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Studies

Policies and Institutions for Assuring Pro-Poor Rural Development and Food Security through Bioenergy Production

Case studies on bush-to-energy and Jatropha in Namibia

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Abbreviations

AALS	Affirmative Action Loan Scheme
AGRA	AGRA Co-operative Ltd.
Agribank	Agricultural Bank of Namibia
BoN	Bank of Namibia
CBEND	Combating Bush Encroachment for Namibia's Development
CBN	cost of basic needs
CBNRM	Community Based Natural Resource Management Programme
CCF	Cheetah Conservation Fund
CDM	Clean Development Mechanism
CENORED	Central North Regional Electricity Distributor
CLB	Communal Land Boards
DED	Deutscher Entwicklungsdienst / German Development Service
DNA	Designated National Authority
DoF	Directorate of Forestry
DRFN	Desert Research Foundation of Namibia
EBA	Everything-But-Arms
EC	European Commission
ECB	Electricity Control Board
EJ	exajoule
EMA	Environmental Management Act of 2007
EPA	Economic Partnership Agreement
EA	Environmental Assessment
ESMAP	Energy Sector Management Assistance Program

EU	European Union
FAME	fatty acid methyl esther
FAO	Food and Agricultural Organization of the United Nations
FDI	foreign direct investment
FSC	Forest Stewardship Council
GDI	gross domestic income
GDP	gross domestic product
GHG	greenhouse gas
ha	hectare(s)
HDI	Human Development Index
IEA	International Energy Agency
IRDNC	Integrated Rural Development and Nature Conservation
IRES	Integrated Renewable Energy Solutions for the Rural Namibia
JPC	Joint Presidency Committee of NNFU and NAU
KJFA	Kavango Jatropha Farmers' Association
KW	kilowatt
LaRRI	Labour Resource and Research Institute
LDC	Least Developed Country
LLB	Lev Leviev Biofuels
LSU	large stock unit
MAWF	Ministry of Agriculture, Water and Forestry
MDG	Millennium Development Goal
MeatCo	Meat Corporation of Namibia
MET	Ministry of Environment and Tourism
MFC	Mali-Folkecenter Nyeeta

MLR	Ministry of Lands and Resettlement
MLSW	Ministry of Labour and Social Welfare
MME	Ministry of Mines and Energy
MoF	Ministry of Finance
MTCT	Mukwamahlanga Tukondjeni Community Trust
MTI	Ministry of Trade and Industry
MWh	megawatt-hour
NAB	Namibian Agronomic Board
NaCPA	Namibian Charcoal Producers' Association
NAD	Namibian dollar
NAU	Namibian Agricultural Union
NBC	Namibian Broadcasting Corporation
NDC	Namibia Development Cooperation
NDP	National Development Plan
NFWU	Namibian Farm Workers' Union
NGO	non-governmental organization
NHDI	National Horticulture Development Initiative
NHIES	National Household Income and Expenditure Survey
NJGA	National Jatropha Growers' Association
NOCEC	National Oil Crops for Energy Committee
NPC	National Planning Commission
OECD	Organization for Economic Co-operation and Development
OGEMP	Off-Grid Energisation Master Plan for Namibia
Polytechnic	Polytechnic of Namibia
PRS	Poverty Reduction Strategy
PTT	Permanent Technical Team

REEEI	The Renewable Energy and Energy Efficiency Institute
RPRP	Rural Poverty Reduction Programme
RSA	Republic of South Africa
SABS	South African Bureau of Standards
SACU	Southern Africa Customs Union
SADC	Southern African Development Community
SIA	social impact assessments
SRF	Solar Revolving Fund
SSA	Sub-Saharan Africa
SVO	straight vegetable oil
TA	traditional authority
TWh	terrawatt-hour
UNAM	University of Namibia
UNDP	United Nations Development Programme
USD	United States dollar
VDC	village development committee

Executive Summary

For the past several years, bioenergy has been a very hotly debated issue in the world – for a number of reasons. There is widespread, though fading, recognition that modern bioenergy (i.e. non-traditional bio-based energy carriers, especially excluding wood, compare footnote 1) could be an important component of the global strategy for developing low-carbon, renewable energy. The production and use of modern bioenergy has several potential benefits beyond issues regarding carbon: rural employment and income generation, healthier cooking, cheap and locally adapted transport and energy for industry, and lower adjustment costs. However, significant concern exists about the negative effects of using biomass for energy – including its competition with food production, structural and social changes in rural areas, the effects of greenhouse gas emissions and reduced biodiversity.

The pros and cons of bioenergy have been heatedly debated since the mid-2000s, mostly in terms of the policies of industrialized countries. More recently, the discussion has focused on large-scale land acquisition in developing countries to produce biofuel for export, and in particular on the negative consequences of such investments in rural areas with regard to local livelihoods, social cohesion and the reallocation of land and natural resources that could cause conflict. The large variety of ways to produce modern bioenergy in poor countries, and the many factors that influence its effect at the local and national levels, are less obvious. The economic, ecological, social and political dimensions of the effect of the many ways of bioenergy production on food security and rural development must be studied. The policies and institutions that could help governments of developing countries to steer bioenergy production, thereby avoiding negative, and supporting positive, effects are too often neglected.

Bioenergy is particularly relevant for countries in Sub-Saharan Africa (SSA), many of which have low population densities with most citizens living in rural areas. Agricultural productivity is very low, with little use of external inputs or organic fertilizer. People suffer from energy poverty and mostly use traditional biomass to generate energy; modern energy (electricity, liquid fuels and gas) is hard to come by. Unsustainable forestry management degrades soils and ecological systems. Bioenergy could bring several benefits to rural areas, and is more compatible with the current

situation than most other energy forms because it requires capabilities and practices similar to those in the region, notably in agriculture and agro-processing. Its storability and flexibility in transport, machinery, electricity production and heating fill the typical local energy needs. Its often labour-intensive production can create jobs, and there may also be spillovers from a lucrative bioenergy cash crop on food-crop production. But since most rural people make their livings from food production for subsistence and local markets, and local food markets are little integrated into wider networks, bioenergy production could stimulate immediate and sharp competition between the use of land and crops for food and fuel. Local populations are poor, largely illiterate and often dispersed, with no political power. While SSA countries could reap important benefits from producing bioenergy locally, their populations are very vulnerable to its inappropriate development.

This study seeks to contribute to the discussion of the pros and cons of local bioenergy production and use in and for Africa. It focuses on the opportunities for and threats to food security and rural development, and the policies and formal institutions that can incentivize and regulate bioenergy to be pro-poor and sustainable while suppressing or at least mitigating detrimental impacts. Namibia has been chosen as the study case because it is considered to have substantial potential for bioenergy production, and because there was a high interest in the country at the time of study design for various bioenergy types. The overarching research question is: *What form should national policies and institutions take to support the development of inclusive and sustainable bioenergy production in SSA?*

The report analyses the potential implications on rural development and food security for the two major potential sources of bioenergy in Namibia: encroaching bush which can be converted into charcoal, electricity or briquettes, and Jatropha curcas (a shrub that produces fruits with seeds that contain between 30 and 54 per cent oil which can be used as straight vegetable oil (SVO) or biodiesel). Except for charcoal, most of these value chains have not been developed beyond the trial stage. Bush-to-energy value chains seem to be more appropriate to Namibian agro-ecological conditions than Jatropha, and some business models could prove to be economically viable. The first deceptions regarding Jatropha came to light as we were conducting fieldwork: Jatropha is considered unlikely to generate positive economic returns. However, our main concern is not the profitability of the value chains but rather the policies and institutions that are needed to guide their pro-poor, sustainable development: these guiding policies and institutions can determine profitability and also shape other impacts of the value chains.

The various ways that bioenergy value chains (also called 'business models', i.e. concrete combinations of players, product flow, size, technology, contractual arrangements, markets, etc.) are implemented present very different opportunities and risks – and challenges for policy and institutional support and regulation. The threats and opportunities increase with the scale of operation, particularly the likelihood that the private sector will step in and reduce the need for public support – as found in many small-scale models. We identify eight challenge areas regarding the policies and institutions that are most relevant for developing bioenergy. Consistent strategies for food security and rural development guide specific policies for: agriculture; labour, land and environmental regulations; and the bioenergy market. The various policy fields and institutions must be coordinated. Although Namibia is a lower-middle income country whose institutional framework is more developed than that of most other SSA countries, its policy and institutional environment is still too undeveloped to provide the needed guidance. This study suggests how to improve the framework.

The conceptual framework and methodology

The study introduces the two main raw materials that were being considered for bioenergy production in Namibia in 2009: local bush and Jatropha. Heavily hyped at the time, enthusiasm for Jatropha has since waned because most attempts at large-scale production have failed. However, there is talk of a second-generation boom. As for the various energy products that can be derived from bush, only charcoal has a commercially viable value chain, while the other products that we examine in this report are still in experimental stages. This is true for most bioenergy products in SSA – except for traditional firewood and charcoal. But even if the profitability of these products is not yet proven, the value chains we analyse can show what is needed to make bush and Jatropha – or similar bioenergy crops – pro-poor and sustainable. We discuss the ramifications regarding modern bioenergy's production and use in poorer African countries.

Our study is based on the value-chain approach that acknowledges that effects of a product occur at various stages – from production through processing to consumption – and that policies and institutions have major effects up- and downstream and must be reviewed together. Rural development and food security are key dimensions of our (mostly *ex-ante*) qualitative effect analysis.

Our analysis focuses on various value-chain *business models* – specific ways that a particular raw material is produced, processed into bioenergy and then distributed: the technology; the size of the investment; producers, processors and distributors; the product's destination; and the organizational, capital, technology and standard requirements. For instance, Jatropha can be produced on huge plantations that dislocate many farms and entire villages and establish new industries and power relations. It can also be produced in hedgerows around smallholding plots and processed at the village level – and barely change the rural social setting. Both value-chain models can co-exist, with fundamentally different consequences.

After two months of studying the relevant literature, we embarked on a three-month field trip (from February to April 2009) to interview some 130 experts and key informants in Namibia. We used an iterative approach to sample and select interview partners and gather data, starting with the value-chain actors and our initial hypotheses about effects, policies and institutions, then including more interview partners as information gaps remained and new questions and topics arose. Interviews with individuals and groups were qualitative. Whenever possible, we collected and analysed secondary information – mainly project and 'grey' (non-commercially published) government and project documents – to support the qualitative information. Regional foci were the 'Maize Triangle' in Namibia's central-northern region, and the Kavango and Caprivi regions. A final workshop with about 50 stakeholders provided an opportunity to collect additional information and assessments.

The framework conditions for bioenergy value chains in Namibia

Analysis of the framework conditions reveals that although Namibia is a relatively wealthy and quite developed SSA country, it shares some features with poorer countries on the continent. Namibia is dependent on a few economic sectors, especially mining, and to a much lesser extent, fishery, tourism and livestock. It still suffers from economic, social, educational and political divides dating back to the colonial and the South African apartheid protectorate period that only ended in 1990. Namibia's average poverty level is 30 to 40 per cent; its rate of inequality is among the world's highest. There is a huge gap between the richer, industrialized South and the poor, agricultural North – in particular, the sparsely populated Kavango and Caprivi regions that are the main ones targeted by bioenergy projects and entrepreneurs. This is also true for the energy infrastructure and supply. Namibia plans to develop into a middle-income country with an urban-based economy. Environmental protection, anchored in the Namibian constitution, has a significant domestic lobby.

Farming conditions are hard, with low yield potentials for crops because of scarce rainfall and water for irrigation. For many poor Namibians, the main source of income is subsistence farming; neither most smallholder farmers nor the country as a whole are food self-sufficient. Namibia imports more than half of its staples, especially maize, despite governmental support for industrial agriculture that is mainly practised by white and increasingly by black farmers with larger farms in the Maize Triangle.

The maturity and economic viability of bioenergy value chains

Most bioenergy value chains that we studied in Namibia are still experimental. The only established business is charcoal production. Other bush-to-energy value chains are implemented by pioneering individuals and organizations.

At the time of our study, commercial Jatropha farmers in the Maize Triangle, where frost had severely affected saplings, had experienced major setbacks. Large investors, however, remained interested and continued to expand in the northern, sparsely populated Kavango and Caprivi regions where frost is not an issue. Because of uncertainties regarding Jatropha's environmental and social effects, a moratorium on large-scale Jatropha projects was imposed soon after we had finished our fieldwork. Since then, large-scale Jatropha models have collapsed throughout SSA, mostly because the high-yield expectations did not materialize, but also because of other problems, most of which we had perceived in our field work: Jatropha's uneven growth and maturation; the need for high inputs to achieve high yields; pests and diseases; labour needs and costs; and problems in local markets due to the lack of regulations and standards (but not in international markets, where demand for transport biofuel still is high and has shifted from road vehicles to aviation). The financial and economic crisis abruptly put an end to many high-risk investment projects, including Jatropha plantations.

This study did not specifically consider the economic profitability of individual bioenergy products and value chains, but rather examined the policy and institutional frameworks for incentives and regulations. Regardless of the fate of specific value chains, we believe that our findings are valid and can be broadly generalized.

Factors that influence bioenergy value chains

Although there are important variations in the opportunities, risks and uses of bioenergy production with respect to the specific value chains and business models, it is possible to make some generalizations. Ownership of land and plants is a key factor shaping the opportunities and risks to establishing value chains in various business models – and their effects. In Namibia, the region of implementation – north or south of the former 'Red Line' that demarcates private and collective land, bush and trees – largely determines the type of land and tree ownership and thereby the models of bioenergy production, problems that emerge and the policies and institutions that are challenged. Any analysis of bioenergy value chains must specify site, business model and land, bush and tree ownership as well as governance issues in order to create better understanding of effects and policy and institutional requirements. Distinguishing these factors and how they can be combined to produce bioenergy is at the heart of the descriptive and analytical part of this study.

Bioenergy's main opportunities and risks for rural development and food security

Both bush and Jatropha value chains can create jobs for a large number of poor people because they typically require many unskilled workers, particularly in plant husbandry and harvesting. More sophisticated technologies may require more highly skilled labourers but bioenergy production in Africa will usually be a labour-intensive sub-sector. People from the Caprivi and Kavango regions could profit from working in bioenergy, either in their regions or as migrants in other regions, remitting income back home. The social risks and challenges of migration call for special policies, for example, introducing small-scale production close to villages could reduce the number of (mostly male) migrants by qualifying more local households to produce bioenergy. Furthermore, the resulting cheap local energy (fuel or electricity in local grids), would enable the village to expand agricultural irrigation or lighting, thereby raising local incomes and boosting food security and social development.

Food security is a complex phenomenon. Cash income helps poor households, but bioenergy crop production can lead to certain negative developments, for instance, if Jatropha replaces food crops or if there are fewer household labourers because family members are working on bioenergy crops or have migrated. The prices of staple foods are unlikely to change since Namibia already imports a lot of food and prices are shaped by trade policies and subsidies. Through bush-to-energy value chains, bush is expected to create more feedstuff and grazing potential for livestock, thus boosting food security through higher incomes from livestock, livestock related jobs and lower meat prices.

