Chapter 11
The Impact of Soil Degradation on Agricultural Production in Africa

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11.1 Introduction

The soil degradation has serious impacts on many related fields, especially in Africa. Soil is not only producing food, soil is also filtering rainwater, regulating the climate, sinking and storing carbon. In a small part of earth, an entire population of millions of organisms are living and using the soil to survive, to establish peoples and to keep the soil as fertile as it is. Without fertile soil, loss of biodiversity cannot be stopped, global warming cannot be kept at 2 °C nor will access to adequate food be assured for everybody on earth. Globally, the building of cities and roads damage the soil surface irreparably. In order to further the goal of soil protection, the United Nations considered 2015 as the international year of soils. Some facts illustrate the growing acuteness and importance of soil (from Soil Atlas 2015):

- Land and soil have a multitude of social, ecological, cultural, spiritual, and economic functions worldwide.
- Fertile soil is vital and it forms just a thin layer on the earth surface. It takes 2000 years to create 10 cm of topsoil.
- Millions of hectares of land are lost every year through inappropriate farming techniques, for the construction of cities and roads, and through deforestation. Cities eat into fields, and fields expand at the expense of forest and pastureland.

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- Without protecting the soil, it will be impossible to feed a growing world population, keep global warming below 2 °C, or halt the loss of biodiversity.
- Land ownership is distributed inequitably – even more so than income. Access to land is fundamental in the fight against hunger and poverty. In many countries, women are disadvantaged compared to men.
- Land prices are rising almost everywhere. If individual or communal rights are not assured, local people are forced off the land.
- Competition for land is growing. The causes include the spread of fodder crops, and the growing use of crops to produce 'green' biofuels.
- Global trade has turned arable land into a mobile resource. Developed and emerging economies are exporting their hunger for land to the developing world. They import land in the form of products grown abroad.
- Despite the fact that chemical fertilizers are being used, yields are not increasing as rapid as expected. Organic farming stimulates soil organisms and improves soil fertility in the long term – something that mineral fertilizers fail to do.
- Modern city planning must include soil conservation. Infrastructure and housing must use less fertile land, especially in countries with declining populations.
- An international regulatory framework based on human rights must ensure that the distribution of land is equitable and that fertile soils are not monopolized by the rich.[1]
- Protecting the soil is a global task. But individuals can make a significant contribution by purchasing local products and eating less meat.

With this background, the impact of soil degradation was investigated on examples of agricultural production in Africa. The importance to understand the market relevance and key markets in the agricultural sector is increasingly essential for the success of agricultural production in Africa.

11.2 Indicators of Soil Quality

Soil quality and efficiency are dependent on the use of the soil. Most of the African soil is used for agricultural purposes, e.g. to produce food for human consumption. Therefore, the quality of soil also defines the kind of crops to be planted.

Half of the soil usually contains mineral particles such as sand and clay. About 20% is water, 20% is air, and the rest are plant roots and soil organic matter like

[1] Since 2008, the term 'land grabbing' gained notoriety around the globe. It refers to large-scale land acquisitions mainly by private investors but also by public investors and agribusiness that buy farmland or lease it on a long-term basis to produce agricultural commodities. These international investors, as well as the public, semi-public or private sellers, often operate in legal grey areas and in a no man's land between traditional land rights and modern forms of property. In many cases of land grabbing, one could speak of a land reform from above, or of the establishment of new colonial relationships imposed by the private sector (http://www.globalagriculture.org/report-topics/land-grabbing.html). For more information, see for instance Behnassi and Yaya (2011).

organisms and humus. Humus stores nutrients and water and gives the soil a stable structure with plenty of pores. Humus also contains the carbon plants absorbed from the air as the greenhouse gas carbon dioxide. Beside the topsoil, it is also important to have deep subsoil that allows roots to penetrate and extract water even when the top soil has run dry. These layers regulate the soil fertility.

Soils that are especially fertile are good for growing crops, while less-fertile soils are more suitable for meadows, pastures, and forests. Therefore, even less fertile soil can also be valuable for ecological reasons. If a soil is used too intensively or in an appropriate way, its function declines and it starts to degrade (Fig. 11.1). An estimated 20–25% of soils worldwide are already affected by serious degradation and more than 8 million hectares degrade each year (Soil Atlas 2015).

Because of extensively farming, soils are losing significant amounts of organic matter including humus and soil organisms. Due to these factors, the natural fertility of soils is declining. Techniques such as high-yielding seeds, fertilizers, pesticides, monoculture and irrigation have led to sharp rises in yields. The farm production almost tripled in the last 50 years worldwide while the area of agriculture land expanded by only 12%. This results in changing type of farming (Table 11.1) or even the entire use of agricultural fields.

