Spatial Analysis of Food Insecurity Drivers and Potential Impacts of Biofuels Cultivation: A Contribution to Sustainable Regional Development and National Biofuel Policies in Kenya

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Abstract

The global increase of biofuel production and demand raises concerns about possible negative impacts of this development on food security. Competition for arable land and rise or fluctuation of food consumer prices are seen as the two major risks for the food security of vulnerable communities and households in developing countries. However, reasons for food insecurity are multidimensional and not always related to the volume of food production or the consumer prices of food items. Therefore, understanding the various drivers of food insecurity is necessary to understand possible future impacts of biofuel development on food security.

First results of this study show that levels and drivers of food insecurity in Kenya vary from region to region, are multi-dimensional and associated to several economic, ecological, socio-political, socio-cultural and land use management related factors. Food insecurity is mostly severe in the arid areas in the north of the country. Intervention in view of mitigating food insecurity has to happen at various levels and involves different steering agents. The findings lead to the conclusion that reasons for, and mitigation of, food insecurity are highly context specific and cannot be addressed through simple solutions. They also indicate that the potential impacts of biofuels on food security are likely to be very different from one area to the other. Sustainable biofuel policies must therefore take this diversity into account to identify the adequate solution for each area.

Background and objectives

Food Insecurity

There are different definitions and concepts of food security. One that is widely accepted and used is the definition from the World Food Summit of 1996, which includes physical, political and socio-economic determinants to procure and consume food: "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". Inversely food insecurity exists when people do not have adequate physical, social or economic access to food as defined above (FAO 2010).

The number of undernourished[1] people in the world remains high. In 2010, the Food and Agriculture Organization (FAO) estimated that more than 900 million people suffered from hunger. This indicates a global structural problem threatening the achievement of the Millennium Development Goal (MDG) to halve hunger by 2015 (FAO 2010). Consequently, FAO dedicated its 2010 annual report on "The

[1] Undernourishment exists when caloric intake is below the minimum dietary energy requirement (MDER). The MDER is the amount of energy needed for light activity and to maintain a minimum acceptable weight for attained height. It varies by country and from year to year depending on the gender and age structure of the population (FAO 2012).

State of Food Insecurity in the World" to countries in protracted crises, i.e. which are experiencing chronic food deficits, disruption of livelihoods over a prolonged time and the incapability of the state to respond to and mitigate threats to its population. For the period from 1996 to 2010 the FAO classified 22 countries as being in protracted crisis, out of which 17 are in Africa (FAO 2010). Three out of five countries of the East African Community, including Kenya, are also classified as being in protracted crises (FAO 2011). In August 2011, Kenya was hit by a severe food crisis, during which 3.75 million people were food insecure and 1.4 million pastoralists were in a state of emergency (FEWS NET 2011). Although the food crisis was triggered by drought, it was rather politics that turned it into a severe emergency (Hurni 2011). On the one hand conflicts in Somalia impeded the migration of pastoralists (Hurni 2011), and on the other hand, although the crisis was predicted, there was only poor and disorganised response to Early Warning Systems (Save the Children, Oxfam 2012).

The Food versus Biofuels Debate

Even though drought and politics have substantial impacts on food security, as argued above, the FAO decided to dedicate its 2011 report to "the effect of international price volatility on domestic markets and food security". One of the factors mentioned is the rising demand for biofuels (FAO 2011). The FAO report thus echoes the "food versus fuel" debate that is, since a few years, strongly polarizing development partners. On the one hand, most non-governmental organisations are concerned about increasing competition for resources (agricultural land, water), increasing food prices, and opportunity costs of land and labour. On the other hand, biofuel promoters and some governments point to the rural development and climate change mitigation potentials of biofuels (BEFS-FAO 2010, Ariza-Montobbio and Lele 2010, GTZ 2009, Moraa et al. 2009, Faaij 2008, UN-Energy 2007, SDC 2007, Tomomatsu and Swallow 2007). In East Africa, governmental institutions have, so far, not been able to actively shape this debate, and to take coherent and adequate policy measures pertaining to biofuel development (Hunsberger 2010; Diaz-Chavez 2010, Moraa et al. 2009, Faaij 2008). In his book on "Biofuels in Africa" Mitchell (2010) describes three case studies of biofuel production in East Africa and concludes that clearer policies on biofuels and consistent treatment of possible investors would reduce time to develop biofuel projects as well as administrative costs. Cases of corruption have also contributed to shed negative light on biofuel investments: In Tanzania a Dutch company illegally acquired land with the help of local authorities. The company later went bankrupt (Press, Mail & Guardian online 2011). In Kenya long discussions took place about leasing 50,000 ha in the Dakatcha woodlands to an Italian company to produce biofuel from Jatropha. The project would have displaced 20,000 people and endangered biodiversity (BBC News 2011).