The social dimensions of bioenergy production are difficult to predict. Where household purchasing power plays a role, higher incomes should lead to better education and health, for example through allowing expenditures for school or medication. But this depends on who earns the money and who decides how it will be spent – men or women, old or young people, and individual preferences. Some interviewees argued that higher incomes would cause more alcoholism, while others expected that more jobs would mean less drug use. In some constellations social tensions will increase – for instance, from the massive presence of migrant woodworkers around farms and big plantations, and transmittable diseases – particularly HIV/AIDS – could spread. It is difficult to judge if these effects are more detrimental than the present situation without bioenergy where many poorly educated young people are abandoning the rural areas and streaming into the few cities to search for jobs.

One specific social problem in rural Namibia where bush is encroaching is the lack of villages and markets. Rural workers tend to live on remote farms where high transport costs make them dependent on farmers and employers for food and other provisions. In such circumstances large-scale enterprises in rural areas create high dependence. Local communities have few alternatives so if a project fails the social costs are very high. Market production generally may increase vulnerability to food insecurity because of market risks: the way and degree to which Jatropha is integrated into food-crop systems will have important repercussion as to how it affects production and food security risks. This is another trade-off that is hard to judge. In Namibia, however, which has functioning food markets and governmental capacities to provide food aid and social security, it seems feasible – and preferable – to rely on cash income and food markets instead of relying on subsistence production.

As for ecological effects, there are marked differences between the analysed value chains and business models. Agricultural activity generally threatens wildlife and biodiversity and bioenergy production is no exception, particularly on large-scale Jatropha plantations. Jatropha's invasiveness has often been named as a threat, although the plant has grown in the area for hundreds of years and does not appear to spread. While newly introduced varieties could alter the situation, the alleged threat seems to have given government authorities a pretext to take no action and to use it to argue against large plantations. As long as local commercial farmers were seen as the main cultivators of Jatropha many non-local varieties were imported. On the other hand, Jatropha and its residues could be used to help restore soil fertility in degraded areas. But being forced to select degraded areas is not in the interest of farmers, who prefer fertile land.

In Namibia, bush-to-energy conversion could be a rare exception to the general antagonism between agriculturalists and environmentalists if properly implemented. It is generally acknowledged that bush encroachment causes land degradation and desertification: it increases evapotranspiration and reduces grazing land for livestock and wildlife as well as water infiltration, which is needed to replenish underground reservoirs. Thus, when responsibly conducted without felling large trees and cutting protected bushes, it is a win-win activity both ecologically and economically (if commercially viable). However, the structural differences in the goals and interests of farmers, debushers and charcoal producers call for sound monitoring by forest authorities or farmers.

The main policy areas and institutional challenges regarding bioenergy's viability and effects

Our study concludes that Namibia is ill prepared to manage the risks, opportunities and trade-offs that come with the production and use of modern bioenergy. The necessary policies and institutions are either lacking or inadequate. The various policies and institutional challenges are grouped in eight areas:

1. Namibia lacks a clear concept and strategy for food security. Major strategic framework documents do not consider subsistence production and national food self-sufficiency to be important, but many decision-makers appear not to have taken note of this. The food-price crisis of 2007–08 caused many analysts to believe that Namibia should produce more of its own food, thus reducing the scope for cash-crop production and especially bioenergy crops using arable land such as some Jatropha sites. Strategic action in many areas of rural development, including the production of bioenergy, is hindered by arguments against the wisdom of producing cash crops (including bioenergy) as opposed to food crops.

2. Namibia's vision and strategy for rural development appears to be ambivalent – and sometimes contradictory. The long-term vision for the country does not assign a major role to rural areas, but that is where most poor people live. Living conditions must be improved there since the rural poor have no good alternatives in Namibia's few cities. One of the few options is to improve the use of natural resources by protecting wildlife for tourism, as well as engaging in farming and forestry. Each of these paths has merits and limitations. Insufficient effort is given to creating consistent developmental pathways for rural areas, and too little emphasis to testing and implementing promising ideas. This political inertia has negative implications for all options, including the production and use of bioenergy.

3. In order for bioenergy to flourish, agricultural policy must be strengthened. While agriculture's role in rural development is not yet clear, it is obviously a necessary element of any medium-term pro-poor rural strategy. Research on new technologies and productive processes, such as bioenergy value chains, is in its infancy and links between research and extension services are weak. With Jatropha's productive potential and its relation to other crops in intercropping systems unclear, investors and policy makers cannot make informed assessments or decisions. Allocations of agricultural credit are biased towards political projects, especially land redistribution, while agronomic and managerial capacities are weak. The link between debushing and redistributing land to create

sustainable farms also has not been properly made. Debushing creates conflicts over production targets and problems between landowners and concessional debushers. People who own land and run environmental (wildlife) conservation projects usually want bush removed to improve grazing but do not want any trees cut down. Charcoal producers, on the other hand, prefer harvesting larger trees instead of bush, and are loath to dig up or poison bush roots to prevent restocking. The best harvesting methods for certain bush products do not produce the best results for people who own or use the land. Unfortunately, forestry is not clearly assigned to the agricultural – or any other – ministry. In addition, supervising bush and forest rules and concessions in Namibia's vast, inaccessible areas is very difficult. Furthermore, for many bioenergy value chains to be viable, values must be established for their by-products, which requires more research, standards setting and other measures in the agricultural, food, industry and energy sectors.

4. The implementation of labour regulations in remote rural areas is crucial but insufficient to develop the potential of new jobs in bioenergy value chains, thus creating uncertainty for commercial debushing and bush-to-energy enterprises, and hindering investment. Namibia has established labour regulations in the mining and industry sectors and for commercial farms, but when we were researching, woodworkers in bush-to-energy value chains and seasonal labourers on plantations were barely regulated. But any regulation simply using established rules for industry is likely to inhibit investments and job creation. Regulation must take into account woodworkers' conditions. They live in bush camps, lack permanent jobs, are dependent on employers in remote areas, and do work that is more appropriately paid by the piece than by the hour. Also intermittent employment on large Jatropha plantations must be regulated specifically – perhaps also for migrant workers. Regulation should also take into consideration the challenges to communication and inspection in remote rural areas.

5. Regulations and decision-making processes about land present significant challenges to both value chains in the communal areas. The bioenergy boom created new interest in land and biomass on the part of investors – and revealed inadequacies in land and natural-resource governance and decision-making procedures. It proved hard to finalize Jatropha

land-leasing agreements between investors, chiefs and communities because of uncertainties about rights, procedures, bush ownership and the consequences of innovative tree-leasing arrangements for land ownership. Lengthy and opaque negotiating and decision-making processes at the local level and between local and national entities led to numerous delays and failures. Weak rules helped important actors (local and national elites who were in cahoots with some large investors) engage in power plays, while the use of bush on other peoples' land created institutional and organizational problems and moral hazard.

6. Environmental regulations interfere with bioenergy production in many areas, including forestry, water, biodiversity, land allocation, climate-change mitigation and support for renewable energies. Our analysis shows that the various value chains and business models create very different opportunities and risks for the environment: therefore, regulations must be well adapted, adjustable and closely coordinated with other policy areas. Some bush-to-energy models clearly provide opportunities for balancing wildlife and water, but attention must be paid to prevent tree cutting and to protect certain species. Especially when irrigation is involved, it is harder to reconcile and manage the trade-offs of Jatropha cultivation: negative effects on the biodiversity of large plantations are likely, and for water quality are possible. The officially unanswered question about Jatropha's invasiveness creates uncertainty in bigger investors; for smaller growers this was not an issue in the past but may be one in the future.

7. Bioenergy output markets drive the production of bioenergy. The various chains and business models – from established ones, such as charcoal, to innovative ones, such as biofuels, bush blocks and bush-to-electricity production – have very different market and price-incentive structures. Regulation is needed for feeding (i.e. supplying) electricity and biofuels into existing energy markets, and certification of foreign standards and regulations must be introduced to export them. This is at least partly a public responsibility. For example, Clean Development Mechanisms (CDMs) and other greenhouse gas (GHG) mitigation schemes cannot be certified without national authorizing bodies and accredited certifiers. Blending requirements, testing and certification are needed for biofuels. As new arrivals on energy markets, the various forms of bioenergy

have problems due to their small quantities, high learning costs, and economies of scale and cost reductions that are only gradually realized through experience, making them uncompetitive in the early stages of development. On the other hand, Namibia's cheap supply of electricity from South Africa (RSA) is running out: The rising cost of oil and fossil fuels provide entry points for bioenergy production in land-abundant Namibia.

8. Bioenergy value chains depend on a broad range of interlinked policies and institutions. They cut across sectors from agriculture and forestry to industry and energy, with important implications for food security, water and the environment, and at least initially, they need policies in order to create markets. Finally, the introduction of innovative technologies and partner alliances in various bioenergy value chains and models requires very good (policy and other) coordination.

Main recommendations

The following recommendations regarding the policies and institutions presented here summarize the final chapter. Since many recommendations are far-reaching, with bioenergy issues only a minor element in some of the larger policy fields, it is obvious that not everything can be done right away and that much more reflection and input is needed than is possible in this partial case study on bioenergy.

1. Questions of food security require more knowledge, a clearer definition and a strategy to guide policies and decisions and balance the trade-offs between food production and food imports and the production of food and cash crops (including bioenergy) at the household and the national levels. Without dismissing arguments in favour of producing more food nationally, we consider that Namibia's official strategy – which acknowledges that the country has to rely on food imports for food security – is more realistic and more beneficial for the country, and especially for rural youth. Other strategic orientations are also reasonable. However, a food security strategy must make the interdependencies of production, income, market stability, food prices and social safety schemes explicit, and it must be embedded into longer-term visions regarding Namibia's food security, economy and society. Many compromises can be made to balance issues related to food

security, for instance by supporting positive spillover effects on food production from bioenergy value-chain development (cropping systems, energy, minimum production requirements for large farms, etc.). A reasonable set of intermediary steps leading towards the food security vision is needed, and in particular, a plan to gradually lift the masses of food-insecure Namibians out of their misery. Rural development is certainly important in the short and medium term. While bioenergy need not be explicitly addressed if not being considered as an option for rural Namibia, the broader relationship between food and cash-crop production must be. Such a strategy should be widely disseminated in order to harmonize societal attitudes and policies.

2. Better understanding is needed of the role and potential of major land uses (agriculture, livestock, forestry and conservation for tourism) in developing rural areas economically, ecologically and socio-politically. The role that migration plays in reducing rural poverty must be addressed, with suggestions about how to prepare rural people for urban job markets in realistic time horizons. Such a strategy should guide various sectors in rural areas, particularly agriculture, ecological conservation and tourism. The potential and risks of bioenergy – which could use a very large share of Namibia’s total land area – should be addressed, using reliable information about the economic potential and the socio-ecological effects. These issues require additional research.

3. Agricultural policies should be aligned with strategies for food security and rural development and available governmental resources: supporting smallholder agriculture requires substantial capacities. Within the agricultural sector, the framework conditions for the use of feedstock for bioenergy should be clarified. Such information is a public good used to assess the various business models, increase certainty with regard to planning and making decisions about large investments, and as input for extension services for small- and medium-scale farms. Massive bush encroachment and the serious problems it causes justify serious public-research analysis of, and possibly support for, bush-to-energy options – as a partial solution. Training woodworkers and other actors in the value chain, or extending credit lines can be viewed as supportive measures. Basic questions must be addressed about Jatropha productivity in Namibian conditions. Agricultural support systems need to be adapted

to the preferred scenarios. For instance, if the bush-to-energy value chain is to be developed, then research, extension services, training, input supply, and organizational support should be channelled to poor rural households and farmers. Larger players will also need support, for example, with research, regulations and standards setting, and possibly credit and finance as well. Bioenergy's potentially large-scale local production and market sizes and links to international markets call for specific attention to foreign direct investment (FDI) and more generally, to large agro-investor models. Clearer guidelines regarding land and vegetation use, and possibly remote-control systems to supervise such guidelines, should be developed.

4. Labour regulations should explicitly cover rural workers in bioenergy and other value chains and take account of their special exigencies, such as their seasonality or need to be paid by the piece. Communication could be improved by sensitizing the actors and supporting dialogue platforms. Given Namibia's vastness, bioenergy – and more generally, a bio-based economy – could provide many new and better jobs in rural areas, as long as there is active public support to develop technologies, skills and value chains. Innovative options could be developed to overcome the challenges of labour inspections, for instance by setting up inspections using information and telecommunication technologies.

5. The implications of regulations for land use and the effect that bioenergy value chains have on the land are just some of the reasons to further develop communal land governance; there are others. The rights and roles of stakeholders and procedures, too, should be reformed to enhance transparency, accountability, speed and the fair distribution of the benefits and risks of communal land management, particularly with regard to leasing. The governance of land and the use of natural resources should be more closely integrated, particularly of bush and forest, water and wildlife. An integrated framework could then clarify the space allotted for debushing and bioenergy projects. Debushing could do a lot to curb the pressure on communal and commercial lands by freeing up grazing areas and reducing minimum requirements for farm sizes, while active support for poor households and other weak actors and organizations should help to implement their land rights.

6. Environmental knowledge and regulations must be enhanced to accommodate bioenergy value chains. Bioenergy feedstock production creates new, and potentially huge, challenges and opportunities at the nexus of land, water, biodiversity, energy and climate change. In Namibia, this nexus is influenced by powerful lobby groups and ideological narratives. Independent public research is needed to provide a better – and neutral – knowledge base. How much Jatropha actually constitutes an invasion risk must be clarified.

7. One key to strengthening bioenergy value chains is to support bioenergy output markets. Once the facts are gathered, for example, about the cultivation and profitability of Jatropha or bush-to-energy prototypes, tools like the "National Biofuel Energy Roadmap" or the bioenergy sections of energy policies should be made binding. This could involve research on products and processes, including carbon markets, standards, institutions and financial support for start-ups. However, since resources are limited and energy costs must remain affordable, careful design and realism are required. In the electricity market, for instance, decentralization and a feed-in standard make a good basis for starting to generate bio-based electricity. The higher feed-in tariffs that are often requested should not exceed the medium-term costs of alternative sources. They could, however, be above the currently very low prices of imported electricity – which is going to be phased out. Biofuel blending standards and inspections aimed at developing voluntary blending should be more important than quotas for blending that disregard the competitiveness of biofuels and that would negatively affect transport costs. Cheap transport is essential for Namibia's rural economy to survive.

8. The interplay of actors, effects, policies and institutions across sectors requires good (policy) coordination. In conjunction with agricultural policies and consistent with other policy fields, a bioenergy and renewable-energy policy should clearly identify responsibilities, lead agencies, funding and coordination platforms. Coordination with regional actors is necessary, for instance, for creating and disseminating knowledge across similar agro-ecological zones in SSA, developing standards and markets under South African direction, or regulating foreign direct investment (FDI) in the relevant regional economic communities. We plead for harmonizing policies, public opinions and

attitudes towards bioenergy but also acknowledge the limitations of a top-down approach to planning. At this time, bioenergy is an extremely complex, heterogeneous and politicized field. Official regulations will not eliminate the conflicting positions and perceptions of all the stakeholders. As with many rural developmental issues, solutions are local – with fundamentally different meanings in different locations. Good solutions may also change over time, as new information emerges and technologies and internal and external circumstances develop. Thus, local experimentation with public support is a good intermediate strategy. Public debate and case-to-case decision-making based on local circumstances and a consistent set of policies are indispensable for finding good solutions for bioenergy production.