Agronomic measures involve changing how the crops are grown. Ploughing and planting along contour instead of up and down the slope for example can reduce erosion. Intercropping or rotating cereals with legumes restores soil fertility and reduces the need for nitrogen fertilizer.

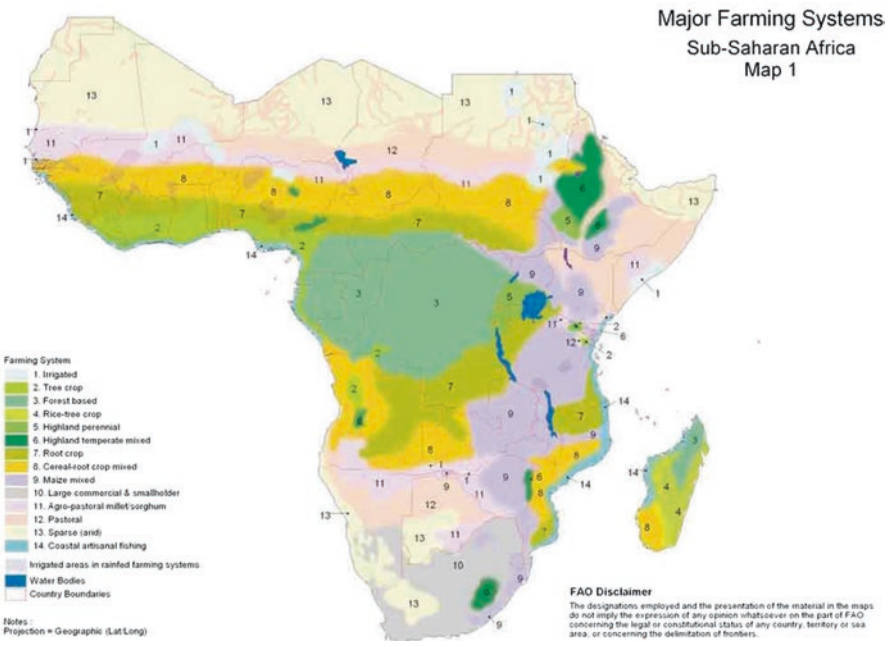

Fig. 11.1 Sub-Sahara Africa farming systems. (Source: Dixon et al. 2001)

Table 11.1 Major farming systems of Sub-Saharan Africa

Farming systems	Land area (% of region)	Agric. Popn. (% of region)	Principal livelihoods	Prevalence of poverty
Irrigated	1	2	Rice, cotton, vegetables, rainfed crops, cattle, poultry	Limited
Tree crop	3	6	Cocoa, coffee, oil palm, rubber, yams, maize, off-farm work	Limited-moderate
Forest based	11	7	Cassava, maize, beans, cocoyams	Extensive
Rice-tree crop	1	2	Rice, banana, coffee, maize, cassava, legumes, livestock, off-farm work	Moderate
Highland perennial	1	8	Banana, plantain, enset, coffee, cassava, sweet potato, beans, cereals, livestock, poultry, off-farm work	Extensive
Highland temperate mixed	2	7	Wheat barley, tef, peas, lentils, broadbeans, rape, potatoes, sheep, goats, livestock, poultry, off-farm work	Moderate-extensive
Root crop	11	11	Yams, cassava, legumes, off-farm work	Limited-moderate
Cereal-root crop mixed	13	15	Maize, sorghum, millet, cassava, yams, legumes, cattle	Limited
Maize mixed	10	15	Maize, tobacco, cotton, cattle, goats, poultry, off-farm work	Moderate
Large commercial and smallholder	5	4	Maize, pulses, sunflower, cattle, sheep, goats, remittances	Moderate
Agro-pastoral millet/sorghum	8	8	Sorghum, pearl millet, pulses, sesame, cattle, sheep, goats, poultry, off-farm work	Extensive
Pastoral	14	7	Cattle, camels, sheep, goats, remittances	Extensive
Sparse (arid)	17	1	Irrigated maize, vegetables, date palms, cattle, off-farm work	Extensive
Coastal artisanal Fishing	2	3	Marine fish, coconuts, cashew, banana, yams, fruit, goats, poultry, off-farm work	Moderate
Urban based	Little	3	Fruit, vegetables, dairy, cattle, goats, poultry, off-farm work	Moderate

Source: Dixon et al. (2001)

In Africa, smallholder farmers sow and weed by hand or using special animal-drawn implements that disturb the soil as little as possible. Changing the techniques, the farmers have to learn new skills, change probably the crops they use, invest in new equipment, and put more effort into controlling the weeds.