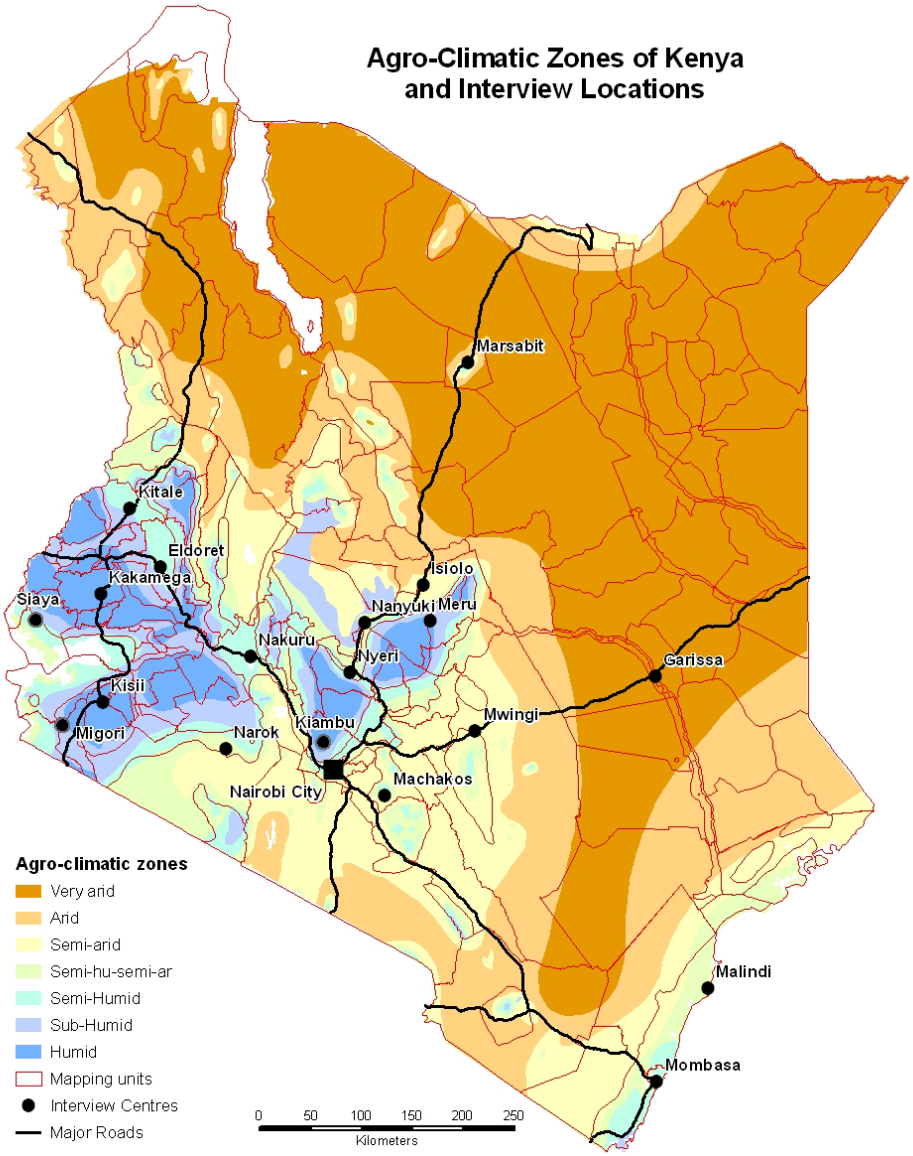
Objectives

Today, the debate on the role of biofuels in improving or threatening food security is still ongoing. At the same time, it is obvious that the reasons for food insecurity are multi-dimensional and not always related to the volume of food production or the consumer prices of food items (BEFS-FAO 2010, Mitchell 2010, Faaij 2008, Misselhorn 2005, Southern African Millennium Ecosystem Assessment 2004). Therefore, in order to understand the current and potential future impacts of biofuel developments on food security and to provide adequate guidance for the formulation and enforcement of sustainable biofuel and regional development policies, it is necessary to gain a better understanding of the various drivers of food insecurity, of their geographic patterns and of the combinations in which they appear. This type of knowledge is lacking in many areas. Therefore, this paper aims at mapping and understanding the most critical drivers of food insecurity in Kenya, as a basis for sustainable biofuel investment and regional development policies. In addition the findings from this paper shall provide a solid interpretation framework of food insecurity and its underlying causes, which can be used for further research and by development practitioners and decision-makers to work out sustainable rural development policies.

