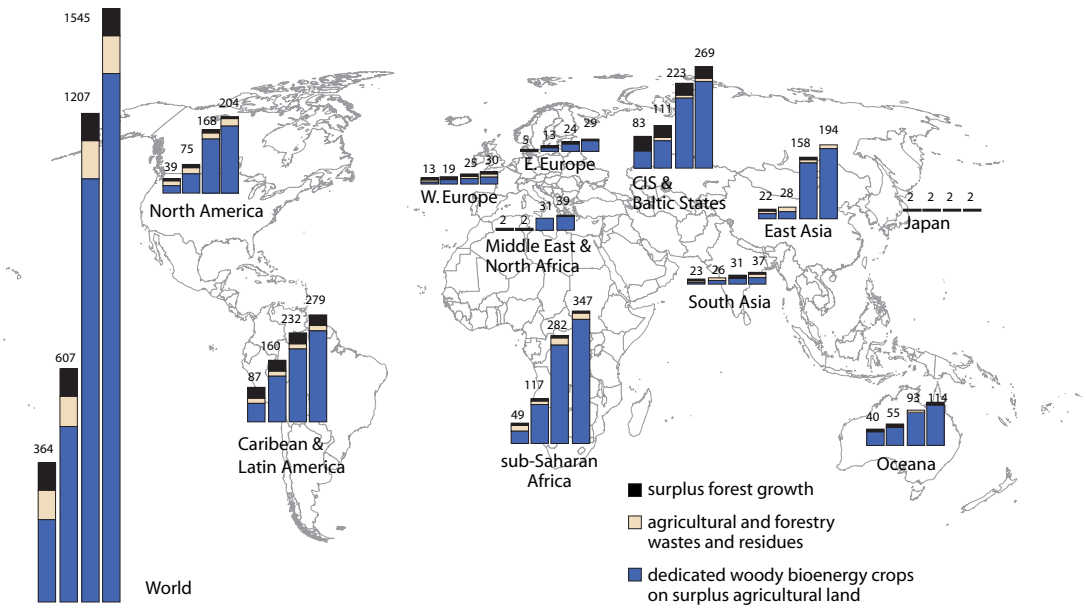
# 7. Opportunities and Challenges for Bioenergy Development

The IEA Bioenergy Task 40 reports (Smeets et al., 2004) that "Africa has the largest bioenergy potential in the world." This is defined as the production of biofuels after food, fuel, and fodder needs for local populations and livestock have been satisfied—and without deforestation (see Figure 7-1).

Though there is some dispute over whether Africa has the "largest" potential, the expert community does believe there is significant opportunity to use biomass for energy development to displace fossil fuel and enhance energy access. Figure 7-2 demonstrates the range of resources available in the UEMOA and Africa-wide.

- Using existing woody biomass resources more wisely can help displace fossil fuel and enhance energy access in the UEMOA.
- Opportunities exist for expanding biomass production using certain crops, residues, and non-food oils.
- Challenge is how to engage the poor.
- Second-generation feedstocks and processing technologies hold greater promise for the UEMOA.

Figure 7-1: Sustainable Bioenergy Production Potential under Four Scenarios by 2050