Further considerations

Our study has shown that the promotion and regulation of bioenergy is extremely complex and involves many effects beyond the actual value chains. Poor African countries that must decide on the promotion and regulation of biofuel production are most concerned about rural development and food security; distributional and ecological issues are also important. So called side-effects of biofuel production are not of minor importance; some are of overwhelming importance, particularly in low-income countries: domestic and foreign energy needs could make bioenergy a huge undertaking.

The different effects and effect channels are regulated in various policy fields. In poor countries, regulatory frameworks regarding bioenergy in general, as well as the effects on food security and rural development, tend to be deficient; capacities are weak, with policy coordination that is often worse than in more prosperous countries. Steep regulatory requirements and low capacities tend to create fewer positive effects, while negative effects are a real threat. Yet compared with other renewable energies, bioenergy has huge potential in low-tech, low-capital countries that abound with natural biomass-based resources.

Namibia has a much more comfortable situation than other SSA countries regarding the capacities of state and private actors. But although progress has been made in the regulatory framework, industrial policy remains weak and the implementation capacities – particularly of governmental agencies – are even more limited. There are more private actors there, both international and national, than elsewhere in SSA, with coalitions of commercial farmers and entrepreneurs that can develop considerable drive to innovate.

Namibian insights will be very valuable for SSA countries with fewer capacities, less experience and fewer issues at stake – if they are put in perspective. For these countries, it is crucial to pilot bioenergy slowly, using experimental designs and solid research, monitoring and evaluation. For some non-scalable issues, such as feed-in tariffs and certification that new species and varieties are not invasive, this will not suffice; for them, open, scale- and technology-neutral formulations should be found to facilitate and regulate the emerging sector, with due diligence and serious monitoring. Framework policies and institutions can then be scaled up, improved and harmonized in light of the test results. Good sequencing could alleviate excessive demand for policy coordination and coherence. This recommendation derives from recent lessons learnt in Europe regarding bioenergy policies and experience in SSA with large-scale land acquisitions made in conditions of uncertainty and market and private-sector failures. Such projects should be pioneered and screened for models of good practice before being offered to the broader public, and should then be offered through bidding. Advice and guidelines for developing bioenergy policy in SSA must follow these principles. Some policy and institutional frameworks should guide others, however, especially those for food security and rural development should have the lead during periods of structural change and the commercialization of agro-based value chains such as for bioenergy.

One question not addressed in this study but crucial for the future of bioenergy in SSA is the costs of providing energy and its competitiveness with other sources – energy used in households, transport and industry, where bioenergy could make important contributions. Poor countries cannot afford to subsidize energy over the long run. Support is needed in the form of upfront public investments in infrastructure and management. This is even truer for fossil energies, whose subsidization constitutes a perverse disincentive for renewable energies and is often economically unsustainable, creating vested interests with path dependencies that may end up more costly than renewable energies. Given the limited financing and other pressing needs, in order to succeed, developers of bioenergy (and renewable energy more generally) have to be more sensitive to the costs in SSA than in industrialized countries.

1 Introduction

1.1 Bioenergy's potential role in Sub-Saharan Africa: The opportunities and risks

There is widespread – though fading – recognition that modern bioenergy[1] could be an important component of the global strategy for developing low-carbon, renewable energy (International Energy Agency [IEA], 2006; Wissenschaftlicher Beirat der Bundesregierung für globale Umwelt-veränderungen [WBGU], 2008; IEA, 2011; see discussion in Bioenergy Wiki, 2012). Derived from various feedstocks, modern bioenergy can be very flexibly used for electricity or heating and transport fuel – thus supporting numerous energy development pathways to make human energy use more sustainable. However, there is limited production of biomass – plant materials or animal waste that are used as a source of fuel. The use of biomass for energy competes with other uses, especially for food but also for fibre, construction and nature (if natural vegetation such as forest is used as feedstock). Biomass also consumes limited natural resources that are threatened by human use and over-use. Bioenergy is a highly contested item on the low-carbon renewable-energy agenda.

While bioenergy is given a prominent place in scenarios about a future mix of renewable, sustainable energies, there is no consensus about how this will happen because of the many different considerations in using biomass to produce energy. Along with risks to food security and the environment and related social aspects are questions about the proper energy mix and

1 The United Nations' Food and Agricultural Organization (FAO, 2008, p. 10) defines 'biofuels' as energy carriers that store the energy derived from biomass and 'bioenergy' as the final product. In this definition, biofuels also include gaseous and solid forms (such as fuelwood, charcoal and wood pellets) and not just liquid biofuels or agrofuels, liquid fuels derived from food and oil crops produced in large-scale, plantation-like, industrial production systems. However, 'biofuels' is often used as a synonym for modern liquid biofuels. 'Bioenergy' is used here for the general family of energy carriers based on biomass as well as the energy derived from these carriers; 'biofuels' refers to liquid biofuels.

Another distinction made in this study is between 'traditional' and 'modern' bioenergy, a distinction that is also made in other studies such as WBGU (2008). While traditional bioenergy forms include firewood, charcoal and manure, modern forms encompass various standardized gaseous, liquid or solid products that are produced from various types of biomass using modern technologies. Straight vegetable oil (SVO) and wood pellets have long been used for energy.

whether the system should be centralized or decentralized, as well as the roles of individual mobility and bioenergy. Most science-based sources discuss both the positive and negative aspects (Brown, 1980; Kammen, 2006; Organization for Economic Development and Cooperation [OECD], 2007; Food and Agriculture Organization of the United Nations [FAO], 2008; WBGU, 2008; IEA, 2008; Leturque & Wiggins, 2009; IEA, 2011; United Nations Environment Programme [UNEP], 2012).

Support for modern bioenergy in many industrial countries, and increasingly in developing countries, too, is motivated by three lines of arguments:

- First, bioenergy could contribute to reducing greenhouse gases (GHG) by replacing fossil energy because plants assimilate the carbon that biomass releases to the air during combustion. Especially important in this context are liquid biofuels, which are often seen as playing a major role in the transport sector, given that electromobility is unlikely to fully replace liquid fuel-based engines due to limited electricity storage and weight of batteries for long-distance transport. In aviation these arguments are even stronger.
- Second, sometimes the sustainable use of fuels derived from locally grown energy crops is an important component of a strategy to increase a country's energy security.
- The third line of arguments is based on how bioenergy production could improve rural incomes, employment and general development by creating demand for agricultural products and new labour-intensive value chains, and fostering investment in rural areas – thus helping to reduce poverty.

Critics of bioenergy cite its negative aspects:

- First, bioenergy's GHG balance might be less positive than expected, or even be negative, depending on the production site and mode, the inputs used to produce and transform the biomass, and especially the land-use changes that result from having to cultivate a crop that was displaced by the bioenergy crop if virgin forest and grassland are used, which have high initial GHG emissions.
- Second, massively increasing the amount of land used to produce bioenergy exacerbates pressure on natural resources such as soil and water, heightens conflicts over land use and threatens biological diversity.

- Third, food prices could rise as a consequence of increased competetion for feedstock, land, water and other resources.
- Fourth, food prices could be more volatile as a result of further coupling the markets for energy and food and making them susceptible to the dynamics of the energy market, possibly threatening food security.
- Fifth, bioenergy production could cause losses or only slight gains in the revenues of poor rural stakeholders compared with those of agro-industries, particularly if it occurs on large, highly mechanized farms that displace smallholders.

The debate is complicated by the fact that bioenergy can be produced in many different ways:

- From different types of biomass (algae, wood, cellulose, various permanent, pluri-annual and annual crops, etc.);
- With different production processes (residues, by-products, main products; production on newly cleared forest land, arable lands or grasslands, on marginal and degraded soils; with intensive use of external inputs or under low-input systems; large- or small-scale);
- Embedded in different production systems that have complex systemic effects concerning crop rotation, technology spillovers, improved credit access, management, labour allocation, mechanization, and so forth;
- Through a wide range of technologies that transform biomass into bioenergy (biological, chemical and physical processing and combinations thereof) as well as multiple forms of use (electricity, heat, liquid transport fuel and cascading uses);

Produced from a given feedstock to different extents and in combination with other products (many crops can be converted partially and/or simultaneously into food, feed, fibre, chemicals, biofuels, and the shares may vary depending on the price relation).

Scale also matters: While the biofuel use at the micro-level depends on local factors and individual decisions and might be harmless for food security or other outcomes, at a higher level the aggregated effect of many such decisions can become a challenge. Such repercussions concern GHG emissions, natural resource use balances, social and political effects and the international agricultural trade. Policy interventions to shape and correct such repercussions produce still more effects at all levels. But aggregating the effects is difficult because of bioenergy production's complex interactions with the environment. For instance, while under certain low-input conditions modern bioenergy production could improve the crop productivity and entire farming systems through spillover effects, in high-productivity agriculture crop competition could cause reduced food production in a given region or even worldwide. A reduction in food area and production as a result of increased bioenergy production could also pressure farmers to use land in forests, locally or in other areas of the world (indirect land use change). Massive use of crops for bioenergy could also create a floor price for biomass, thereby reducing the downward volatility of food prices to the farmers' advantage.

The multi-dimensionality of the assessment of any given bioenergy process and its aggregated effects poses serious problems for analysis in terms of data and methods. Furthermore, biomass and energy markets tend to be highly volatile, technology develops very dynamically and important frame conditions are fraught with many uncertainties, including deriving from erratic policy-making. Bioenergy's sheer diversity and complexity makes it hard to give simple answers about how it could sustainably become part of a low-carbon economy.

Another problem in assessing modern bioenergy is that its production rarely emerges spontaneously (without political support), like a competitive industry. As other innovative energy forms, bioenergy also has to compete in markets with natural fossil fuel monopolies, economies of scale, path dependencies, externalities such as environmental costs and national security concerns, extremely long technology-development cycles and capital-amortization periods, and so forth. Energy supply and costs are usually considered to be key factors of modern industrial development. Few governments abandon the energy sector to market forces; they all intervene to different degrees by supporting technological development, regulation, taxation, pricing policies or even nationalization of (parts of) the industry. No new energy source develops in a political and economic vacuum: to compete with heavily regulated energy carriers and technologies it must be supported, too. This aspect alone makes it tricky to assess bioenergy.

It is widely believed that modern bioenergy production in SSA could significantly contribute to the continent's development, especially in rural areas. Modern energy is widely acknowledged as being key to economic and social development. SSA lags far behind other regions in using modern energy (World Bank, 2009). From a macroeconomic perspective, the high costs and unreliability of Africa's existing energy systems hinder the economic competitiveness of many SSA countries (ibid.). Only an estimated 26 per cent of all African households have access to electricity (547 million people) (World Health Organization [WHO] & United Nations Development Programme [UNDP], 2009, p. 11); this is unequally distributed between urban (51 per cent electrification rate) and rural areas (8 per cent) (World Bank, 2009). When South Africa (RSA) and the Maghreb are excluded, the figures are much worse. Limited electricity and energy services negatively affect education and health services and public health, that is, the lack of modern energy prevents most Africans from raising their standard of living and stymies economic growth.

High energy prices also contribute to make transport costs in SSA the highest in the world, so that rural products have difficulty reaching world markets competitively and industrial goods are expensive to reach the hinterlands – leaving rural households with unfavourable price relations and little choice of goods and services (United Nations Economic and Social Council – Economic Commission for Africa [UN ECA], 2009). Transport absorbs about 20 per cent of Africa's final energy consumption (International Renewable Energy Agency [IRENA], 2011).

Another macroeconomic aspect of SSA weak energy systems is that they almost exclusively rely on imported oil, with even the crude oil-exporting countries importing most of their refined oil products. SSA countries are highly dependent on oil for their total primary (modern) energy consumption (ESMAP 2005) so the higher oil prices of recent years have caused large economic shocks – especially for the poorer fragile economies without own oil and mineral resources (IEA 2004 in FAO, 2007; Energy Sector Management Assistance Programme [SMAP], 2005). The expected decline of global fossil fuels and climate change will put additional pressure on SSA energy systems.

Increasing SSA's basic energy provision is crucial for development yet would only slightly increase the region's share of global GHG emissions (World Bank, 2009). A carbon-neutral solution is clearly preferable in light of climate change – provided that it is not too costly in terms of reducing energy poverty and boosting economic growth.

Bioenergy is a suitable form of energy for many situations in SSA (UNEP, 2012) for several reasons. In Africa today, traditional biofuels (wood and charcoal) provide more than half of the final energy use, and up to more than 90 per cent in poor SSA countries. Biomass will remain the most important energy source until 2050 (IRENA, 2011). For cooking in particular, in rural areas, wood is used and in urban areas, charcoal. Bioenergy carriers can be stored so they are much easier to handle than other renewable energies that require sophisticated grid and off-grid management. A wide range of semi-sophisticated technologies for bioenergy could be manufactured with the limited means of SSA industries, thereby reducing technology imports and the need for foreign currency. These devices are also easier to maintain than most other renewable-energy technologies. Finally, bioenergy, particularly biofuels, is very flexible and can be used for heating, cooking, electricity and especially for transport. SVO and biodiesel are highly suitable for water pumps and mechanizing land-use and post-harvest operations. Bioenergy is particularly appropriate for rural areas that are off-grid and, with the very high cost of constructing grids, will remain so for a long time to come.

However, much of the biomass that is used is not sustainably produced and degrades the land and biosphere. Transforming biomass into modern forms could boost efficiency and allow greater energy consumption without using more natural resources. Inclusion in modern, commercial value chains could create an entry point for more sustainable production by introducing better technologies and improving better control because formal markets are easier to regulate (World Bank, 2011).

Africa's potential for producing sustainable bioenergy is huge. The continent has the lowest population densities and vast amounts of under-used (not *un*-used) lands. The Bioenergy Task Force for 2040 of the International Energy Agency (IEA) estimated Africa's potential at between 317 and 410 exajoules (EJs) (Smeets, Faaij, Lewandowski, & Turkenburg, 2007), which is approaching the whole world's primary energy consumption of 450 EJs in 2007 (World Energy Council in Gueye 2008). Other estimates are much more conservative but often only assess particular forms of bioenergy. For instance the German Advisory Council on Global Change estimated that, according to four scenarios, only 5 to 14 EJs (12 to15 per cent of global bioenergy potential) of liquid biofuels could be sustainably produced in SSA from special energy grasses and trees (WBGU, 2008). Other authors arrive at very different conclusions (IRENA, 2011). These huge variations result from the different models, assumptions and especially landmasses used in the calculations (in some cases, entire countries are excluded). For instance, the WBGU (2008) not only excluded all areas with forests, wildlife or other ecological value (which many other studies also exclude), but also does not factor in many politically unstable countries or productivity increases on cropland, and is reluctant to convert grassland into cropland – which drastically reduces the potential. Many factors must, thus, be considered in order to realistically assess the potential supply of bioenergy: alternative land use; limitations due to biotic and abiotic factors, especially water; limitations in extracting biological material to maintain soil fertility; synergies in cropping systems including improved rotations, fertilization levels, manure production and recycling; the integration of livestock, technical progress, transport costs, the costs for and prices of alternative agricultural crops and energies; and many others (Berndes, Hoogwijk, & van den Broek, 2003). Yet any comparison of the current and projected demand and bioenergy's appropriateness for SSA shows that its potential is far from being exploited.