Research Design and Methodology

This study was conducted within the frame of the ERA-ARD (European Research Area - European Agricultural Research for Development, www.era-ard.org) funded Bioenergy in Africa (BIA) project

(www.bioenergyinafrica.net), which was implemented between 2009 and 2011 in East Africa and Central America. Institutions from 5 European, 3 African and 2 Central American countries collaborated on identifying potentials and risks of jatropha curcas and related crops for the rural poor. Different disciplines, including environmental, political and economic sciences, as well as geography, agronomy and engineering were represented, making the BIA an interdisciplinary initiative. Research for this paper was conducted through a MSc thesis in Kenya (Grimm 2012, forthcoming).



Map 1: Kenya agro-climatic zones, mapping units and locations visited for the interviews and the participatory mapping of food insecurity levels and drivers

The following methodological steps were used in the frame of this study:

1. A **definition** of the most important **drivers of food insecurity**, adapted to the Kenyan context, was developed. A study on food insecurity in southern Africa (Misselhorn 2005) served as a main reference. Misselhorn conducted a meta-analysis of 49 case studies implemented in southern Africa using the Household Economy Approach. From that she derived 33 drivers of food insecurity divided into 6 driver classes. The 17 drivers covering 80% of the overall driver impact according to Misselhorn where used as basis for the present study. To arrive at an adapted definition of food insecurity drivers for Kenya Misselhorn's study was completed with expert discussions and a systematic review of 50 short and long rain assessment reports from the Kenya Food Security Steering Group (KFSSG 2010 and 2011).

2. **Mapping units** were identified by intersecting county and division boundaries with agro-climatic zones in a Geographic Information System (GIS). This approach was selected in order to achieve a manageable number of agro-climatically homogenous units falling within one governance entity (Map 1).
3. A **participatory mapping** was conducted with local resource persons in 19 towns in Kenya (interview centres in Map 1); mostly rural advisers, or officers from irrigation, agriculture, gender and social development offices at the district level. Resource persons were requested to identify the three major food insecurity drivers and the food insecurity level of each mapping unit within their geographic region of competence. This had to be done using the outputs of step 1, i.e. a predefined list of food security drivers and a predefined food insecurity scale.
4. **Group discussions** were conducted with the same resource persons as in Step 3, to contextualise the results of the mapping exercise and to collect additional information on causes of food insecurity and possible mitigation measures.
5. **Analysis** of the mapping and group discussion results was conducted in Excel and in a GIS, to obtain quantitative results as well as a spatial representation of the levels, drivers and combination of drivers of food insecurity for each spatial unit.

Results

Deriving Food Insecurity Drivers

The in-depth analysis, through literature review and expert interviews, of the underlying causes of food insecurity in Kenya resulted in a list of 27 drivers (Table 1) that can be grouped into five classes (economic, socio-political, socio-cultural, land use management and production systems, and ecological).

Table 1 Drivers of food insecurity, driver classes

Drivers	Driver classes
Income	Economics
Employment	
Costs of living	
Food prices	
Prices of agricultural inputs	
Prices of agricultural products	
Marketing	
Infrastructure	Socio-political
Government policies	
Extension servicesE	
Education	
Health	
Dependency syndrome	Socio-cultural
Unrest and violent conflicts	
Attitudes and perceptions	
Tradition	
Overpopulation	
Agricultural practices	Land use management and production systems
Post-harvest management	
Overdependence on one crop	
Land degradation	
Management of water resources	
Human-wildlife conflicts	
Livestock pests and diseases	
Crop pests and diseases	
Rainfall variability and water shortage	Ecological
Soil and / or terrain	

As context specificity is important in assessing the reasons for food insecurity and the potential impacts of biofuels on it, a spatial analysis is required, which can help identifying patterns of food insecurity that could be associated with key geographic factors, such as the ecological, socio-political, economical and cultural characteristics of the various parts of the country.