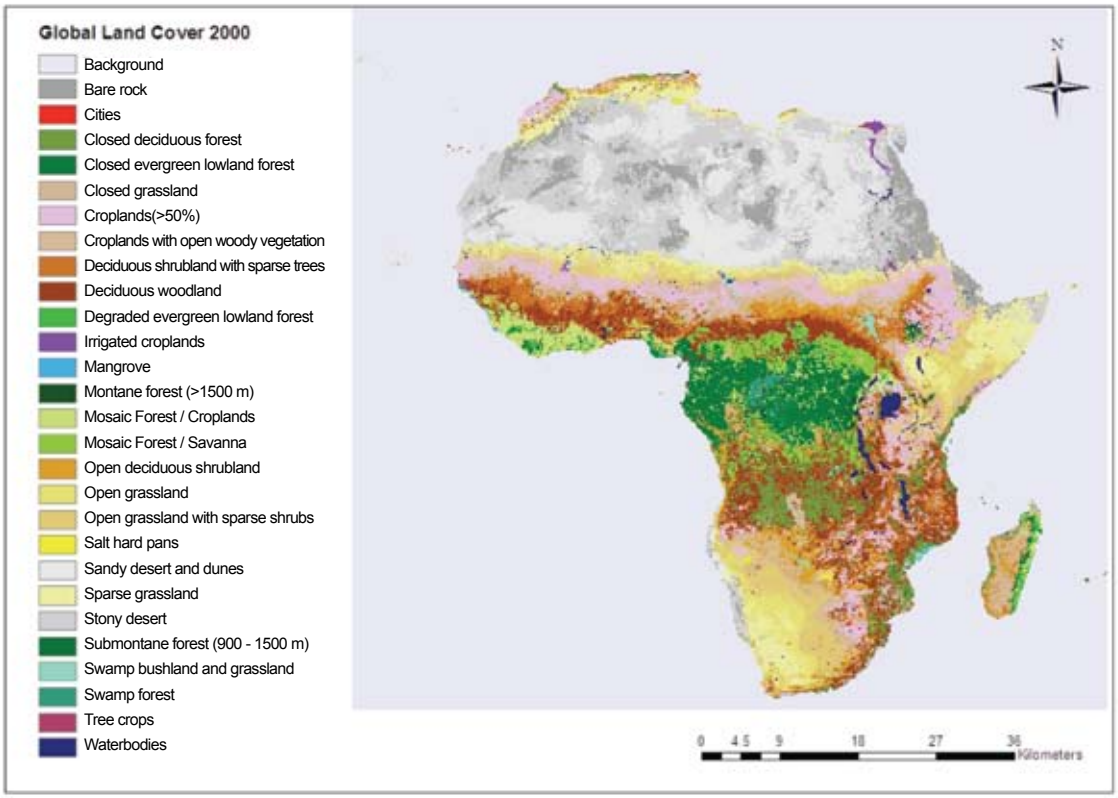



Total bioenergy production potential in 2050 based on system 1 to 4 ($EJy^{-1}$; the left bar is system 1, the right bar is system 4

Source: Smeets et al., 2004. The four bars indicated for each region reflect four levels of advancement of agricultural technology in the year 2050; these vary with respect to the efficiency of food production.

Nonetheless, this potential must be further examined in view of the many issues posing both opportunities and constraints for sustainable bioenergy development.

Figure 7-2: Land Cover 2000, Africa




Source: COMPETE, 2007.

## 7.1 OPPORTUNITIES

At present, a number of converging trends provide opportunities for enhanced bioenergy consideration in the UEMOA member countries. These bioenergy options span potential technological, social, economic, environmental, and security benefits as outlined below.

### 7.1.1 LEVERAGING TECHNOLOGY ADVANCES

Though bioenergy is not a new concept, advances in the last few years have improved the performance and reliability of these technologies and reduced costs for a range of power, heat, and fuel applications. Further, research, development, and demonstration efforts focusing on second-generation technology applications promise continued cost, performance, efficiency, and environmental gains that could significantly expand market opportunities for these technologies worldwide.

### 7.1.2 SUPPORTING MODERNIZATION AND DIVERSIFICATION OF THE AGRICULTURAL SECTOR

Mechanization of the agricultural sector in West Africa is very limited in the production and processing of agricultural products. Yet, several initiatives to alleviate this problem and assure sustained productivity are underway. Both national and regional level policies have made broader access to mechanization among the top priorities for modernizing the agriculture sector. To achieve this goal, farmers will need access to energy.

The rising cost of and limited access to fuel in rural areas is a major threat to achieving success in this area. Thus, bioenergy can make a valuable contribution to modernizing the agricultural sector. Locally produced biofuels offer a reliable, cost-effective alternative to diesel for powering motorized agricultural equipment (e.g., water pumps, tractors, cultivators, processors, grain grinders, etc.). As bioenergy supports increased mechanization, it helps to improve agricultural production efficiency and enhance output processing and distribution. Bioenergy also presents significant new cropping opportunities and improved crop management (see Box 7-1).