Carriers of bioenergy (fuels) in solid, liquid or gaseous forms also provide trade opportunities. Currently, only 0.2 per cent of the fuelwood used worldwide is traded internationally, although the international trade of processed and solid fuels such as pellets is increasing (WBGU, 2008). For the time being, also most liquid biofuels are consumed domestically. Currently only 10 per cent of all ethanol and 12 per cent of all biodiesel is traded internationally (ibid.). Brazil is the main exporter of ethanol (from sugarcane); Malaysia and Indonesia dominate the global trade of biodiesel (made from palm oil). The RSA is the largest African exporter of biofuels, mainly sugarcane-based ethanol, although it has no real comparative advantage for biofuels (ibid.). However, many other land-abundant agriculture-based countries in SSA, such as Mozambique, Tanzania, Zambia and Angola, do enjoy a comparative advantage.

The European Union (EU) could become an important trade destination for African biofuels. Almost all SSA countries benefit from privileged tariff-free quota-free access to the European market under the Everything-But-Arms (EBA) initiative for Least Developed Countries (LDCs) and most of the other countries under interim Economic Partnership Agreements (EPAs). At the same time, the EU has created a high demand for liquid biofuels through its Renewable Energy Directive of 2009 imposing up to 10 per cent renewable energy in transport fuels until 2020. It stipulates a number of sustainability criteria (GHG emissions, biodiversity and land-use effects, etc.; European Union [EU], 2009). However, biofuels GHG related, ecological and social standards have been increasingly sharpened within the EU. On one hand, the evolution of standards leads to the creation of standardized bioenergy carriers, which are needed to overcome political barriers to being imported and could also improve and assure positive local effects; on the other hand, improved ecological and social standards lead to higher trading costs and are difficult for African producers, particularly smallholders, to guarantee and certify. But except for some types of solid biomass, biofuels require fewer of the sanitary and phytosanitary standards that hamper the trade of many other agricultural products from Africa. For a review of trade issues regarding bioenergy see Junginger, van Dam, Zarrilli, Mohamed, Marchal, & Faaij (2011).

SSA could also benefit from global climate policies by making use of funding mechanisms, for example, the Clean Development Mechanism (CDM) for carbon offsets including through using biofuels. While this possibility exists in theory, hardly any CDM projects have been accredited in SSA up to now. Instead, most CDM projects go to the large emerging powers, especially China, probably because they anticipate high administrative hurdles and are aware of the low absorptive capacities for CDM rules in Africa (Desanker, 2005; UNEP, 2008).

Since we examine the particular risks regarding bioenergy later in this study for the case of Namibia, we only mentioned them briefly here for the entire continent, without providing a larger review of the literature (see IRENA, 2011; UNEP, 2012):

The wide range of technologies that are used to produce bioenergy in industrialized and emerging countries are largely unknown in SSA. While any technology must be adapted to local conditions, in SSA there is little empirical knowledge that could be used to make the best decisions about production. Within individual countries in SSA, conditions vary substantially with respect to the ecological, economic, social and political conditions, beginning with the fundamental question of available and producible feedstock. Technologies must be adapted, taking into account available skills and knowledge – simplifying them to involve large parts of the population, massively scaling-up local skills or creating larger projects under the control of specialized actors (e.g. FDI). SSA countries are often not big and wealthy enough to develop their own technologies, markets and regulations, and must depend on external forces to introduce bioenergy and related issues such as technology, business models, policies, standards, and capital.

Some approaches developed elsewhere in industrialised countries are simply not applicable in SSA. There is hardly any fixed energy infrastructure (electricity grids or gas pipelines), which is very costly to build in the rural areas where most people live. Sophisticated network regulation ('smart grids') is wishful thinking.

Realizing SSA's bioenergy potentials also poses many non-technical problems. Most of the economic sub-sectors and policy fields that are important for developing bioenergy, such as energy markets, agriculture, food security, natural resources, environment, science and technology, are currently underdeveloped. Of course, more general factors – political instability, low state capacities, the lack of an enabling environment, low investment security, the high costs of doing business and the lack of local skills and capacities – contribute to low economic performance in SSA, and not just in the bioenergy sector.

At present, most bioenergy is produced traditionally by collecting wood, cutting trees and producing charcoal in the familiar, inefficient ways. Poor forest use and inadequate reforestation often contribute to deforestation, loss of biodiversity and land degradation. Agriculture is mainly executed without restoring soil fertility, resulting in severe soil mining. Despite expectations that entry into formal markets will encourage adherence to environmental standards, modern bioenergy risks being produced in similar unsustainable ways.

Africa has particular problems regarding food production and food security, which could well be exacerbated through the increased production of bioenergy feedstock. Insecure land titles, insufficient land regulation and the absence of the rule of law raise the risk that profitable production processes will contribute to concentrate land in the hands of wealthy (national and foreign) investors, driving small farmers off their lands, causing even more poverty, food insecurity and inequality.

In summary, bioenergy does have potential in SSA and could help SSA to sustainably increase its energy supply and income. However, this potential is accompanied by a long list of risks and handicaps. This calls for policies to shape, support and regulate the emerging bioenergy sectors. A number of African countries have already created biofuel or bioenergy policies or introduced them in broader energy policies (COMPETE, 2009). However, these attempts have yet to succeed, perhaps partly because of the complexities. In addition, creating proper regulation of the ecological and social issues involved in bioenergy production does not guarantee implementation, since governance in SSA is particularly weak. SSA governance weaknesses and resource constraints hamper the execution of consistent policies and long-term strategies not only for bioenergy. Bioenergy production is always site specific. This compounds the general technical, economic, political and social challenges listed above, making it hard to generalize about the potentials and limitations of biofuel production in Africa, and how policies and institutions must be shaped to guide sustainable and inhibit unsustainable production. The size and complexity of the (potential) bioenergy sectors is faced by a wide lack of empirical investigations about what exactly is required to support and regulate them.

This study aims to help fill this gap by analysing specific cases as well as deriving policy recommendations to help support modern pro-developmental bioenergy sectors in SSA. Special attention is given to the most important concerns surrounding bioenergy – food security and rural development.

1.2 Research objectives

The overarching research question of this study is:

What form should national policies and institutions take to support the development of inclusive and sustainable bioenergy production in SSA?

Several sub-questions are linked to this main question. Which factors explain why bioenergy technologies have made so little progress? Are the risks seen as being too high, or is it hard to seize opportunities? Which factors can and must be changed? Which policy fields are concerned? Is the political and institutional framework insufficiently developed, or has it not been implemented? Which actors must be involved? What international issues are connected to national policies (markets, policies, regulations and incentives)? How can potential negative implications and risks be mitigated or avoided?

Special attention is given to rural development and food security since these are the most relevant topics concerning bioenergy development in SSA. These issues are multi-dimensional in nature; they also partially overlap. In contrast, the issues of national energy security, urban energy consumers and macroeconomic growth that might be affected if a massive shift towards bioenergy took place are rather neglected. But in SSA, unlike in industrialized countries, these are not the main concerns.

Very few SSA countries have policies regarding modern bioenergy, much less bioenergy sectors that are operational. In most cases, only bits of legislation exist, along with a few implementations and isolated pilot projects and investments, usually in their early phases. Thus there are no international comparative databases for a quantitative cross-country assessment, and there are few comprehensive empirical studies about the political and institutional issues of bioenergy in Africa. Full-fledged impact assessments hardly exist. Given the lack of comprehensive study objects, as well as the complexity and site-specificity of the issues, we used an explorative approach for a given country, examining all the potential areas of concern in an open and iterative way. We chose to look at one country – Namibia – where two commodities and their energy value chains are considered promising by national stakeholders: Jatropha and invader bush.

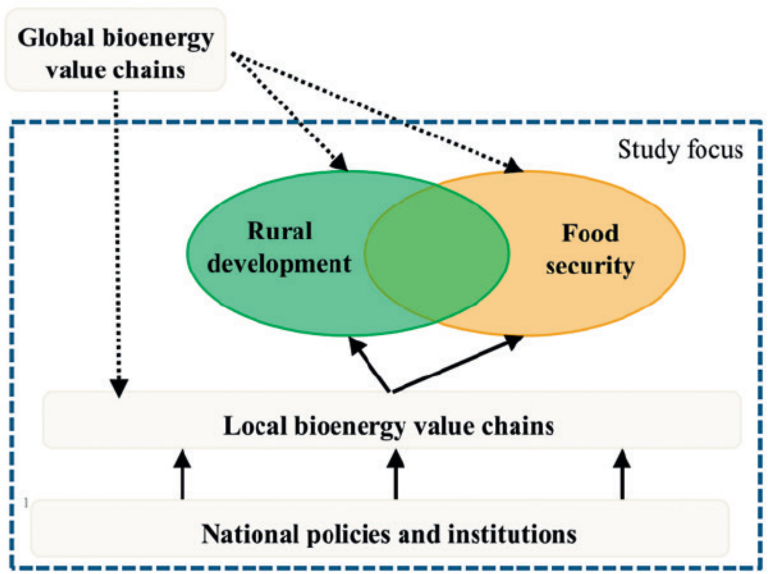
1.3 The structure of the study

Chapter 2 describes the theoretical and empirical approach taken to answer the main research question. Chapter 3 is devoted to the contextual issues – rural development, food security and energy in Namibia – that are relevant for the value chains analysed. An assessment of the viability and developmental effects of the two value chains follows – Chapter 4 on bush-to-energy and Chapter 5 on Jatropha-to-biodiesel. Chapter 6 discusses key policy and institutional challenges for Namibia and Chapter 7 presents major recommendations for eight policy fields: food security, rural development, agriculture, labour, land, environment, bioenergy output markets and policy coordination.

2 The conceptual framework and methodology

As elaborated in Chapter 1, a conceptual framework for guiding the development of national policies and institutions to support inclusive and sustainable bioenergy production in SSA must combine: i) identifying the main obstacles to bioenergy in SSA in terms of profitability and sustainability; ii) assessing the opportunities and risks of producing domestic bioenergy and using it to alleviate local/national poverty, increase food security and boost rural development; and iii) assessing the policies and institutions needed to support and regulate bioenergy and its effects on rural development and food security. The study's focus is depicted in Figure 1. International bioenergy markets and global effects of national bioenergy production have not been included, aside from how they influence local value chains through technological spillovers or standards and regulations.

Figure 1: The focus: National policies and institutions used to steer the implementation of bioenergy value chains and their effect on rural development and food security



Source: Authors

Since bioenergy production is very heterogeneous and few empirical investigations have been made of it, the framework should be flexible enough to allow for a wide variety of production methods and unexpected issues. The framework should also take into account the highly heterogeneous effects of bioenergy that are created along the value chains – from production to consumption – and involve a wide variety of actors and people who are passively affected (stakeholders). As policy oriented research, it focuses on policies and formal institutions within the available formal policy space without neglecting basic issues such as available technologies, costs and prices, informal institutions, environmental and international framework conditions, and societal realities that interact with policies and formal institutions . Together, these issues shape the short- and medium-term limits to bioenergy production.

2.1 Basic elements

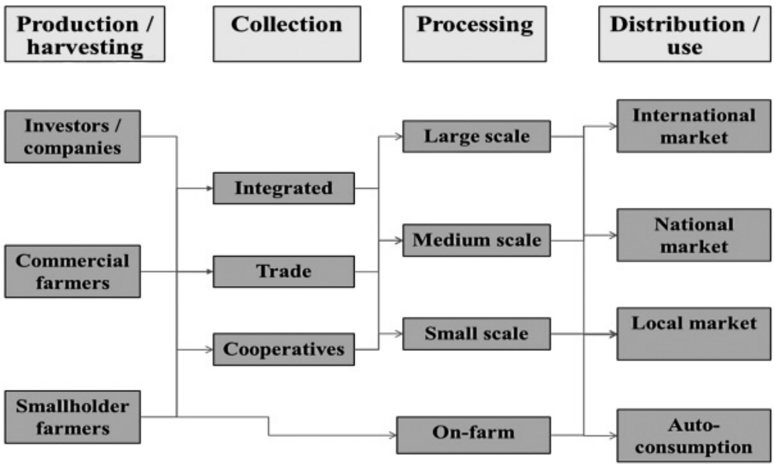
Some key elements of the necessary conceptual framework are specified below since they guide the need for information and the chosen methodology.

2.1.1 Value chain approach and business models

Recognizing bioenergy development as a chain of activities that transforms feedstock into an energy carrier and, through further steps of production and transformation often involving assorted economic actors, into energy, our conceptual framework uses the value chain approach, whereby a 'value chain' is understood as "*the full range of activities which are required to bring a product or service from conception, through the different phases of production […], delivery to final consumers, and final disposal after use*" (Kaplinsky & Morris, 2001, p. 4).

All value chain analysis has a structure of input-output relations (Figure 2) identifying the important functions (production, harvesting, etc.), actors (boxes) and product flows (arrows). In agriculture-based value chains, value chains typically start from various types of farmers (here without their up-stream suppliers). The factors that affect a chain's profitability and the distributional effects within the value chain are: the costs of production and processing; the production factors and their ownership by the various actors; the institutional arrangements of production and exchange; and the larger local and national institutional and political environment. Power relationships along the contractual arrangements of product flows and the externally imposed and internally negotiated rules (institutions) can also be part of value chain analyses. Apart from describing and analysing value chains (e.g. Gereffi, 1994), the value chain and similar concepts have also been used to design interventions in development policy (Mayoux, 2003; Stamm, 2004; Meyer-Stamer & Wältring, 2007; Vermeulen, Woodhil, Proctor, & Delnoyeet, 2008; Deutsche Gesellschaft für Technische Zusammenarbeit [GTZ], 2007a).

Figure 2: Basic variations of bioenergy value chains



Source: Authors

One important aspect of this study is that it distinguishes between 'value chains' that are defined by different outputs and production modes, and 'business models' which specify the types of institutional arrangements within the two selected value chains. The various business models use the same feedstock to produce the same output (value chain), but at substantially different scales, with different actors, technologies and sometimes institutional environments. The need to differentiate them became clearer as we conducted our field research because the various business models can have important ramifications for opportunities and threats, necessary institutions and supporting policies – in some cases, more important than the distinctions of value chains. However, since policy issues are also related to many or all of these business models and value chains, both general and differentiated policies and instruments must be designed. For a similar differentiated view with regard to one value chain but various support models in Indian states, see Altenburg, Dietz, Hahl, Nikolidakis, Rosendahl, & Seelige (2009).