A 2007 study (Badgley et al. 2007) has shown that in developing countries the yields from organic farming methods were an average of 92% of those using con-

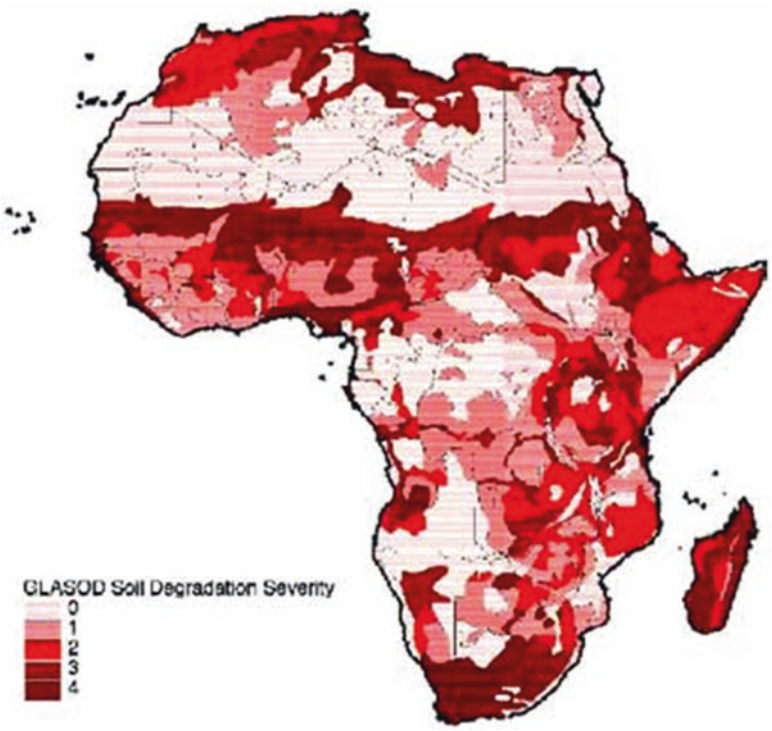

Fig. 11.2 Soil degradation in Africa. (Source: FAO 2001)

ventional methods, and organic systems produce 80% more than conventional farms in developing countries, because the materials needed for organic farming are more accessible than synthetic farming materials to farmers in some poor countries. In the tropics, an analysis showed that organic farming boosted yields by up to 74% without depleting the long-term soil fertility (Soil Atlas 2015).

With these mentioned indicators and additional soil indicators like soil wetness, pH, water-holding capacity, etc. the productivity of different soils can be evaluated (Nkonya et al. 2013). The soil quality has dropped over the last centuries (Fig. 11.2). With this kind of evaluation it will be possible to estimate the economic efficiency and therefore concrete market potentials of the soils.

11.3 Importance of Soil Quality and Related Economy for Africa

The soil quality in agricultural driven countries is directly related and essential for the economic growth. On the first sight, it could be the most effective way to increase the yields. But the increase of yields in the short run has a negative impact on soil

quality in the future and therefore a drop in soil fertility, soil quality and also resultant in limited economic benefits from soil degradation.

Some African countries have understood the relations between quick agricultural yields and sustainable economic growth (Fig. 11.3). With the 'green economy', poverty, creating employment, and improving the overall well-being of the population will be addressed. The green economy must be built from the cultural traditions and roots in Africa that are deeply tied to environmental stewardship; it must be inclusive and engage women, youth, and the spirit of future generations to be truly transformative.

Beside, mismanagement and negative circumstances in agriculture malnourishment in rural areas are an additional serious problem in Africa and therefore also for the African economy. Malnourishment affects roughly 223 million people in sub-Saharan Africa – about one quarter of the region's total population – according to estimates by the Food and Agriculture Organization (FAO).

Fig. 11.3 Countries with specific green economy strategies. (Source: UNEP 2015)

One important fact to increase economic aspects combined with increased yield and nourishment is to use organic fertilizers such as manure, compost, and plant residues to increase total productivity. African farmers need a local adapted solution to increase the needed economy. All outside solutions have high potential to fail.

11.4 Conclusion

The study describes the potential of soil quality and soil efficiency to create the linkage between agricultural soil treatment and local economic success on the African market. Small-scale farming has shown a very positive success in constant yields, and therefore constant soil fertility even by using organic farming techniques.

To raise the yields, chemical fertilizers are added to the still fertile soil only to raise yields in the short run. With this change of the entire soil structure and chemical composition, the economic advantage cannot be kept up.

For antagonizing this process, it is important for each African country to establish land use concepts to decouple organic farming of small farmers from bigger commercial communities. This decoupling process could keep the soil fertility for small farming communities while other profit-yielding agriculture will support the regional economy.

Farming should always be a field for securing food and nutrients to the local people in the first sight before it gets to a profit-yielding agriculture of competing counties. Many samples in Africa has shown that this approach can be achieved but still new techniques of organic farming have to be established and accepted on the basic agricultural level of application.

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