#### Box 7-1: Expanding Bioenergy Crop Opportunities in West Africa

- *Multi-cropping.* Multiple cropping is the practice of growing two or more crops simultaneously in the same space during a single growing season. It can take the form of double-cropping, in which a second crop is planted after the first has been harvested, or relay cropping, in which the second crop is started amidst the first crop before it has been harvested.
- *Intercropping.* Another kind of multi-cropping is intercropping, which can also be appropriate for bioenergy. Intercropping is the agricultural practice of cultivating two or more crops in the same space at the same time, with the most common goal to produce a greater yield on a given piece of land. In intercropping there is typically one main crop and one or more added crops, with the main crop being of primary importance for economic or food production reasons. An example of successful intercropping exists in Senegal, where jatropha has been integrated with local banana plantations. As a result of the jatropha–banana intercropping, arable land is more efficiently used; pest control, weed control, and soil quality are improved; and overall crop yields have been increased. This crop diversification has also led to a reduction in farmer risk.
- *Crop cascade management.* Cascade management is a process in which every single part of the crop is used—from the grain as food, to the straw as biomass for heat and power applications. The grain and stem can be further processed by crushing to produce oil or by fermentation to produce sugars. The cake can then be used as animal feed or fertilizer, or energy from biomass. Crop cascade management is being done today in a number of countries and will be further advanced as second-generation technologies come to market.

### 7.1.3 ENHANCING POWER ACCESS

Currently, less than 7% of the rural areas in UEMOA member countries are electrified. On average, electricity in rural areas costs seven times more than it does in urban areas.[9] Most rural energy needs are met by traditional biomass, primarily for cooking.

The lack of access to modern energy constrains economic and social development, contributes to poverty, and reduces the chances of achieving the MDGs. Modern energy—provided at affordable prices in sustainable and appropriate ways to people living in rural and peri-urban areas—is key to poverty reduction, increased food production and consumption, and improvements in environment, education, and health. Bioenergy can play a major role in helping to achieve broader energy, agriculture, poverty reduction, and national development strategies and should occupy an important place in framework documents and in the basic laws of almost all the subregion's countries.

### 7.1.4 IMPROVING ENERGY SECURITY

As noted previously, with the exception of Côte d'Ivoire, the UEMOA member countries are virtually 100% dependent on petroleum imports. Near record oil prices are consuming cash-strapped country budgets, hampering economic growth, and threatening to roll back advances made through anti-poverty campaigns. For example:

- FAO states that "Increasing oil prices in recent years have had devastating effects on many poor countries, some of which spent six times as much on fuel as they did on health."
- The World Bank documents that "even a small percentage increase in oil prices takes a high toll on a country's GDP."
- The Ministries of Agriculture in UEMOA coastal countries report that fishermen can no longer afford to pay for fuel, thus negatively impacting business, revenues, and livelihoods.

Bioenergy can assist in advancing energy security in the UEMOA region by diversifying the country's energy mix, reducing demand for petroleum imports, and decreasing the impact of fossil fuel price uncertainty on the balance of payments.

### 7.1.5 ACCELERATING ECONOMIC DEVELOPMENT AND EMPLOYMENT

The UEMOA is a region where the population grows at an average rate of 3% per year. This is significantly higher than sub-Saharan Africa overall, which has an average annual rate of 2.5%, and regions such as Latin America and Asia with rates of 1.2%. At this pace, Africa's population would double in approximately 28 years. More than 80% of UEMOA's population lives in rural areas, and

[9] Dr. Ibrahim Mayaki, Executive Director, HUB RURAL, Dakar, Senegal.

most are unemployed or under-employed. Challenged by poverty and worsening living conditions, many migrate to cities and foreign countries.

### Box 7-2: Côte d'Ivoire Raising Oil Prices to Keep Up With Costs—But Still Not Enough

In early July 2008, Côte d'Ivoire—an exporter to Benin and Mali—significantly increased its oil products prices. This step occurred at the recommendation of the IMF, which found in June that the country was heavily subsidizing its oil consumption. Among the increases were 44% for diesel, 29.2% for gasoline, 33% for butane gas, and 17% for lamp oil (largely used even in urban areas where the poor cannot afford electricity and where shortages often happen). Even with these increases, the government says it is still not covering the rising costs of crude oil.