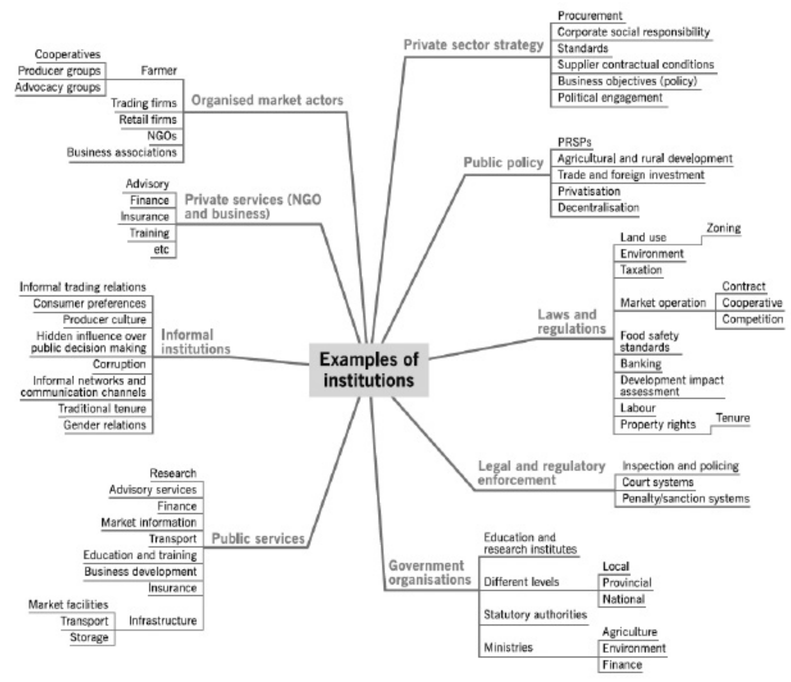
Despite the importance of using the value chain approach, many effects of bioenergy, particularly the most disputed ones such as food security and rural development, are *indirect* effects that happen to people and affect production and the environment outside the value chain. For this reason, the promotion and regulation of bioenergy production must be viewed in a wider context that includes aspects that are not directly linked with the analysed value chains. While this may be unnecessary in a well-regulated industrialized country, in SSA this is not the case since bioenergy production may pose fundamentally new challenges and many aspects are yet un- or underregulated. However, the last years have shown that even in industrialised countries the emergence of strong bioenergy sectors has raised issues that had not been foreseen (on water, biodiversity, food production, GHG emissions, etc.), which has fuelled the emergence of nexus approaches that take such wider linkages more or less systematically into account (Zhang, 2013; Martin & Grossman, 2015).

2.1.2 Institutions and policies

Formal and/or informal institutions are understood to be the rules by which stakeholders act and interact (North, 1990; German & Keeler, 2010). Three issues make it necessary for us to analyse institutions. First, rules of production, transformation, sales and the interactions between actors in value chains determine the production and transactions costs and the incentives to initiate value chain operations (‘economic-efficiency’). Second, in addition to power and resources, rules influence the distribution of costs, benefits and risks among stakeholders and the criteria used to include the poor and disadvantaged in value chains (‘equity’ or ‘pro-poor’) (Eaton & Meijerink, 2007). These are referred to as ‘direct’ or ‘first-round’ developmental effects. Third, institutions influence whether or not broader – ‘indirect’ or ‘second-round’ – developmental effects, will occur (Dorward & Kydd 2005).

Markets and value chains can also be understood as institutional systems (ibid.; Eaton & Meijerink, 2007; Vermeulen et al., 2008). On one hand, they constitute certain institutional arrangements for exchanging resources between actors and groups. On the other hand, markets are determined by other formal (e.g. property rights) and informal (e.g. customary law and traditional land-use rights) institutions, which influence trust among market participants and condition the actors' behaviour. Usually a variety of formal and informal institutions co-exist that frequently complement but also disturb each other. An illustration of the various types of institutions that govern agricultural value chains is shown in Figure 3.

Figure 3: Institutions involved in agri-food markets



Source: Birner (2006) in Vermeulen et al. (2008)

The analytical framework should explicitly acknowledge that in a rural African setting where key steps of the bioenergy value chains are taken, many transactions are at least co-governed by traditional informal institutions. This is not entirely new to the value chain approach, but since it generally is applied to international industrial value chains where formal rules prevail and market power is the main driver of development, it is important to emphasize the significance of traditional informality. Detailed frameworks for analysing institutional influence on value chain functioning and pro-poor development were developed by Vermeulen et al. (2008) and the GTZ (2007a).

As highlighted above, this study assumes that institutions both directly and indirectly involved in the value chain influence the effects of bioenergy value chains. For instance, in poor countries and especially in rural areas, smoothly functioning food markets cannot be taken for granted. The consequences of establishing a local bioenergy value chain will be fundamentally different depending on how the markets work. Furthermore, the reactions of rural producers to bioenergy will greatly depend on how well other parts of their farming systems adapt, which is influenced by their own capacities as well as by public and private services for those parts, and by the institutions and policies that govern these non-bioenergy issues. Adopting this wider perspective means that policies for bioenergy value chains must be embedded in and harmonize with broader strategies for food security and rural and agricultural development.

This study uses these principles to analyse the various levels of institutions that influence a) internal first round and b) external second round issues of the selected value chains and business models. Then it identifies leverage points, which are often key formal institutions established by policies that can frame bioenergy production to positively affect food security and rural development. Informal institutions may be equally or even more important, but they are difficult to influence by policies. Informal institutions, as powerful as they may be, are more difficult to influence from outside. They change much more slowly, tending to follow rather than initiate. International institutions established by agreements or foreign powers and strong price signals induced by policies abroad can also act as leverages, but can hardly be influenced by African policy makers. For these reasons, we accord great attention to formal institutions and public policy.

2.1.3 Food security and rural development

Food security is arguably the most pressing problem in SSA, where about one of three persons suffers from hunger and undernourishment (World Bank, 2007). Food security is a goal in itself – the human right to food. The World Food Summit Plan of Action (1996) defined food security as "*when all people, at all times, have physical, social and economic access to sufficient amounts of safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*" (FAO, 1996). Food security has four pillars: food availability, access, utilization and stability. These abstract concepts are usually translated into more tangible factors such as subsistence production, food markets and prices, income, social security, and so forth. For rural populations who simultaneously produce, sell and buy food and whose markets are less well established than those in urban areas, and who live in places where many activities are indirectly linked to agriculture, the issues can be quite complex, with a given activity (i.e. bioenergy production) producing contradicting effects.

In the following, we examine the literature on the potential influences of bioenergy on food security, and highlight the need to analyse the effects of an important new sub-sector such as bioenergy on food security – not only taking the perspective of food production (i.e. availability) but also looking at other issues (income = economic access, social conflicts, risks, etc.).

Aspects of rural development often overlap with food security issues, yet rural development also brings independent and additional aspects to the front. These are also summarised below as being (potentially) affected by bioenergy.

2.2 Bioenergy value chains, food security and rural development

The effects that bioenergy can have on food security and rural development may be very significant, and they can be both positive and negative (De Castro, 2007; Dubois 2008; World Bank, 2007; FAO, 2008; WBGU, 2008; FAO, 2009). The following section sheds more detailed light on the different aspects.

Food availability

The competition of biofuel and food-crop production for land, water and labour can lead to food shortages. This relation has been mainly discussed for the global level (see above) but less for the local African level where it may be more diverse. When the food markets are small and isolated, as is true in much of rural Africa, reduction of local food production could make food less available. In contrast, that will not happen if food markets are fully integrated and able to counteract any reduction in local production. If, however, SSA bioenergy production can improve access to and use of productivity-enhancing technology, for example, by introducing modern power into agriculture and boosting credit and inputs, the competition between biofuels and food crops even could become synergistic, as shown in some cases of cash-crop production (v. Braun & Kennedy 1986; Maxwell & Fernando, 1989; Brüntrup, 1997; World Bank, 2007).

In addition, many African regions still have under-used land that offers opportunities for improving yields and production without creating strong competition for land. Some bioenergy crops such as Jatropha grow on (and help recover) degraded soils, where they compete less with food-crop production than if they are grown on fertile land that had been used to cultivate food. Processing waste products or rampant plants can also prevent competition for land, while making degraded agricultural land arable again helps to support food production and food availability. However, competition might continue to exist with regard to capital and labour.

Access to food

Food access occurs by producing for one's own use (subsistence production), purchasing at markets or receiving cash or food transfers. When food must be bought, food prices and the purchaser's income are the key determinants of food security of these households.

Bioenergy production can affect both incomes and prices. Various scenarios and stakeholder groups must be distinguished. If bioenergy production does not compromise food production and incomes of producer households raise, these gain food security and nobody else loses. If, however, local food production declines and causes food prices to rise due to imperfect local markets, the situation is more complicated: The bioenergy producers will still gain, but less than in the first scenario. External net food consumers – non-bioenergy farm households that have to spend more for food than they earn from food sales – will suffer from reduced incomes and thus access to food, while the incomes and food access of net-seller farming households (more food sales than purchases) increase.

However, effects can be even more complex. Spillover effects from the modern biofuel value chains might benefit the entire local rural economy in the longer run. Such advantages could result from various linkages such as better cultivation techniques, more mechanization, greater access to financial services, more efficient input and output markets, improved managerial skills and local infrastructure and stronger farmer associations. Second-round effects from production or consumption linkages could stimulate on- and off-farm activities in rural areas and increase access to food. Local use of bioenergy can also contribute to other income-generating activities that could improve education and the provision of health services. It could also make affordable energy accessible in remote areas that are not on energy grids or where the costs of delivering fossil fuels are unaffordable – creating other favourable conditions for the rural economy and improving economic access to food.

The answer to the question which direct effects prevail depends mainly on how income changes are distributed, which in turn depends on the value chain models and production, processing and distribution modes, resource distribution and bargaining powers. For the balance of indirect effects, the distribution of rural households' food production and consumption is a most important factor, followed by the extent and distribution of second-round effects, taxation and redistributive channels from the government to the rural poor.

Utilization of food

The utilization pillar of food security refers to health and nutrition factors, such as food composition and macronutrients (calories, fat and proteins), micronutrients and health-relevant food ingredients, hygiene, contamination, preparation and intra-household distribution. Food utilization can be influenced by such factors as education, income and gender issues, availability and quality of water, as well as customs of preparing food, such as cooking with firewood which is generally assessed as bearing many health risks.

Bioenergy can negatively or positively affect households integrated as producers and/or consumers into a certain value chain, for instance, through their use of biogas for cooking, the variety of goods available in local markets, the effects of modified agricultural and bioenergy production on water use and quality, or women's involvement. Widespread cheap, local bioenergy can transform rural development.

Stability of food

In many African countries, national food production, sales and prices are unstable because of high natural fluctuations and deficiencies of mitigation technologies and capacities such as irrigation, fertilizers and pesticides, as well as low food stocks. The fact that many food products are non-tradable and markets are weakly integrated means that even relatively weak production changes cause great price changes. Rural consumers are particularly vulnerable towards such changes and seek to engage in inefficient yet risk-reducing subsistence production much more than they would under stable conditions. Reduced soil fertility and environmental degradation as well as climate change exacerbate this rural phenomenon of vulnerability towards instability of food availability and access.

Introducing cash crops for bioenergy production could further reduce the production of food for markets and disturb the region's environmental balance and biodiversity. Incentive policies for biofuels can be formulated to make demand rigid, but this exacerbates food price fluctuations. But incentive policies can also lead to more and better production, storage, market integration and stability of biofuels, of income and even of food if positive spillovers exist. Planting cash crops or harvesting bush to recover degraded soils and recovering degraded areas for bioenergy could be good for both the environment and food production. Bioenergy value chains are especially reliable if they are based on perennial and resistant plants or biomass that is abundantly available and sustainably harvested. New employment opportunities for the rural poor help to diversify livelihoods, stabilize household income and enhance food security. The commercialization of agriculture also brings more capital to rural areas that formerly were characterized by subsistence farming – thus increasing security and stability. In the long run, a large and flexible bioenergy market could create lower minimum prices for agricultural products, but increased dependence on global markets increases exposure to market risk.

That political stability is a major factor for food stability is often forgotten. The impacts of bioenergy can be tremendous, both at the local level around large-scale investments and the national level because they can lead to social unrest.

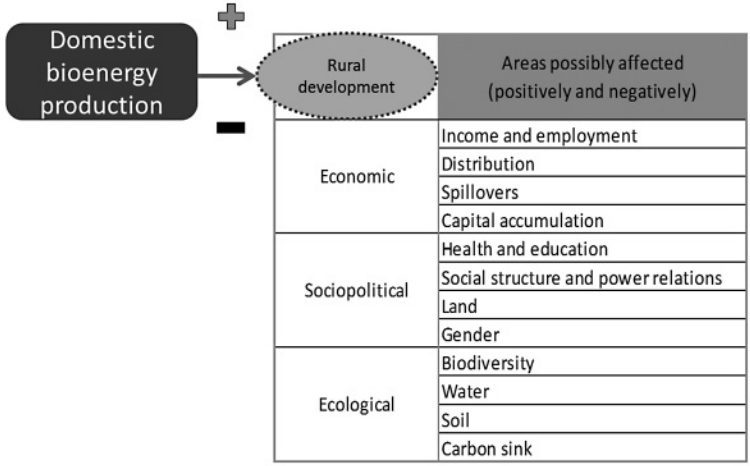
Rural development

Normally, four dimensions are used to define and analyse rural development: ecological, economic, social and political. Despite SSA's rapid urbanization, the vast majority of the population still lives in rural areas (World Bank, 2007) where poverty generally is vaster and deeper than in urban areas. The vast majority of people in rural areas directly or indirectly depend on agriculture for their livelihoods. Low asset bases and low productivity as well as the high volatility of nature and production means that smallholder production often cannot guarantee food security. Stable and sufficient incomes are needed to alleviate poverty. The poor infrastructure, high transaction costs and weak governmental systems outside cities exacerbate individual insufficiencies and account for the pervasiveness of poverty and food insecurity in many rural areas.

At the same time, ecological conditions in rural SSA are often deteriorating critically, with vegetation cover and soils becoming degraded through deforestation, soil mining, overgrazing and other inappropriate human practices (ibid.). Water resources are stressed, and very few crop areas are cultivated using proper technologies. Agriculture is the major user of most natural resources and can seriously degrade the environment. A strong link is often made between poverty as such and the overuse of natural resources – meaning that poverty must be reduced in order to stop and reverse environmental damages and vice versa. This gives rise to the core question regarding agricultural and rural development, "*whether, and how, agricultural growth can be compatible with conservation of the farmland natural resource base and of the commons (the forests, wetlands, and bushlands)*" (Vosti & Reardon, 1997, p. 1). Although the long-term ecological and economic dimensions of rural development are complementary, in the short term they could compete in some areas.

This study views rural development as a systemic and normative concept of the sustainability of rural areas that incorporates the various goals of agricultural growth, natural conservation, poverty reduction and social development that must be balanced to improve rural livelihoods. Important and complex components of rural development related to bioenergy production (WBGU, 2008) are listed in Figure 4. The concept of rural development is a broad framework for classifying issues with a geographic focus. It is not possible to quantitatively weigh the issues because of the different spatial and temporal dimensions, scales and interests of actors and stakeholders.