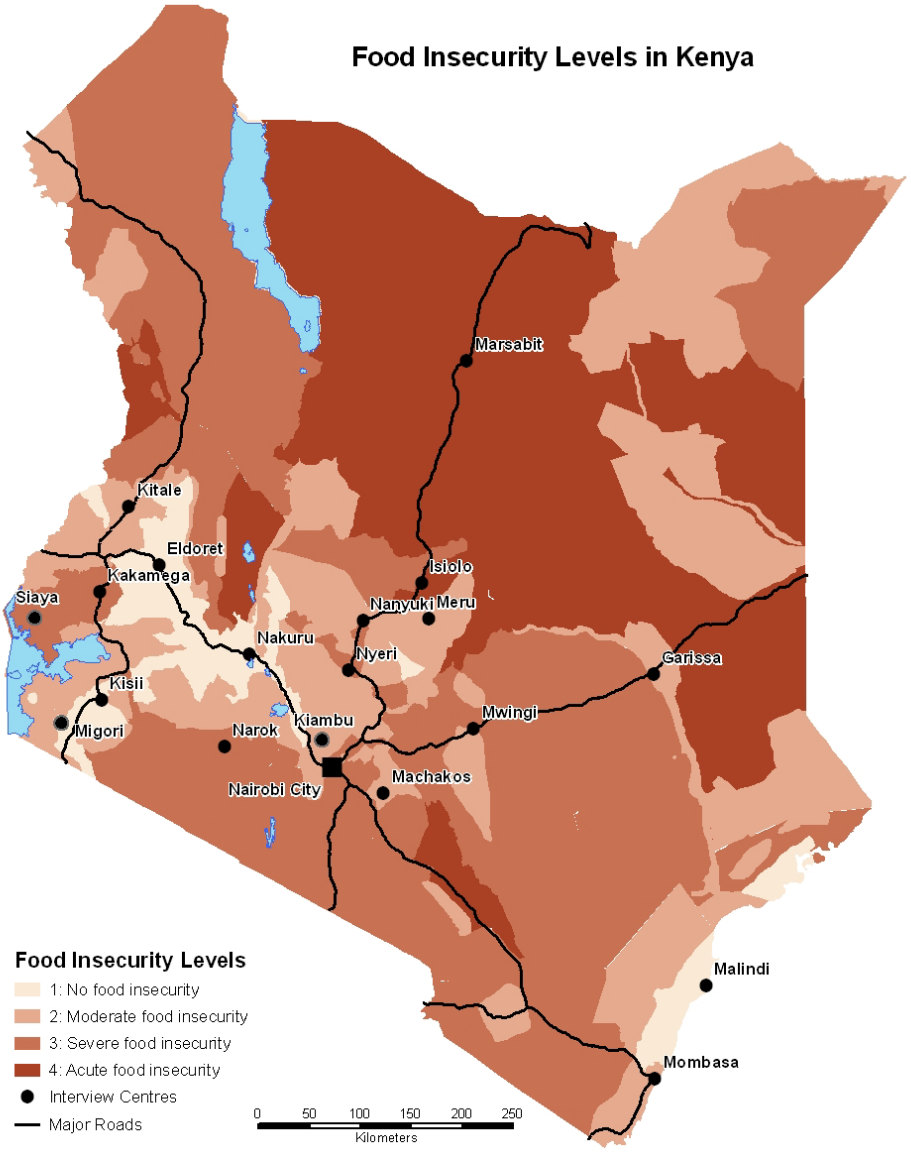
Spatial Patterns of Food Insecurity Levels

Four levels of food insecurity were defined on the basis of the food insecurity severity scale of the Famine Early Warning System Network (FEWS-NET, www.fews.net): (1) no food insecurity; (2) moderate food insecurity; (3) severe food insecurity; and (4) acute food insecurity. Food secure households have adequate and stable access to food. Moderately food insecure households have borderline adequate food access in a region experiencing short-term instability. In a situation of severe food insecurity, households experience highly stressed and critical lack of food access with high and above usual malnutrition. If acute food insecurity prevails households face nearly complete lack of food and/or basic needs.

Apart from a few exceptions, Map 2 below shows a strong correlation between agro-climatic suitability (Map 1) and food security[2]. The western and central high-potential areas, as well as the coast are generally food secure, while the arid and semi arid areas in the east and north are generally food in-

[2] When interpreting the results on food insecurity levels one has to keep in mind the distribution of population in Kenya. In the semi-arid north and northeast regions, population density hardly reaches 2 persons per km^2, whereas in the rich and fertile western, population density rises to 120 persons per km^2. In the well endowed Rift Valley, population density varies from one area to another with an average of 13 inhabitants per km^2 (Statehouse Kenya 2012).

secure. The north is most affected by food insecurity, with Marsabit and Wajir Counties facing the worst situation; but there are also less affected areas (parts of Mandera County, Wajir County, Kakuma and Turkwell in Turkana). Inversely, there are areas with severe food insecurity in the south, e.g. Makueni along the Nairobi-Mombasa highway. Overall, the map shows that food insecurity affects regions with low population densities, marginal arid and semi arid areas, as well as transition areas with high rainfall variability. It is also striking that only few areas of the country, concentrated along the Nairobi-Uganda highway, experience no food insecurity at all.