By providing energy to rural areas and improving agricultural productivity, bioenergy has the potential to bring significant economic and social improvements in living conditions. In particular, the income-generating potential of bioenergy is linked to the production, transformation, and commercialization of biomass resources. Local production and consumption of biomass can play an important role in sustainable livelihood strategies, particularly for rural women in developing countries. Many biofuel production processes are labor intensive, thus bioenergy programs can generate employment opportunities and contribute to the overall development of the region. The local availability of energy is fundamental to intensifying agriculture and agricultural development, another essential step in alleviating poverty.

At the seed production level, for example, the need for labor is very high. In Senegal, intercropping of jatropha with peanut plants and bananas has enabled the creation of an inter-season vegetable crop. Agricultural workers have been able to stay employed throughout the year instead of having to stop work during the rainy season.

Beyond direct employment in bioenergy production, access to cost-effective energy services in rural areas has significant spillover effects that could create a new dynamic for job creation and development. Such jobs increase employment and revenues, which will lead, in turn, to higher consumption and demand for goods and services. Such demand generates more employment.

#### 7.1.6 ENHANCING THE ROLE OF WOMEN

According to FAO studies, while women in most developing countries are the mainstay of the agricultural sector, the farm labor force, food systems, and day-to-day family subsistence—they are the last to benefit. Throughout sub-Saharan Africa, women are responsible for between 70 and 80% of household food production. They tend livestock, grow vegetable gardens, and cultivate subsistence crops, such as rice. Women are also responsible for gathering wood for home cooking and heating, and carrying water for household needs and farm irrigation. This consumes their days and leaves little time for studying or income earning.

Gender bias and gender blindness persist throughout the UEMOA region. Farmers are generally perceived as "male" by policymakers, development planners, and agricultural service providers. Women find it more difficult than men to gain access to valuable resources such as land, technology, training, and services that would enhance their production capacity. Moreover, as women are typically unable to use land as collateral, they lack access to formal credit schemes and are limited in their ability to acquire productive inputs. High oil prices further reduce women's access to modern fuels and make agricultural activities less efficient and more burdensome. By growing biofuel feedstock alongside food crops, women can spread their risk and gain access to additional energy sources, thus making their own work more efficient and freeing up time to spend on other activities. Women's organizations can be empowered to implement a sustainable "food-and-fuel" system, allowing local energy needs to be met and providing income opportunities from the sale of biofuels and byproducts to broader markets.

### 7.1.7 IMPROVING HEALTH BENEFITS

The collection of traditional fuels for cooking—wood and charcoal—represents a large part of the daily chores of women and children. This activity subtracts from time that could be devoted to other more productive activities, such as education or women's participation in socially productive and revenue-generating activities. Beyond the considerable loss of time to collect them, traditional fuels engender health problems (respiratory) among women and children linked to their exposure to harmful domestic pollution from open air smoke and indoor airborne pollutants.

In fact, many studies have shown the negative impacts of exposure to internal pollution from fossil fuels, which alone cause more deaths among women and children than malaria and tuberculosis combined (UNDESA, 2007). Recognizing the health and other environmental impacts of inefficient cooking fuels, the ECOWAS/UEMOA white paper, Increasing Access to Energy Services for Rural and Periurban Areas in Order to achieve the Millennium Development Goals in West Africa, set the objective of increasing access to modern cooking fuels and stoves in West Africa (ECOWAS and UEMOA, 2006).

Using modern forms of biomass in more efficient stoves can contribute substantially to improving air quality, health, and nutrition for rural populations. As processed wood pellets or ethanol gel are used in stoves, time spent collecting firewood is reduced, therefore freeing up women's time in particular to undertake new income-generating activities. Moreover, using bioenergy permits wider use of refrigeration to keep vaccines and other heat-sensitive medical products safe from deterioration, thus improving health conditions for children in rural communities.

### 7.1.8 SLOWING LAND DEGRADATION

The United Nations Environment Programme (UNEP) Global Environment Outlook (UNEP, 2007b) singled out land degradation as the "biggest threat" to Africa's achievement of the MDGs. In the arid and semi-arid regions of Africa that encompass most UEMOA member countries, land degradation, deforestation, and desertification, compounded by global warming, are extremely

alarming issues. The Intergovernmental Panel on Climate Change (IPCC) projects that Africa will be among the regions worst affected by climate change.

Agricultural and forestry-based means of generating bioenergy can play an important role in addressing these key environmental challenges. In their National Plans of Action for Adaptation, UEMOA member countries have identified several adaptation strategies and options related to bioenergy. These include the development of agro-forestry, reforestation, and afforestation.