Figure 4: How local bioenergy production is expected to affect rural development



Source: Authors

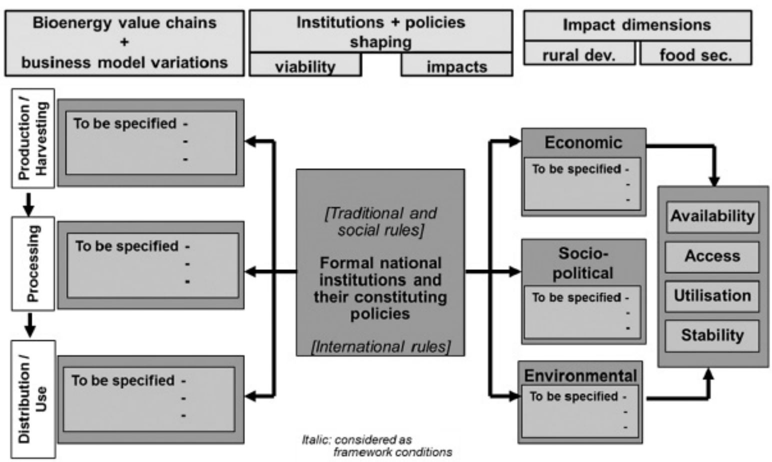
Food security's reverse effect on rural development

Food security is not just a goal that can be influenced by the direct and indirect effects that bioenergy production has on rural development, food prices and poverty; the repercussions of changes to food security should also be mentioned. Greater food security enhances human health and physical and mental capacities, thereby increasing people's ability to work, innovate, earn income, invest, and protect and improve the environment. It can also play an important role in fostering political stability, both locally and nationally (FAO, 1996).

2.3 The conceptual framework for analysing the impact of bioenergy value chains on national food security and rural development, and the role of policies and institutions

This overview of the previous section has shown that a variety of complex causal relationships must be considered when studying the opportunities and threats of bioenergy with regard to rural development and food security. Figure 5 presents a conceptual framework including the elements discussed thus far. The value chain at the left links production, processing and distribution; typical actors at the different levels are shown in the next column. Actors can coexist at any given step of the value chain (e.g. large-scale producers and smallholder suppliers), acting in geographical proximity or in different regions – and potentially modifying a value chain or business model because they follow different rules. The principal types of institutions and policies that affect the activities and actors are shown in the centre. Different effects in terms of food security and rural development arise *within* and *without* the value chain. Institutions and policies, some identical with those that govern the value chains, others distinct and overarching such as policies for food security or strategies for rural development, shape and modify these effects. Environmental issues indirectly affect food security by (de)stabilizing conditions for rural livelihoods, for instance through securing (deteriorating) water resources or preserving (weakening) nature and thereby wildlife or eco-tourism. They also represent values by themselves, particularly if bioenergy production affects wilderness.

Figure 5: Institutional dimensions of the viability and developmental effects of bioenergy value chains



Source: Authors

2.4 Case study selection

To study the problems of bioenergy production in SSA we chose Namibia. With a population of just about two million and a surface area of over 800,000 km², both scientists and policy-makers consider that bioenergy has great potential in Namibia (Interim Bio-Energy Committee, 2006; Metzler, 2006; Leinonen, 2007; Mathews, 2009). Government and private- sector actors are searching for the right ways to realize this potential, while several individual initiatives – some of them very large scale – are being made to establish modern bioenergy in the country. Namibia's governance is good enough to attract many private investors; its level of technological skills and economic performance is higher than in most SSA countries yet still within the range of many other African countries so that lessons from Namibia can be transferred there. Environmental protection is anchored in the constitution and has a sizeable domestic lobby. All this makes Namibia both a pioneer and a realistic role model for other SSA countries.

Our research focused on the two types of bioenergy feedstock in Namibia that were considered to be most promising at the time we were designing this study: i) encroaching woody shrubs (bush) and ii) Jatropha.

i) Encroaching bush covers approximately 26 million hectares (ha) of Namibia, a potential stock for producing energy that could easily satisfy the country's annual needs (GTZ, 2007b; Leinonen, 2007). While bush encroachment is a major environmental and ecological problem (see Chapter 3.1.4 for a more detailed discussion) it can also be seen as a resource for modern bioenergy production. The technologies for using bush for energy that are being considered in Namibia are extending existing charcoal production as well as introducing new value chains – woodgas for electricity and wood briquettes.

ii) In recent years, developing countries have paid a lot of attention to Jatropha because of its promise as a bioenergy crop. A shrub that yields seeds with high oil content, Jatropha is promoted for the production of SVO and biodiesel for transportation, lighting, cooking and mechanization (Heller, 1996; Riedacker & Roy, 1998; Henning, 2000; Jongschaap, Corré, Bindraban, & Brandenburg, 2007). It is often referred to as a 'low-input' crop that needs little water, few nutrients and not much labour (these – misleading – basic assumptions are discussed in Chapter 5), which would make it suitable for arid and semi-arid regions since it does not compete with food production for resources and has fewer negative ecological effects than conventional energy crops. Jatropha has been identified in SSA in general, and in Namibia in particular, as the most promising bioenergy crop (Takavarashara, Uppal, & Hongo, 2005; Interim Bio-Energy Committee, 2006; Metzler, 2006). In some areas of the country, enthusiasm for Jatropha had already waned in 2009 when we were conducting field research, particularly due to frost, which is a real threat to Jatropha. In the frost-free North, however, it continued to be valued for energy production.

Despite the potential to produce bioenergy in Namibia and the numerous initiatives to realize it, there is little to show besides traditional charcoal production. In 2006, a National Bio-oil Energy Roadmap was drafted that set ambitious but hypothetical goals for a bio-oil industry based mainly on Jatropha feedstock. Bush-to-energy technologies were addressed in various policies including land distribution and land degradation, livestock production and poverty reduction. But the strategy had no legal basis, contained major knowledge gaps and its implementation was weak and uneven. No overarching bioenergy policy or coherent supporting mechanisms are in place. Many questions are unanswered, and the government is hesitating to fully implement the strategy and is even – openly or discreetly – blocking certain options. Probably the most important concerns are not issues in the energy sector but rather local and national food security and rural development, as well as ecology. The first country to include protection of the environment in its constitution, Namibia relies more on nature and wildlife tourism than most other countries. Many African countries share Namibia's concerns. Although Namibia is more advanced than most SSA countries, it still lacks knowledge about the opportunities and threats of its bioenergy potential, and how to develop it without unleashing the risks.

2.5 Research design and data collection

After two months of intensively reviewing the relevant literature, we interviewed some 130 experts and key informants in the field over three months (see Table 1; summary and details are in the Annex) and collected mostly project and 'grey' government documents. This study is based on information from interviews, with secondary data to support our arguments.

Table 1: Types und number of interviewees	
Ministries & governmental institutions, Windhoek	22
Ministries & governmental institutions in the Maize Triangle, Kavango and Caprivi regions	13
Donors & international organizations, Windhoek	4
Donors & international organizations in the Maize Triangle, Kavango and Caprivi	2
Universities, research institutions & NGOs, Windhoek	11
Universities, research institutions & NGOs in the Maize Triangle, Kavango and Caprivi	8
Private sector, Windhoek	9
Private sector in the Maize Triangle, Kavango and Caprivi	7
Unions & other institutions, Windhoek	5
Unions & other institutions in the Maize Triangle, Kavango and Caprivi	9
Farmers & farmworkers in the Maize Triangle, Kavango and Caprivi	9
Source: Authors	

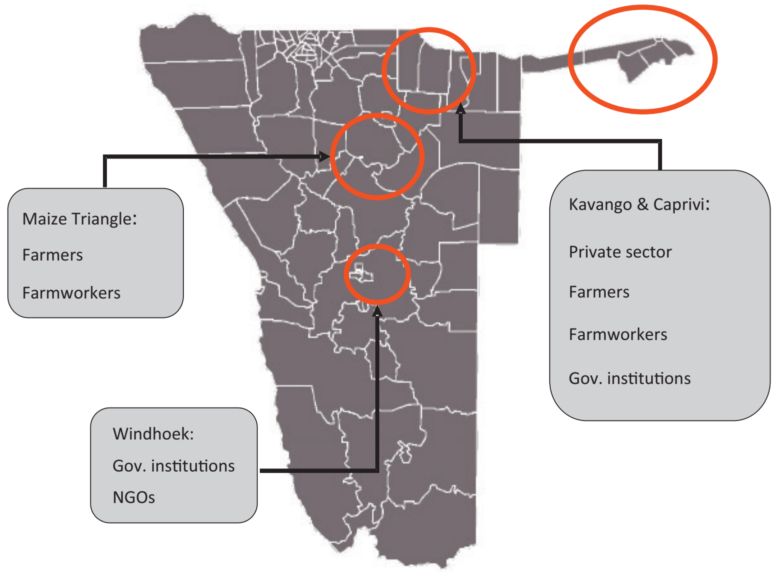
When we conducted our fieldwork only the bush-to-charcoal value chain was fully in place (bush-to-pellets were operational but still in a non-commercial phase and Jatropha had been planted in experimental plots but without proper scientific monitoring and accessible data), so it was not feasible to observe changes and collect 'hard data' such as the yields, prices, costs, benefits and effects of bioenergy. Wherever possible, data from value chains or projects with traits similar to those anticipated in the bioenergy value chains (e.g. cash crops, rural finance, extension or investment projects) were analysed to derive lessons and conclusions for issues regarding bioenergy value chains.

To gather data and select interviewees we used an iterative approach, guided by non-random purposive sampling (Nichols, 1991; Mitchell, Agle, & Wood, 1997). First, single interviews with key bioenergy experts, as well as value chain, policy and other stakeholder representatives, were conducted in Windhoek. In the second phase, extensive field research was conducted in the ‘Maize Triangle’ (see Figure 6) where most bush encroachment and bush-to-energy projects are located, and in the potential Jatropha growing areas (in Kavango and Caprivi). Representatives of the key target groups (farmworkers and smallholder farmers) were interviewed; local and regional traditional and governmental authorities were interviewed in a group or singly (Figure 6; Annex). The third phase involved meeting with other experts and stakeholders in Windhoek. Following each phase’s first wave of interviews, and especially in phase three, snowball techniques were used to identify additional interview partners to help us to fill information gaps and explore new issues.

The interviews were structured around core points about the effects of and obstacles to the bioenergy value chain, as well as reasons for project failures and institutional challenges and experience with various policies. A separate list of questions was written for each (type of) interviewee based on their special knowledge and qualifications; open questions were also used. We cross-checked the information (triangulation: see Chambers, 2000 and Mikkelsen, 2005) to confirm and/or follow up on problem areas. While the initial interviews were guided by our general hypothesis on linkages derived from the literature and our initial understanding of value chains (see above), subsequent interviews were oriented towards collecting information on issues that were unclear or had emerged as interesting, particularly about other institutions and policies. It was not always easy to understand labour laws, forestry and conservation, issues regarding policy coordination and how business models represent a crucial addition to the value-chain concept.

Some aspects of bioenergy production proved to be touchy issues in Namibia (especially regarding the labour conditions of woodworkers in bush-to-energy value chains and issues of land, food security and environment related to Jatropha production), with the perceptions of stakeholders and (other) interviewees sharply contrasting. In such cases, we documented the opposing views without drawing definite conclusions. A final workshop with some 50 stakeholders approved provisional results and further information and assessments.

Figure 6: Map of Namibia with study regions and interview itinerary



Source: Interim Bio-Energy Committee, (2006)

3 Framework conditions for bioenergy value chains in Namibia

This chapter presents factors and data to help to contextualize bioenergy issues in Namibia and guide recommendations for policies and institutions. Namibia's macroeconomic environment, mediocre economic situation, state of rural development and food security, the target populations that are supposed to work in the bioenergy value chains and that would be indirectly affected, as well as competing and complementary activities in the 'livestock' sector (which is the reference for the bush-to-energy value chains) and 'crop' (the reference for the Jatropha value chains) sub-sectors must all be considered in order to: realistically assess the possibility of these types of bioenergy feedstock competing in the rural economy; anticipate likely bottlenecks; understand how bioenergy production might impact on rural development and food security; and identify the kinds of complementary measures needed. Of course, Namibia's national energy situation and policies must also be taken into account.

3.1 An overview

3.1.1 The Namibian economy

In terms of population, Namibia is a small country with only about 2 million inhabitants. But it covers a huge land area of 842,000 km² giving Namibia one of the world's lowest population densities (2.4 inhabitants/km²) (FAO, 2005). The main limitation for agriculture and the country as a whole is water: Namibia has an average precipitation of approximately 270 mm/year (Odendaal, 2006) and is the driest country south of the Sahara Desert. The great temporal and regional variability of rainfall ranges from 20 mm on the coast to more than 700 mm at the eastern end of the Caprivi Strip in the North (Government of Republic of Namibia [GRN], 2006). Namibia has four different climatic zones: 22 per cent of the surface area is 'desert' with less than 100 mm of annual rainfall; 33 per cent is 'arid' with 100 to 300 mm of rainfall; 37 per cent is 'semi-arid' with rainfall between 300 and 500 mm; and 8 per cent is categorized as 'semi-humid' with up to 700 mm of rainfall. Bioenergy is restricted to the latter two zones (see Figures 6, 7 and 12). Nearly two-thirds of the population lives in rural areas, mainly in the North and Northeast.

Namibia is one of the youngest states in the world. It gained independence in 1990, after seven decades as a League of Nations mandate under South Africa which took over from Britain in 1920, which had succeeded the Germans. Remnants of the German colonial and South African apartheid regimes are still found in many areas of social and economic life, including in connection with bioenergy development. Pertinent to this study is the distinction of private and communal land along the 'Red Line' that once separated the white (mainly south of it) and black populations (mainly located north of the line) and since the 1960s has marked the 'veterinary fence', an attempt to isolate outbreaks of foot-and-mouth disease (see Chapter 3.1.5). Other heritages include: the high concentration of white farmers on private property, a marked dependence on the RSA in many areas including education and research, energy and fuel supply, banking and numerous regulations, a relatively strong development of the private sector, and a trade policy formulated within the Southern Africa Customs Union (SACU, including Namibia, the RSA, Swaziland and Lesotho), the oldest tariff union in the world. The extreme disparities in terms of population density, income, education and other issues between the regions and population groups originated before Namibia became independent.

With an annual per-capita income of USD 4,820 in 2008, Namibia is now classified as an upper middle-income country (World Bank, 2012) (on income distribution and poverty see Chapter 3.1.2). Industry and mining are Namibia's main economic sectors and account for about 30 per cent of GDP and over 75 per cent of exports (diamonds, metals and uranium ore). The other principle economic sectors are fisheries, fish and meat processing, and services; agriculture accounts for just 6 per cent of GDP (see Chapter 3.1.3).

These sectoral shares are only partially reflected in the income composition of Namibian households (Table 2). Although salaries and wages are clearly the dominant contributors, in rural areas, agriculture and especially subsistence farming are the most important sources of income. The table underrates the importance of commercial farming for income generation since farmworker wages are subsumed elsewhere (see Chapter 3.2.4).