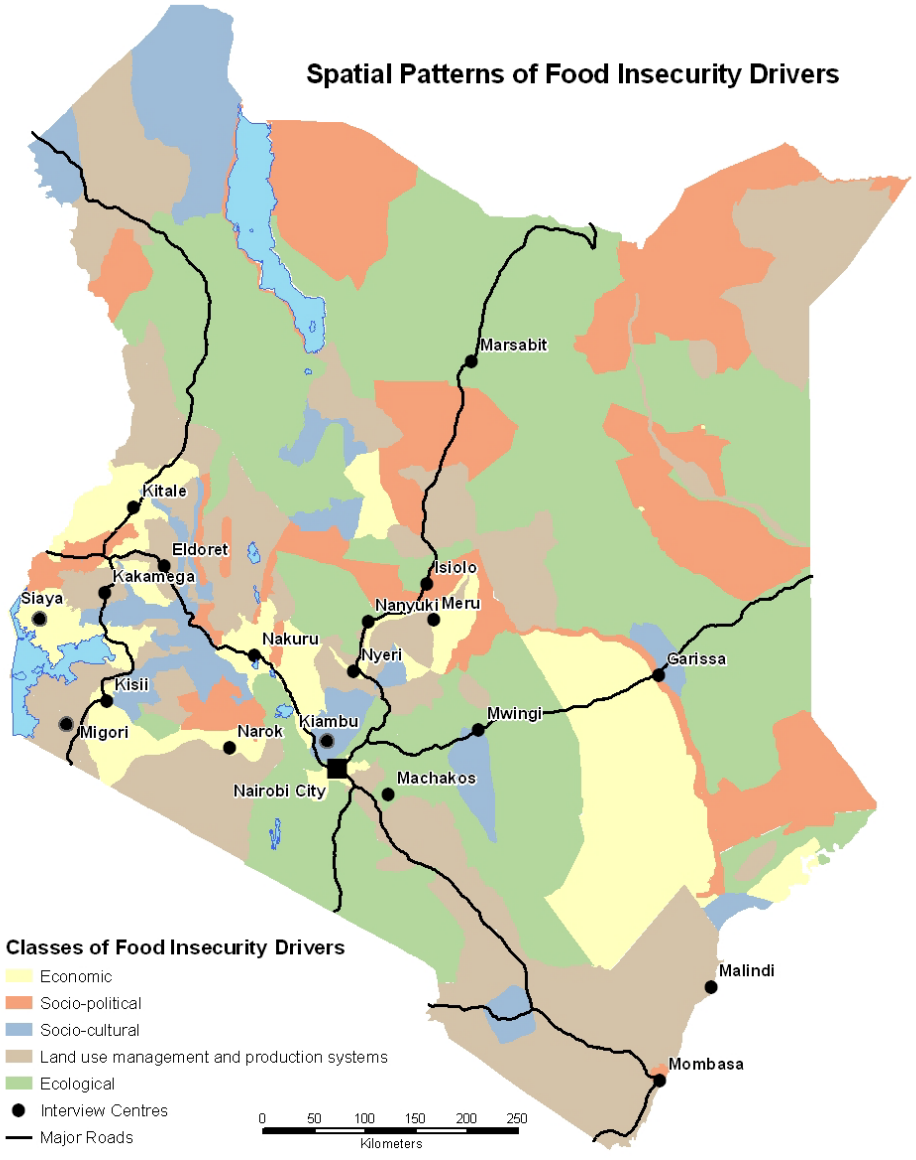


Map 2: Food insecurity levels in Kenya

Spatial Patterns of Food Insecurity Drivers

Preliminary spatial analysis of the most important food insecurity drivers (Table 1, column 1) for each mapping unit in Kenya does not reveal clear patterns that can be interpreted or associated with key factors such as the ecological, socio-political, economical and cultural characteristics of the various parts of the country. However, clear patterns can be identified, when analysis is based on the classes of food insecurity drivers outlined in Table 1 (column 2) above. According to this classification, most important food insecurity drivers in the north of the country are either ecological or socio-political (Map 3). Mainly, they include rainfall variability, adverse policies or lacking infrastructure. Regional socio-

cultural issues are also important and concern mainly unrest and violent conflicts, for example as a result of cattle rustling and competition for grazing areas in the pastoral areas of the northern Rift Valley, south and west of Lake Turkana. In the south-eastern arid and semi arid lands ecological issues (mainly rainfall variability) and land use management issues (inappropriate agricultural practices and water management) dominate, but there are also economic and regional socio-cultural issues, mainly lack of access to markets and overpopulation. In the central and western highlands all classes are represented, but economic issues (prices of agricultural inputs and marketing) and land use management issues (agricultural practices and overdependence on few crops) seem to dominate. Unrest and violent conflicts, as well as overpopulation affect food security in the area of the Mau escarpment, roughly between Nakuru and Kisii. This area was affected by the 2008 post-election violence.



Map 3: Classes of first priority drivers of food insecurity

Conclusions and discussion

Levels of Intervention for Mitigating Food Insecurity

The above outlined results show that the intensity and causes of food insecurity vary depending on geographic areas in Kenya. This raises the question whether food insecurity mitigation has to be adapted to regional or even local contexts in order to be effective and sustainable. Potential for mitigating food insecurity exists at various levels of intervention, ranging from local to international, and can be addressed by various steering agents, such as households, community leaders, and regional political institutions, the state or international regulations. It is clear that in many cases multi-level interventions involving several steering agents are required. However, group discussions and expert interviews also hinted towards the fact that there are preferred, most likely, or most efficient levels of intervention and steering agents depending on driver classes. For example, infrastructure and education was widely seen as the responsibility of national government, whereas attitudes and perceptions have to be dealt with at the local level. Columns 3 and 4 of Table 2 are an attempt to capture these stated linkages between drivers and levels of intervention.