### Box 7-3: Population Growth—A Social Constraint

The UEMOA countries have the highest population growth rates in sub-Saharan Africa (an average annual rate of 3%), the lowest levels of women's literacy, and among the poorest levels of access to family planning and broader reproductive health services. Between 1980 and 2005, the total population in the UEMOA countries doubled from 40 to over 80 million due to some of the highest total fertility rates in the world (five or six children per woman, according the United Nations Population Division) and young average ages of childbearing.

Yet, most of the subsistence food crops are produced and marketed by women; men often confine their role to the export crops. For a small-producer revolution to occur, women farmers will need access to land, credit, and inputs. They will need extension services and support. Their functional literacy (closely related to their capacity to effectively access credit and take advantage of extension services) and their economic productivity could be vastly improved if they could determine for themselves when and how often to bear children.

East Asia's economic success is closely correlated with strong social programs, including primary health care, universal education, and access to family planning. These corollary investments reinforced gains in agricultural productivity that resulted from investments in agriculture. This complementary strategy was crucial to East Asia's ability to grow out of the "poverty trap" where annual population growth exceeds the growth in food production.

The UEMOA member countries have a high percentage of unused arable lands. The cultivation of certain bioenergy crops such as jatropha, which has the potential to grow in marginal lands, could help revive certain areas. However, more agronomic research is needed to determine the best species and conditions for these lands.

#### 7.1.9 IMPROVED WASTE MANAGEMENT

Modern biomass technologies can enhance waste management practices in the UEMOA. For example, biomass power plants can process a range of agricultural, forestry, and crop residues as a feedstock to produce energy. This could be done in a village generator, a multi-system platform, or in large generators.

## 7.2 CHALLENGES

Though there are several prospective benefits to bioenergy development, a number of barriers exist.

The debate is thus not about *food or fuel*, but about how to best integrate *all biomass resources* in a win-win relationship benefiting the poorest of the poor.

### 7.2.1 FOOD AND FUEL

Biofuel mandates in the developed world have been linked to rising food prices globally—resulting in demands that biofuel production be stopped or constrained. For countries dependent on fuel and food imports, such as those examined in this report, cost increases in both fuel and staple food imports threaten the very survival of the rural poor. Policies over the last two decades in this region have favored export crops over basic food crops, promoting declines in domestic per capita food production. Conversely, policy changes that improve overall agricultural productivity and bring more arable land into sustainable use have the potential to improve both food and fuel production. The challenge is to adopt the right policies and provide support to small farmers. For much of rural West Africa, food and fuel production may yield important synergies that advance development.

### 7.2.2 WATER AVAILABILITY

Water availability is essential for food security and sustainable agriculture. The water requirements of sugarcane and cotton, for example, need to be carefully considered given the groundwater shortages and limited rainfall in the UEMOA area. The expansion of irrigation systems and greater access to untapped surface and groundwater resources through the use of bioenergy powered pumps may be an important option in some regions. Moreover, certain bioenergy feedstocks can improve water retention in fragile soils, thus improving water access for neighboring plants and countering desertification. Given limited rainfall and low water tables, water conservation, rainfall harvesting and other techniques might be more appropriate for some countries. Identifying how to best use water and what technology options to deploy will be critical to success.

### 7.2.3 LAND TENURE

Land access will underpin successful agriculture and bioenergy development in the UEMOA. The current land tenure system fails to ensure the security of land ownership. Given the importance of access to land for growing agricultural or forestry-based feedstocks, some experts fear that small producers may be forced out of their land in favor of large or foreign producers. Protecting the interests of small farmers and balancing the interest of potential investors demand effective and fair land policies. Although beyond the scope of this report, the UEMOA must identify "best practices" and promote them if rural development plans are to succeed (see Box 7-4).

### Box 7-4: Land Access and Land Rights

The implications of bioenergy development for land rights and land access have yet to be fully studied and the experience so far does not allow a general answer to the question of whether risks exist for small producers. A recent study examines the current and future impacts of the spread of biofuels on access to land (Cotula et al., 2008). It emphasizes caution prior to presenting its results, due to the recent biofuels debate and the "scarcity of empirical research on the linkages between the spread of biofuels and land access," noting that "the findings of this study can only be considered as preliminary, and as a stepping stone for more in-depth research."