Table 2: Main household income sources (by region)											
	Salary/wages	Business	Commercial farming	Subsistence farming	Pension	Remittances	Maintenance grants	Drought relief	Other	All households	
										%	Number
Caprivi	32.5	17	0.1	17.8	12.9	10.4	1.3		7.2	100	18,607
Kavango	28.1	12.8	0.2	33.9	11.3	5.7	0.8	0.2	5.9	100	32,354
Namibia	46.4	7.1	0.7	28.9	9.2	4.3	0.6	0.4	1.6	100	371,668
Urban	76.7	10.8	0.1	0.9	4.9	3.7	0.7	0	1.1	100	150,533
Rural	25.7	4.5	1.2	48	12.1	4.7	0.4	0.6	2	100	221,136

Source: National Planning Commission [NPC] (2006). Namibian Household Income & Expenditure Survey 2003/2004

The two main frameworks guiding Namibian developmental policies (National Development Plans, NDPs, which are published every 5 years) are the overarching Poverty Reduction Strategy (PRS) and Vision 2030. The latter was introduced in 1998 (NPC, 1998) and launched in 2004 (NPC, 2004). PRS and Vision 2030 foresee Namibia becoming highly urbanized by 2030 because the agricultural base is considered too weak to adequately support rural development. Rural communities are expected to migrate to cities, with only a minority of the population remaining in the countryside where they will rely on diverse economic activities such as agriculture, tourism, and small and medium-size enterprises.

3.1.2 Poverty and equity

Namibia has a relatively high per-capita gross domestic income (GDI) but one of the world's most unequal income distributions (World Bank, 2008). Its Gini coefficient (a measure of inequality) of 0.6, based on 2003–04 household survey data, represents a decline from even higher levels of 0.7 in the 1990s, shortly after independence (Sherbourne, 2004).

According to the United Nations Development Programme (UNDP) Human Development Report of 2007, Namibia is making progress towards the first MDG of eradicating income poverty (UNDP, 2007). Using a food-share approach to estimate national poverty levels, the National Household Income and Expenditure Survey (NHIES) of 2003–04 showed overall poverty dropping to 32 per cent and severe poverty to 4 per cent, down from 38 and 8 per cent in the 1993–94 national survey (0 compare NPC, 2004; Sherbourne, 2004).[2] However, the food-share approach has been criticized, for instance by Levine and Roberts (2007) and Schmidt (2009). The cost of basic needs (CBN) approach (ibid.) revealed significantly higher poverty rates of 38 per cent for standard poverty and 29 per cent for severe poverty in 2003–04, down from 58 and 47 per cent, respectively, in 1993–94.

Table 3: Human development and poverty indicators (by region)

	Life expectancy		**Literacy**		**Gross enrolment ratio, 6-24 years (%)**		**HDI**		**Income poverty levels (%)**	
	2001	**1991**	**2001**	**1991**	**2001**	**1991**	**2001-04**	**1991-94**	**2003/04**	**1993/94**
Caprivi	41	53	80	66	60	66	0.421	0.441	40	46
Kavango	44	57	72	62	63	66	0.410	0.480	50	71
Namibia	49	61	84	76	66	68	0.557	0.607	32	38
Urban	54	64	94	90	60	63	0.661	0.719	6	17
Rural	46	60	78	69	68	70	0.473	0.530	45	47

Notes: ‘Income poverty levels’ are defined by the National Planning Commission (NPC) as the share of people who spent more than 60 per cent of their household expenditures on food.
Sources: UNDP (2007); Odendaal (2006)

When the definition of poverty is expanded to include other measures of essential human capabilities such as the Human Development Index (HDI),[3]

2 Income poverty in Namibia is officially measured using a food-share ratio with households considered ‘poor’ if more than 60 per cent of their total consumption expenditure is devoted to food, and ‘severely poor’ if this share exceeds 80 per cent.

3 The HDI concentrates on three dimensions: life expectancy, literacy and income (deprivation of longevity, knowledge and standard of living), thereby broadening traditional measures of income (UNDP, 2007).

national poverty appears to have increased (0). Access to basic education has indeed become more equitable and primary health care is more widespread (NPC, 2008). But the 20-per-cent HIV/AIDS prevalence rate (Ministry of Health and Social Services [MHSS], 2004) is one of the main reasons why life expectancy decreased dramatically from 61 years in 1991 to 49 in 2001 (UNDP, 2007). The Namibian government has acknowledged that HIV/AIDS is "*one of the most daunting development challenges facing Namibia today*" (NPC, 2004, p. 31).

According to the food-share approach, rural poverty remained constant at 40 per cent, while the CBN method shows a decrease in rural poverty from 69 to 49 per cent, compared with urban poverty, which dropped from 31 to 17 per cent in the last two decades (Schmidt, 2009). In the same period, the share of urban households increased from 33.8 to 40.5 per cent. Most poor people still live in the rural areas, especially in the North where unemployment rates are very high (45 per cent in rural – compared with 29 per cent in urban – areas) (NPC, 2008). Differences in human development and poverty between regions do not seem to have improved because of the deteriorating conditions in the poorest northern regions (Ohangwena, Kavango and Caprivi) (UNDP, 2007). In terms of education and health care, disparities between urban and rural settings remain large, although they are improving (NPC, 2008).

Key contributors to poverty in Namibia have been identified as lack of wage employment, low productivity in subsistence farming and lack of access to credit and financial services (UNDP, 2004). Despite economic growth of 4.7 per cent per annum in recent years, total employment appears to not have increased (NPC, 2008; Sherbourne, 2009). In 2007, youth unemployment reached 36.7 per cent (NPC, 2008). The persistence of high unemployment is seen as one of the main challenges to national development (Sherbourne, 2009).

The big rural/urban and regional wealth discrepancies are recognized as key and urgent problems: reducing regional disparities has been declared a core objective for national development (UNDP, 2007, p. 7). The Third National Development Plan (NDP 3) for 2007 to 2012 mentions improving education and diversifying income in rural areas, but headway was slow (NPC, 2008). In the short and medium terms, boosting crop cultivation by smallholders is considered an important way to reduce poverty, with special emphasis placed on Namibia's northern regions, where most smallholders live and the most water and highest soil fertility are found. The potential target groups for bioenergy production also live in these areas (see Chapter 3.2). Initiatives to increase production, crop value and productivity in these regions have priority. NDP 3 also stipulated the construction of rural infrastructure, decentralization and diversification of income sources, giving special attention to the needs of rural youth and land-tenure problems – a key issue in bioenergy development (see Chapter 3.1.5). The National Planning Commission (NPC) coordinates the Rural Poverty Reduction Programme (RPRP) whose numerous areas of intervention are funded by the European Commission (EC). The strategy for young people seems to be to empower them by organizing youth groups and developing their skills in horticulture, as well as 'life-skills' training.

3.1.3 Food security

Food security is key for poor people, and subsistence an important means to access food. But in the Namibian context, cash income has an important role to play in securing food even for smallholder farm households. In addition, aside from compensating food deficits from subsistence agriculture, cash is needed for school fees, clothes, clinic bills, daily necessities such as soap and oil, bus fares and one-off events (funerals, weddings and emergencies).

The National Programme for Food Security (NPFS, 2007, p. 7) summarizes:

> *[A]lthough Namibia has a per capita income of about US$2 900; it has severe food insecurity at the household level. The percentage of the population suffering from under-nourishment in Namibia decreased from 34 percent in 1990-92 to 23 percent in 2002-03. The percentage of people that are food insecure is likely to be significantly higher. According to World Food Programme, the number of people receiving food aid over the last 15 years varied between 200 000 (1995) and 600 000 (2003). Households that earn between N$250 and N$350 a month, experience serious food deficit and resort to coping strategies such as own production and bartering and exchange of labour. The people disproportionately affected by food insecurity include smallholder farm communities, the rural landless, communities whose livelihoods depend on herding, fishing or forest resources, and poverty stricken urban dwellers.*

Poverty is aggravated in Namibia by frequent droughts and floods that cause a large part of the population to require regular governmental food aid. In 2003, a drought year, one third of the Namibian population needed humanitarian food assistance (NPC, 2008).

Land degradation from soil erosion, bush encroachment and soil salination have been identified as the principle causes of food insecurity by decreasing agricultural productivity (NPC, 2004). These trends are for their part attributed to overgrazing, excessive land clearing and poor policies and regulations that encourage such inappropriate land-management practices.

Despite progress in production (see Chapter 3.1.4), the national demand for cereals must be strongly supplemented through imports. Between 1995 and 2005, total annual cereal production averaged only 98,800 tonnes, just 36 per cent of national cereal consumption, so that an average of 174,000 tonnes had to be imported each year (Mendelsohn, 2006). In the 2007–08 season, national agricultural production covered 43 and 11 per cent of the domestic demand for maize and wheat, respectively. Dependence on agricultural imports is even greater in the fruits and vegetables sector: in 2007 Namibia imported 77.5 per cent of its domestically consumed produce (Namibian Agronomic Board [NAB], 2009). However, the amount of maize (mostly imported from the RSA) decreased from 95 per cent of total consumption in 1995 to 61 in 2004 as a result of price and trade policies (Bank of Namibia [BON], 2006; see below). Fruit and vegetable self-sufficiency slightly improved as a result of being included in the trade policy scheme. Demand for beef, mutton and pearl millet was almost completely satisfied by domestic production (BoN, 2006). Between domestic production and food imports, food availability in Namibia does not seem to be a national problem.

In contrast, many households have problems accessing food. The 2003–04 NHIES revealed that food accounted for more than 60 per cent (the official 'poverty' level) of total expenditures in 42.3 per cent of rural households and more than 80 per cent (the 'severe poverty' level) of expenditures in 6 per cent of households (NPC, 2006, compare Table 4).

Table 4: Households (by food consumption ratio, region and urban/rural areas)

	Food consumption ratio (%)				Households
	80-100	60-79	40-59	0-39	Number
Caprivi	7.1	36.6	28.8	27.5	18,607
Kavango	8.0	42.4	29.1	20.4	32,354
Namibia	3.9	24.0	27.3	44.9	371,668
Urban	0.6	6.0	18.3	75.0	150,533
Rural	6.1	36.2	33.4	24.3	221,136

Source: NPC (2006)

Namibia's policy on food security remains embedded in its agricultural policy of 1995, in which the Namibian government stated its aim "*to maintain or increase levels of agricultural productivity and to increase real farm incomes and national and household food security*" (Ministry of Agriculture, Water and Rural Development [MAWRD], 1995, p. ii). But Vision 2030 states that "*food self-sufficiency objectives"* are only aims "*to the extent that it is financially rewarding and economically viable to do so. … Food availability will be improved through increasing agricultural productivity and overall production, providing local storage capacity, and by developing competitive import and domestic markets*" (MAWRD, 1995, p. 42). The focus seems to be less on maintaining subsistence farming and more on increasing marketable agricultural productivity (without specifically mentioning staple food crops) as a way of expanding employment in rural areas by focusing on comparative advantages. Examples include the Green Scheme Initiative and efforts to commercialize the livestock sector (Chapter 3.1.4).

NDP 2 (NPC, 2002) covering the years 2002 to 2006 sought to assure food security through raising the productivity of subsistence agriculture, which involves most of the population. But this was unsuccessful. NDP 3 states: "*[T]he lesson is that subsistence agriculture is not an appropriate means to reduce poverty in Namibia*" (NPC, 2008, p. 21).

Vision 2030 (NPC, 2004) more clearly distinguishes between food self-sufficiency and food security and recommends focusing on the latter instead of the former – meaning that each Namibian should have enough to eat whether or not they produce their own food crops or whether their food was produced in Namibia. It places special emphasis on the need to save scarce resources such as water and stresses the trade-off between increased agricultural production and environmental protection. It acknowledges that the country's agricultural base is too low and its agro-climatic conditions do not allow Namibia to become entirely food self-sufficient; crops that use vast amounts of scarce resources (particularly water) should be imported. But it also advises against producing cash crops that do not enhance food security. NDP 3 recommends expanding the livelihoods of rural communities and assuring food security by diversifying and improving agricultural production. Recent government initiatives such as the Green Scheme Initiative have focused on larger commercial farms rather than on subsistence and communal farmers.

In order to create a market for local grain products and storage for food aid, the Namibian government built several silos in the North (AZ online, 2008). Recently, white maize, wheat and (recently) mahangu (a form of pearl millet) were gazetted as 'controlled crops', meaning that import and export barriers as well as floor prices have been established for these crops, and mahangu has a guaranteed market (NAB, 2009). However, most of Namibia's poor are net food buyers who do not necessarily benefit from these measures; in the worst case, they suffer from higher prices.

A new strategic plan of the Ministry of Agriculture, Water and Forestry (MAWF, forthcoming) reiterates the importance of market integration ("*creating and expanding markets*", "*increasing product development*", "*value addition and diversification*") for smallholder farmers, and improving households' access to food.

In summary, the linkage between food security and agriculture in Namibia is not clearly defined. Key documents argue for separating food security and food self-sufficiency. Yet those and other authors find that subsistence agriculture contributes to food security. More significant, however, is the emphasis on achieving food security through broad-based income growth.

3.1.4 Agricultural development

Given Namibia's unfavourable agro-climate with its sandy soil, scant and erratic rainfall and the few rivers that flow all year located only at the borders, agricultural production is generally limited to extensive cattle and small ruminant farming (on about 80 million ha). Rain-fed cropping is limited to the northeast, with some irrigated agriculture found near rivers at the northern and southern borders. Of the total agricultural production in 2004, 76 per cent was in the livestock sector and just 24 per cent in crop cultivation (Mendelsohn, 2006; Supporting Environmental Education in Namibia [SEEN], 2008).

The 'Red Line' or 'veterinary fence' marks the frontier of land ownership and production systems. The history of Namibia's land-tenure system (see above and Chapter 3.1.5) helps to explain why the country's agricultural sector is highly dualistic. Whereas most agriculture in the commercial areas found south of the line is well-developed, capital intensive and commercial (often export-oriented), farming in the communal areas north of the line is low-input, labour-intensive and subsistence-oriented. Of national livestock production, 70 per cent is from commercial areas and just 6 per cent from communal areas (ibid.) – despite the fact that half of Namibia's population lives in the communal areas that have better conditions for agriculture and livestock. Other factors such as lack of education, skills and access to credit and extension services, unclear perspectives for the future and absentee landlords are increasingly affecting productivity systems in the commercial area.

Agriculture's share of national gross domestic product (GDP) is relatively low and decreasing, having dropped from about 12 per cent in the 1990s to its current 6 per cent (OECD, 2009). In the commercial areas, exports of beef, mutton and high-value agricultural goods that exploit niche markets (table grapes and dates) account for 27 per cent of total exports, and livestock for 7 per cent (OECD, 2009; BON, 2006; NPC, 2008); they also significantly contribute to foreign exchange earnings (11.5 per cent of the total in 2004). Apart from low agricultural capacity, other factors responsible for Namibian farming's low performance are: the very high levels of capital and technology in other sectors, particularly mining; undeveloped markets; the low productivity of most communal areas; and the minimal amount of value added through local processing (Mendelsohn, 2006).