Table 2: Preferred levels of intervention and steering agents for mitigating food insecurity

Driver classes	Levels of intervention	Steering agents
Economic	National to international	National governments, international regulations
Socio-political	National	National government
Socio-cultural	Regional	Regional political level, community leaders
Land use management and production systems	Local	Households, with support from extension services, government offices, private sector, etc.
Ecological		

Accordingly, and in order to identify interesting potentials for mitigating food insecurity, the five classes of food insecurity drivers shown in Map 3 can be further aggregated into 3 groups that reflect the preferred levels of intervention and steering agents (Table 2):

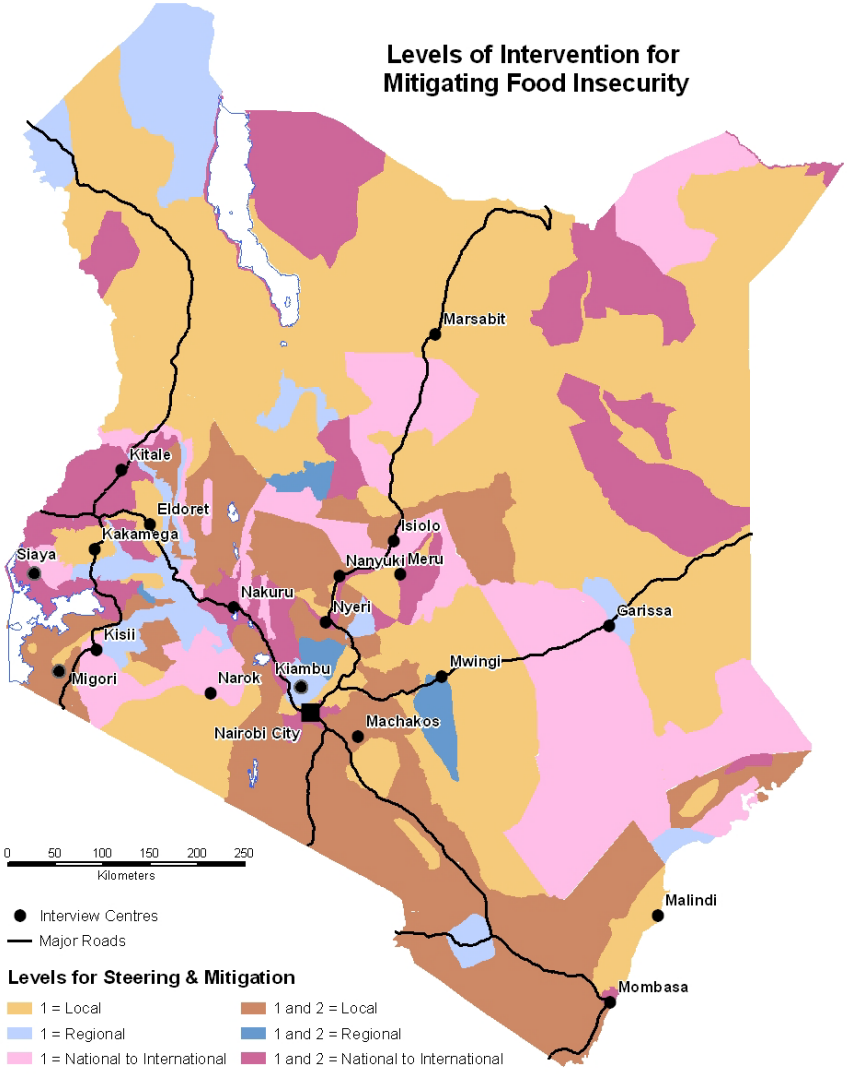
1. **Local** level of intervention: Drivers that need to be addressed locally, as they depend on the agro-climatic potential of an area and can therefore only be mitigated through adaptation of livelihood strategies; or drivers that are related to land use management and production systems of local smallholders, such as agricultural practices, water management, etc.
2. **Regional** level of intervention: Drivers that are linked to regional societal issues such as unrest and violent conflicts, traditions and attitudes, etc. These drivers can be addressed by concerned communities and their leaders, with the help of external mediators, extension officers, etc.
3. **National to international** levels of intervention: Drivers that are influenced by governmental or economic forces and therefore depend on external intervention by the government or international regulatory institutions for mitigation.