The literature review supports the belief that such disquiet is well founded. Policies and markets that promote biofuels production will tend to raise land values. Where appropriate conditions are not in place, especially where small-scale farmers do not benefit from security of rights to their land, the poorest groups will tend to lose access to the plots on which they depend. Indeed, increases in land value are likely to cause or to accelerate individualization of land rights, which in turn is likely to cause or to accelerate commercialization of land rights. Without regulation, such development of the land rights market will lead to the exclusion of the poorest small-scale farmers and marginalized groups.

The fact that biofuels crops can be cultivated on poor soils should not lead to the conclusion that risks related to land tenure and land access will be avoided. Because those soils seem to be useless, they are categorized as "idle," "underutilized," or "marginal" lands. These terms should not lead to the belief that these lands are "free." Such lands are used by pastoralists or for gathering and occasionally for farming activities: they provide vital resources for the survival of vulnerable groups.

Local land tenure systems bring into play complex social relations, elaborate relations with power and authority, deep issues of social identity, and various micro-political regulation systems. These features are highly important to social stability and should be taken into account, even if the information needed to predict the extent to which the development of large-scale biofuels production will disturb such social mechanisms is still lacking.

### 7.2.4 SCALE OF PRODUCTION

A risk of bioenergy development is the tendency toward large industrial projects, given the economies of scale. This approach works against small land holders and producers. Organizing rural producers into village-scale, market-based cooperatives has proven elsewhere (e.g., Malawi) to respond to production scale issues. While village-based power is limited, connecting villages to more efficient subgrids might provide a better solution than a national grid. These models merit consideration given their potential contribution to rural development and poverty alleviation—priority areas for all UEMOA governments.

### 7.2.5 LACK OF INFRASTRUCTURE

A key obstacle to agriculture and bioenergy development in the UEMOA is inadequate infrastructure. This includes roads, railways, and telecommunications to ensure market access and to bring new areas into cultivation.

### 7.2.6 KNOWLEDGE BASE

The widespread neglect of agriculture in developing countries at the global, regional, and national levels since 1980 has created gaps in the knowledge base. Comprehensive and accurate data on land area potential, optimal land use, crop production potential, and agronomic techniques is essential for decisionmakers and farmers. One positive result of the current food price crisis may well be the willingness to invest in new information systems that will provide timely data to policymakers. The Gates Foundation has already responded with a commitment to support enhanced agricultural and related data collection in the UEMOA region.

### 7.2.7 RESEARCH AND DEVELOPMENT

Bioenergy research is in an embryonic state in West Africa. Crops and plants have been identified as potential sources of energy, but greater understanding is required of their energy properties and the most efficient energy conversion options. Other plants may have unassessed potential as energy sources. Research needs to expand to tap traditional knowledge, identify optimal growing conditions, assess environmental impacts, and determine production costs. Such research will pave the way for introduction of second-generation feedstocks that promise greater productivity. UEMOA countries have participated in several successful regional research alliances—this best practice approach should be applied here as implementation proceeds nationally.

### 7.2.8 CLIMATE CHANGE

West Africa is among the most vulnerable regions to climate change worldwide. Examples of the effects of climate change include rainfall decline, water shortages, recurring drought, degradation of water quality, threats to ecosystems and biodiversity, rising sea levels, coastal flooding, damage to housing and infrastructure, social and economic costs of extreme climate events, conflicts over water, and negative impacts on agricultural productivity. A recent study has shown that global climate change will reduce agricultural production in developing countries, led by Africa (see Box 7-5). Mitigation of climate change impacts through active reforestation and land management, sustainable bioenergy production, and other technological innovations, combined with adaptation to climate change and climate variability, will help to constrain potential risks and increase resistance to prospective impacts in the future.

Investments in bioenergy in the UEMOA member countries should take the predicted regional climate change impacts into account. Crop choices and agronomic practices will need to be adaptable, adjusting to changes in precipitation and other impacts. Similarly, investments in

bioenergy infrastructure such as processing facilities should be done with an eye towards climate change adaptation.

