrespective of land tenure and ownership systems implemented in a country, some type of a cadastral database or registration system is needed to guarantee the rights of people, especially of disadvantaged people. A **cadastral database** is a comprehensive register of the boundaries and ownerships of properties in countries. It commonly includes details of the ownership, the tenure, the precise location (some include *GPS* coordinates), the dimensions (and area), the land cover and classification, and the value of individual parcels of land. In most countries, legal systems and cadastres have been setup to define the dimensions and location of land parcels. The cadastre is a fundamental source of data in disputes and lawsuits between landowners.

5.5 Land Grabbing

Land grabbing is the legal or illegal acquisition of large pieces of land in developing countries by domestic and transnational companies, governments, and individuals. Land grabbing occurred historically since a long time, but the term was particularly reused following the 2007–2008 world food price crisis. There are many different types and implementations of land grabbing.

The food price crisis led to increased interest of investors in the acquisition of additional agricultural land, especially in developing countries. Investors thereby include agribusinesses, governments, and speculative investors. In addition to the investment in food production, also investments in biofuels grew rapidly in the last years. The increased production of food and biofuels led to increasing pressure on land use.

In general, investment in the agricultural sector in developing countries is positive, since much agricultural land is cultivated far below its potential of productivity (Cotula et al. 2009) due to the lack of financing and investment. The problem is that this type of large-scale investment is often associated with negative impacts on land security, local consultation and compensation for land, displacement of local people, employment of local people, negotiation processes, other socio-economic issues, and the environment (Hall 2011).

5.6 Conclusion

Due to the growth of the world population, the need for food and energy increases rapidly. In addition, fossil resources are running out, thus creating the need for new types of energy, such as renewable energies. One of them is bioenergy which provides the only alternative for hydrocarbons to fossil fuels. The main bottleneck of bioenergy is the large need for feedstock. Feedstock can be covered to some extent by residues and wastes, but a large fraction will be purposely cultivated to meet the future energy needs. Therefore, large areas of land and investments in agriculture are needed. To some extent increases in agricultural efficiencies may compensate the demand for land, but the high global demand for land is likely to continue in the long term. Thereby, the poor are bearing disproportionate costs, but reaping few benefits, because of poor governance, including the weak protection of their resource rights, corrupt and unaccountable decision-making, the side-lining of their rights within trade regimes, and the policy neglect of smallholder agriculture (Anseeuw et al. 2012). Women are particularly vulnerable.

Negative impacts of increased land use change are not only caused by bioenergy, but also (and most likely to a large extent) by other factors such as population growth and dietary changes. However, the recent development of the bioenergy sector has the potential to improve the agricultural sustainability in general, as for the first time sustainability standards are required for a whole product sector in the agricultural field. Initiatives on **mapping** and **zoning** of several crops used for biofuels, such as sugarcane, are important towards the protection of high-value land from the social and environmental point of view. Such initiatives have been recently developed for Brazil, Argentina, and Mozambique.

Another important issue in many countries is the enforcement of existing national legislation and the reduction of corruption. In many countries, good legislation on land use is in place, but weakly enforced.

Thereby it is important to always consider the specific framework conditions of the country. Different approaches for developed and developing countries will be

needed. It has to be furthermore considered, which type of feedstock and biofuels are produced, on which land, under which conditions and at which production scale (Rutz and Janssen 2012).

Finally, the ultimate challenge will be to slow down the population growth to fulfill the needs of the current world population and also for future generations: food, feed, fiber, and fuels.

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