Map 4 shows the spatial patterns of preferred intervention levels for mitigating food insecurity. Deep colours correspond to areas, in which both the first and second rank driver classes belong to the same level; light colours show areas, for which only the first rank driver class belongs to the concerned level. The emerging spatial pattern indicates the following perception of respondents:

- In the north of the country food insecurity is mainly caused by environmental (rainfall variability and water shortage) and external forces (lack of government support and lack of infrastructure investment leading to marginalisation). Hence, the preferred strategies to improve food security in the north are through either adaptation to rainfall variability, or through political work to reduce marginalisation of the concerned areas. In some cases, mainly in the northern Rift Valley, localised con-

flicts, especially due to cattle rustling between neighbouring tribes, are severe food insecurity drivers. Conflict mitigation and transformation, with the involvement of local to regional authorities and external mediators would help improving the situation in these cases.

- In the south-eastern part of the country food insecurity is mainly caused by environmental (rainfall variability and water shortage) and land use management issues (inappropriate agricultural practices or water management). In the areas along Tana River, between Garissa and Mwingi, external drivers prevail slightly and are related to lack of access to markets. Overall, mitigation of food insecurity in the south-eastern part of the country is mainly possible through the adaptation to rainfall variability and the improvement of current livelihood strategies, with a focus on agricultural practices and water management. Some infrastructure development in the more remote eastern parts of the region would also be favourable.
- In the south-western part of the country, including the central and western highlands and the lowlands around Lake Victoria, the situation is more complex and mainly characterised by lack of government support and adverse economic situations. Additionally, food insecurity occurs due to overdependence on few crops, poor water management and inadequate agricultural practices. Unrest and violent conflicts linked to the access to land are also an important aspect in the areas affected by the 2008 post-election violence in the Rift Valley. Hence steering food insecurity drivers in this region would mean to find lasting solutions to long term land conflicts, environmental protection and improvement of agricultural practices, as well as income situation of farmers.



Map 4: Levels of intervention for mitigating food insecurity.

Conclusions for future biofuel development policies

The above findings show that the drivers of food insecurity in Kenya are indeed multi-dimensional and complex. Policy makers and development practitioners need to adopt an integrated, context specific approach to address food insecurity in an effective and sustainable manner. This is also valid for the conclusions to be derived pertaining to investment in biofuel development, or any other commercial activity that would increase the requirements for agricultural land. Hereafter are a few conclusions and recommendations developed on the basis of the analysis of food insecurity drivers outlined above:

1. Increase of pressure on land resources should be avoided by all means in (a) environmentally sensitive areas of the Rift Valley, (b) arid and semi-arid lands where overpopulation is an important food insecurity driver, and (c) in the high-potential food producing areas of the central and western highlands, where pressure on land is already high and leading to overuse and sometimes to conflicts. In these areas, biofuel production can only be encouraged, if it does not increase pressure on land and water resources, for example as Jatropha hedges or live fences.
2. The arid areas, mainly in the northern and north-eastern parts of the country, are probably not suitable for biofuel production, at least at commercial scale. In these areas, sustainable small scale production could be encouraged in areas where water availability is sufficient (e.g. along rivers) to help improving access of local communities to energy and to reduce pressure on forest resources.
3. In areas, in which water management and availability of water were mentioned as being the main drivers of food insecurity, mainly in the south-eastern part of the country, investment in biofuel production should not increase pressure on water resources. Hence, biofuel production in these areas should not use irrigation and should favour drought resistant varieties.
4. In areas in which rainfall variability is the main cause for food insecurity, production of drought resistant biofuels like *jatropha curcas* could offer an alternative to smallholders, and help them to reduce dependence on few food crops. However, no development of local biofuel production should be undertaken, unless a reliable market has been established and sustainability of such investment carefully investigated.
5. Similar statement can be made for regions in which food insecurity is mainly linked to unsuitable agricultural practices. In such areas, like the coast, Makueni and patches in the western Rift Valley, a careful promotion of biofuels could be envisaged, provided that such initiatives do not increase pressure on resources and competition with food crop production

References

Ariza-Montobbio, Pere; Lele, Sharachchandra (2010). Jatropha plantations for biodiesel in Tamil Nadu, India: Viability, livelihoodtrade-offs, and latent conflict. Ecological Economics 70 (2): 189–195.

BBC News (2011). Kenyans fear Dakatcha Woodlands biofuel expansion. http://www.bbc.co.uk/news/world-africa-12819035, retrieved 22.04.2011

Bioenergy in Africa (BIA): Bioenergy in Africa and Central America. The project. http://www.bioenergyinafrica.net/the-project.html, retrieved 22.3.2011. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Eschborn/Germany.

Bioenergy and Food Security Project (BEFS), Food and agriculture Organization (FAO) (2010). Bioenergy and Food Security. The BEFS analytical framework. Rome, BEFS & FAO. http://www.fao.org/docrep/013/i1968e/i1968e00.htm.