### Box 7-5: Climate Change and Agriculture

In 2007, the Intergovernmental Panel on Climate Change released its Fourth Assessment Report, confirming that climate change impacts were accelerating and cautioning that developing countries will be the most vulnerable. In a country-by-country study of the global trends, Dr. William Cline concluded that all agriculture is likely to experience modest global damage and cautioned that assumptions that a "carbon-enriched" atmosphere would improve yields had yet to be proven. For sub-Saharan Africa, average losses due to climate change by 2050 were estimated at 17% of production and losses as high as 28% were possible, if the "fertilization effect" failed to materialize. Africa, in general, is among the worst affected regions in Cline's analysis. Clearly, production losses in this range would have severe implications for food and human security—underscoring the urgent need to adopt policies that can improve the resilience of agriculture to the potential impacts of climate change (Cline, 2007).

Nonetheless, while bioenergy offers significant potential for GHG emission reductions, there are concerns that some types of biofuels may generate net increases, rather than reductions in GHG emissions. One of the latest rounds in the biofuels debate centers on GHG emissions from indirect land use changes. At present, biofuels are made predominantly from food crops. But while biofuels worldwide account for a small fraction of total agricultural acreage, new fields and land are being cleared in some countries to produce biofuels and meet market demand. Increased cultivation adds pressure to already stressed ecosystems, requiring more land, water, and other natural resources. There are also risks to native ecosystems, such as forests, that store large amounts of carbon that can be released from burning vegetation to clear fields and from tilling soil. At present, the field of research on environmental impacts of biofuels is fairly new, with a number of efforts ongoing to better understand the dynamics of land use and GHG emissions. As we move forward in this area, it will be important to take a full life-cycle accounting of biofuel agriculture and production, including direct and indirect land use changes, feedstock type, agricultural practices, energy replacement options, conversion and refining processes, and end uses. Putting aside the potential GHG emissions from indirect land use change, conventional corn-based ethanol is believed to produce 15 to 35% reductions in GHG emissions; soy-based biodiesel results in a net GHG emission reduction of 30 to 50%; and Brazilian sugarcane ethanol reduces net GHG emissions by 80 to 90%. These are important gains to consider (Hunt, 2008).

### 7.2.9 TRADE AND STANDARDS

> Where bioenergy development proves economic, production should address domestic energy needs rather than those that seek to supply export markets. (COMPETE, 2007).

The focus on trade with respect to bioenergy centers on policies to promote ethanol and biodiesel as a replacement for petroleum in the transport sector. Several countries, including the United States and those of the European Union, provide policy support to promote the use of biofuels, spurred by three primary objectives: energy security concerns regarding increasing world petroleum prices; environmental concerns about reducing rising GHG emissions, primarily in the transport sector; and an interest in supporting domestic agriculture production in the context of international negotiations for agricultural trade liberalization. The key policy issues affecting the potential for trade are import barriers, agricultural policy regimes (including domestic support and market access) affecting feedstocks, and tax reduction and production subsidies affecting biofuels. In general, lowering trade barriers will increase global welfare in the long run by increasing competition, which should lead in turn to improved efficiency, reduced costs, and enhanced market share for efficient producers.

As international trade in biofuels increases (today it is very small), non-policy issues such as technical barriers may also emerge. The major technical barrier is likely to be certification of and standards for environmentally sustainable biofuels. In the case of the UEMOA, therefore, it will be important to work with standard-setting bodies to ensure that their activities benefit the member countries, and do not serve as an obstacle to local use and trade of biofuels.

## 7.3 SUMMARY

- Significant opportunities exist for bioenenergy development in the UEMOA. These include leveraging of technology advances, supporting the modernization and diversification of the agricultural sector, enhancing energy access, improving energy security, accelerating economic development and employment, bettering the role of women, improving health benefits, enhancing land degradation, and improving waste management.
- Nonetheless, a number of barriers hinder advancement of these technologies: food and fuel issues, water availability, land access and land rights, scale of production, lack of infrastructure, insufficient knowledge base, research and development support, trade and standards, and climate change adaptation.
- The UEMOA's challenge is to build upon the opportunities and reduce or eliminate the barriers. Though constraints persist, the potential to enhance the region's living standards through bioenergy—recognizing the various trade-offs in food security, environmental impacts, and others—warrants further attention.