Diaz-Chavez, Rocio; Mutimba, Stephen; Watson, Helen; Rodriguez-Sanchez, Sebastian; Nguer, Massaër (2010). Mapping Food and Bioenergy in Africa. Executive Summary. A report prepared on behalf of FARA. Ghana.Forum, for Agricultural Research in Africa. http://www.visbdev.net/visbdev/fe/Docs/africa_energy.pdf.

Endevelu Energy; World Agroforestry Centre; Kenya Forestry Research Institute (2009). Jatropha Reality Check. A field assessment of the agronomic and economic viability of Jatropha and other oilseed crops in Kenya. Eschborn/Germany, Deutsche Gesellschaft für Technische Zusam-

menarbeit (GTZ) GmbH. http://www.worldagroforestry.org/our_products/publications/details?node=52985.

Faaij, André (2008). Bioenergy and global food security. Externe Expertise für das WBGU-Hauptgutachten "Welt im Handel; Zukunftsfähige Bioenergie und nachhaltige Landnutzung". Berlin, Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen (WBGU). http://www.wbgu.de/fileadmin/templates/dateien/veroeffentlichungen/hauptgutachten/jg2008/wbgu_jg2008_ex03.pdf.

Famine Early Warning Systems Network (FEWS) (2011). KENYA Dekadal Food Seucrity Monitoring. September 15, 2011. Kenya, FEWS. http://www.fews.net/Pages/countryarchive.aspx?pid=500&gb=ke&loc=2&l=en

FAO (2010). The State of Food Insecurity in the World. Addressing food insecurity in protracted crises. Rome, FAO. http://www.fao.org/publications/sofi/en/.

FAO (2011). The State of Food Insecurity in the World How does international price volatility affect

domestic economies and food security?. Rome, FAO. http://www.fao.org/publications/sofi/en/.

Hans Hurni interviewed by Jürg Keller (2011). Die Politik verursacht den Hunger. AMNESTY JOURNAL DEZEMBER 2011. Amnesty International, Schweizer Sektion. http://www.amnesty.de/journal/2011/dezember/die-politik-verursacht-den-hunger.

Hunsberger, Carol (2010). The politics of Jatropha-based biofuels in Kenya: convergence and divergence among NGOs, donors, government officials and farmers. Journal of Peasant Studies 37 (4): 939-962.

Kenya Food Security Steering Group (KFSSG) (2010,2011): Long and short rain assessments reports. KFSSG.http://www.kenyafoodsecurity.org/index.php?option=com_content&view=article&id=122&Itemid=113.

Moraa, Violet; Iiyama, Miyuki; Nzuma, Jonathan; Munster, Cristel; Mbatia O.L.E; Hunsberger Carol (2009). Food or Jatropha curcas for biodiesel production? A Cost Benefit analysis in Kwale district. DSA Paper. University of Nairobi. World Agroforestry Center (ICRAF).

Misselhorn, Alison (2005). What drives food insecurityin southern Africa? a meta-analysis of household economy studies. Global Environmental Change 15 (1): 33–43.

Mitchell, Donald (2010). Biofuels in Africa. Opportunities, Prospects and Challenges. Herndon, VA, USA, World Bank Publications.

Press , Mail & Guardian online (2011). Tanzania's biofuel project's promise proves barren. http://www.commercialpressuresonland.org/press/tanzanias-biofuel-projects-promise-proves-barren, retrieved 26.3.11.

Save the Children; Oxfam (2012). A Dangerous Delay. The cost of late response to early warnings in the 2011 drought in the Horn of Africa. Great Britain, Oxford, Oxfam GB for Oxfam International and Save the Children. http://oxfam.de/publikationen?terms=dangerous+delay&type=All.

Scholes, R.J.; Biggs, R. (ed.) (2004). Ecosystem services in southern Africa: A regional assessment. Pretoria, South Africa, Council for Scientific and Industrial Research. http://www.icp-confluence-sadc.org/documents/ecosystem-services-southern-africa-regional-assessment.

Swiss Agency for Development Cooperation (SDC) - Natural Resources and Environment Division (2007). Biofuels opportunity or threat to the poor?. Issue Paper July 2007.Bern, SDC.

Statehouse Kenya (2012). Kenya in Brief. http://www.statehousekenya.go.ke/, retrieved 14.06.2012.

Tomomatsu, Yuka; Swallow, Brent (2007). Jatropha curcas biodiesel production in Kenya. Economics and potential value chain development for smallholder farmers. Working Paper 54. Nairobi, World Agroforestry Centre. http://www.worldagroforestry.org/our_products/publications/advancedresults.

United Nations (UN)-Energy (2007). Sustainable Bioenergy. A framework for decision makers. UN-Energy. http://www.fao.org/docrep/010/a1094e/a1094e00.htm.