Yet the farming sector is high relevant for Namibia, considering that it remains the largest land user and employer (see Table 2). Farming in Namibia (including livestock) uses 78 per cent of the total landmass and employs 1.2 million people or 206,000 households (Mendelsohn, 2006). Agriculture also affects most Namibians' ecosystem services, for instance, it accounts for more than 70 per cent of the water used (NPC, 2004). In 2004, agriculture's share of the national labour force was 27 per cent, down from 49 per cent in 1990 (BoN, 2006). In communal areas, 60 to 70 per cent of the population practises agro-pastoral subsistence farming (NPC, 2004)[4] while having additional income sources. Even if larger shares of their food requirements derive from purchases, they still consider themselves farmers. How rural householders view themselves as farmers probably will have important repercussions for Namibia's agriculture and bioenergy policy by hindering a more commercial approach to land use (see Chapters 3.1.5 and 6).

The Bank of Namibia (BoN, 2006) identifies various constraints that prevent the agricultural sector reaching its full production potential: fewer marketable animals, the lack of markets for some products and the lack of economies of scale, high input and transport costs, lack of finance, climatic and weather conditions and producers scattered over large distances which makes it costly to service them. The bank also identified several agricultural crops with definite potential, including vegetables, fruits and Jatropha. It estimates that NAD 885.9 million (about USD 80 million) would be needed to realize that potential. The BoN acknowledges public support for accessing credit and input and output markets and notes that several governmental initiatives have been fostered but do not cover the broad need.

NDP 3 suggests increasing both crop and livestock production in a sustainable manner (NPC, 2008). The MAWF's strategic plan for the period from 2008–09 to 2012–13 terms "*Renew*[ing] *National Agricultural Policy*" as an important initiative for the near future (MAWF, forthcoming). The ministry also plans to improve the legal and regulatory frameworks for agricultural development by coordinating all stakeholders. Its strategic plan foresees the creation of various councils and institutes to take charge of woodlands, seeds, agricultural research, agro-chemical regulations, bush utilization, capacity building for farmers, and so forth.

4 NPC (2006; see Table 3) presents the much lower figure of 28.9 per cent that is dependent on subsistence farming, down from 34.7 per cent in 1993–94. The main income of 106,145 of rural households – 48 per cent of all rural households – came from subsistence farming (Sherbourne, 2009, p. 73).

3.1.4.1 The livestock sub-sector and the role of bush encroachment

Namibia's dominant form of farming is extensive livestock farming. Livestock production on freehold cattle ranches in commercial areas supports approximately 11,000 households or 47,000 people (Mendelsohn, 2006). In communal areas, most livestock is traditionally reared in low-input, unfenced systems by a large number of agro-pastoralists. Both before and after independence, in these areas Namibian governments fenced off cattle ranches between 1,000 and 8,000 ha for larger-scale commercial production. According to Mendelsohn (2006), 5,500 households and 35,000 people in communal areas are associated with this new system of farming.

Although the Interim Economic Partnership Agreement allows commercial farmers to export unlimited numbers of cattle and meat to the EU market tax and quota free under the interim Economic Partnership Agreement, the recurrence of foot-and-mouth disease in Namibia bars communal cattle farmers from entering this lucrative market. Attempts to control quarantine and feed-lot stations to rid the North of the disease have had only minimal success because of difficulties in management and control.

In recent decades, severe bush encroachment has become a major obstacle to livestock activities in large areas of savannahs with medium to high rainfall (De Klerk, 2004) with the annual economic loss estimated at more than NAD 700 million (ibid.; Southern African Development Community [SADC], 2006; Hager, Schultz, & van Oertzen, 2008). The BoN (2006) assumes that bush encroachment is one reason why Namibia was unable to fulfil its quota to export 13,000 tonnes of meat duty-free to the EU ahead of the EPA, and thereby lost export revenues. Bush encroachment also negatively affects biodiversity, efficient water use and underground water tables (ibid.) and is therefore classified as a form of desertification. Vision 2030 cites bush encroachment as one of the main causes for the decline in agricultural production and the decrease in food security, which induces migration, rapid urbanization and a greater need for the government to import food (NPC, 2004). More recently, the Namibian government set the goal of reducing the encroached areas from 26 to 22.1 million ha (NPC, 2008; wrote the Draft Bush Encroachment Management Policy cited in Hager et al. (2008) and began to promote the restoration of degraded land through the sustainable utilization of unwanted bush (NPC, 2008). Most of these options are bush-to-energy activities.

3.1.4.2 The crop sub-sector

Only areas with an average annual rainfall exceeding 400 mm – 34 per cent of the country's landmass or 28 million ha – are considered to be usable at the margin for rain-fed agriculture and just 820,000 ha (1 per cent of Namibia's total land area) are said to have high potential for crop production (National Drought Task Force, 1997). Irrigated agriculture is limited to areas with access to water sources (frontier rivers and groundwater) and appropriate soil.

Mahangu, maize and sorghum are the dominant rain-fed cereals grown as staples in Namibia; maize and wheat are cultivated on irrigated commercial farms. In communal areas, mahangu is the dominant dryland cereal crop (mainly in the Central North, Kavango and Caprivi regions) and is the traditional staple food crop for subsistence farmers. Well adapted to local conditions, mahangu can be stored for up to five years (NAB, 2009). For climatic reasons, maize and sorghum are limited to the northern communal areas, apart from a small but significant area of commercial maize production in the Maize Triangle east of Etosha National Park (see Figure 6).

After independence, the Agronomic Industry Act of 1992 delegated market promotion and regulatory powers to the Namibian Agronomic Board (NAB) "*to promote the agronomic industry and to facilitate the production, processing, storage and marketing of controlled products in Namibia*" (GRN, 1992a, Article 9). The NAB's role is to regulate the production and importation of gazetted crops, namely maize, wheat and all fresh fruits (except for table grapes that are exported) and since 2008, mahangu, too. A recent complementary initiative is developing regional grain-storage capacities to be able to buy up these products, particularly in communal areas where even in the mentioned regulated markets small farmers have had difficulty selling food. This initiative also creates regional food reserves for emergencies (NAB, 2009) which have become more needed in the wake of the global food-price crisis and the floods of 2009 that affected large parts of the population in the North.[5]

5 In spring 2009, the worst floods in 27 years affected about 600,000 people in northern Namibia. Some 82,000 people needed food assistance until the next harvest; 20,000 people lost a total of 49,000 ha of crops, while about 9,000 livestock died (Mail & Guardian Online, 2009).

An important approach to developing irrigation-crop agriculture to promote agricultural growth, smallholder market integration and overall food self-sufficiency, as well as to reduce poverty, is the Green Scheme Initiative, initiated in the 1990s and relaunched in 2003 and 2008 (Mendelsohn, 2006; GTZ, 2006). This initiative seeks to assist smallholder farmers by linking them to professional service providers who cultivate and provide services such as water supply and other inputs, output distribution and marketing to smallholders on half of the irrigable land and cultivate the remaining land. The crops include vegetables, wheat, maize and more recently, mahangu. These farming complexes – intended for a total area of more than 3,200 ha, with over 6,000 jobs – are located along the Okavango and Zambezi Rivers (Fiebiger, Behmanesh, Dreuße, Huhn, Schnabel, & Weber, 2010). Only a few have already been established. Although supposedly there is no direct competition for water (yet), the scheme has been criticized for using scarce water resources for relatively low-value crops, which conflicts with recommendations in the highest-level policy documents (e.g. Vision 2030). Another critique concerns the high (public and private) costs: NAD 1.4 billion over five years, or NAD 250,000 per job (Donhauser, 2007).

Namibia's crop strategy was relatively successful, at least with respect to the production of commercial staple crops. Some estimates put the total production increase at 96,370 tonnes in 2004 – up from 34,629 tonnes in 1996 (BoN, 2006). The NAB estimated mahangu commercialization of 37,279 tonnes for the 2007–08 season and the total marketed amount of white maize, the main commercial crop, at 55,597 tonnes in 2004, up from only 5,361 tonnes in 1995–96 (ibid.). In 2008, maize was grown on 764,034 ha of dryland in the Maize Triangle and communal areas, and on 4,205 ha of irrigated land in communal areas (NAB, 2009). In Namibia wheat is only grown commercially on irrigated land. Domestic production increased 89 per cent in 2008 – to 14,915 tonnes of wheat on 2,734 ha, up from 6,000 tonnes in 1994–95. But Namibia remains highly dependent on wheat imports.

The National Horticulture Development Initiative (NHDI) is another initiative to boost domestic production of high-value vegetables and fresh fruits because domestic production satisfied just 5 per cent of Namibia's horticultural consumption. The RSA is blamed for having systematically increased Namibia's dependence on it for horticulture by neglecting research, extension and other support measures in Namibia. Local employment is to be enhanced (currently some 2,000 full time employees cultivate 2,000 ha) (NAB, 2009) and in the long run, export markets are also envisaged. Another 50,000 ha of undeveloped land could potentially be diverted from perennial rivers to irrigate horticulture. A major challenge for local producers is to enter markets where much larger South African producers already benefit from efficient marketing and distribution systems (Fiebiger et al., 2010).

Further diversification of crop production is constrained by Namibia's tough natural conditions. Cotton is considered to be an option since its drought-resistant characteristics make it suitable for Namibia's semi-arid regions. The Permanent Secretary of MAWF created a 'Cotton Task Team' in the early 2000s and according to the NAB (2009), cotton was produced on 262 ha under dryland conditions in 2006. But the absence of any cotton ginning capacity in Namibia was a major handicap: raw cotton had to be shipped to the RSA for treatment. Low prices for raw cotton caused farmers to lose interest in cultivating cotton; raising the prices could rekindle their enthusiasm. Jatropha has also been identified as a crop that could enhance the agricultural sector but it has rather low value per hectare compared with other agricultural options.

3.1.5 Policies for land ownership and use, and community-based natural resources management

Land issues in Namibia influence all agricultural and bioenergy activities. Despite agriculture's relative macroeconomic insignificance, land policy is highly political (Werner, 2003; Legal Assistance Committee [LAC], 2005; Fuller, 2006; Mendelsohn, 2008).The Ministry of Lands and Resettlement (MLR), is responsible for land issues. Since independence, reform policies and initiatives have sought to redress past injustices regarding land ownership and access. However, early experience has shown that redistribution easily leads to the creation of economically unsustainable farms and a sharp drop in productivity. Land policy must strike a delicate balance between several objectives. In addition to land redistribution, there are other problems of land tenure, such as those linked to communal property rights that affect bioenergy production.

From an ownership perspective, land available in Namibia for agricultural production can be divided into three broad tenure categories: 'commercial' farmland with freehold tenure, communal areas, and state land that also includes conservation areas (Odendaal, 2006). The dualism of communal versus commercial land tenure dates back to the territory's first land policy that was implemented in 1892 by the German Colonial Authority. It first introduced the 'Red Line' – a massive fence stretched over 1,000 kilometres – to prevent *rinderpest* spreading south, but soon it became the physical divide of the colonial and native populations and land ownership. In 1962, the Odendaal Commission consolidated the South African apartheid policy of 'separate development' by establishing 'homeland' reserves in the northern areas. Since Namibia gained independence, tribal names have been replaced by neutral regional names, some boundaries were changed and migration rules abolished, but in essence, the present communal areas in the North are the former 'homelands' (ibid.).

Historical injustices account for the large inequalities regarding land ownership in Namibia today. Less than 10 per cent of the country's population (4,422 white and 324 black commercial farmers) live on 5,124 privately owned farms with an average size of 5,700 ha that collectively make up 44 per cent of Namibia's total land surface (SEEN, 2008). In contrast, some 65 per cent of the population – and up to 95 per cent of the country's farmers – live in the unsurveyed and unfenced communal areas in the North – a mere 41 per cent of Namibia's total land area (NPC, 2004). The remaining 15 per cent is 'state land', found mainly in the west of the country, which is leased for diamond mining or set aside as a national park.

After independence, the Namibian government embarked on two complementary approaches regarding the redistribution of private lands:

The Commercial (Agricultural) Land Reform Act of 1995 provides for land acquisition through the MLR. The Affirmative Action Loan Scheme (AALS) helps disadvantaged Namibians to buy freehold farms with governmental loans. The aim of the reform is to

> *contribute to the alleviation of poverty in Namibia by empowering more citizens with land or access to land, and by providing beneficiaries with the necessary attributes to use the land to generate a sustainable and meaningful livelihood* (Ministry of Lands Resettlement [MLR], 2007, p. vii).

The AALS programme has proven to be popular, supporting the purchase of more than 660 farms that constitute some 10 per cent of the land available in freehold areas (Fuller, 2006). However, by design the AALS has a limited indirect effect on poverty alleviation because it only benefits poorer farmers by freeing up communal land (Sherbourne, 2004). Perhaps worse, uncertainties regarding white farmers' land (and new laws on wages and working and living conditions), along with the low productivity of farms that were created through the land reform, have led to fewer investments being made in commercial farms and farmworkers being made redundant (Int. Commercial Farmer, Int. NAB).

The National Resettlement Programme has redistributed more land, albeit in smaller plots, than the AALS. 'Resettlement' involves purchasing large commercial farms on a 'willing seller, willing buyer' basis and partitioning them for medium-scale farmers. In 2003, when the pace of land redistribution was deemed unsatisfactory and political pressure was mounting, the possibility of expropriating commercial farmland was introduced, governed by procedures laid out in the 1995 Resettlement Act and the constitution. Despite public outcry to the decision, very few of the 150 farms purchased for the programme were expropriated (Fuller, 2006).

Some 9.5 million ha of freehold land was targeted for acquisition and redistribution between 2000 and 2006. But in 2004 only 45 per cent of this target had been reached – 4.3 million ha for 2,151 families (NPC, 2004).

Issues of land ownership, administration and use are fundamentally different in communal areas. The state formally owns the land that it delegates to traditional authorities (TAs) and the civic administration. Local residents can acquire permanent land-use rights – customary exclusive rights to plots that are used for crop cultivation and residential purposes, foraging or grazing rights for livestock on commonages, or formal leaseholds for businesses such as tourist lodges and designated large farm units.

Apart from government-protected natural reserves and the towns of Rundu and Katima Mulilo, all land in the Kavango and Caprivi regions is communal. Caprivi and Kavango are subject to the TAs' *de facto* leadership and governance, seconded by communal bodies (compare also Traditional Authorities Act, GRN, 1992b). TAs also play an important national role in managing land and resource use and adjudicating local issues (Mitchell, 2009). Most of the land rights that TAs allocate are customary rights for residential and subsistence farming that are granted on the basis of the individual's relatedness and familiarity with the community, their character and the need to avoid future disputes. Immigrants from other regions must present letters of introduction from their TAs and seek the consent of the chief of the area where they wish to occupy land. Someone who intends to use land for business purposes must discuss the matter with the chief and seek authorization from all TA levels.

Three pieces of policy further specify land issues in the communal areas:

The Regional Councils Act of 1992 mandates regional councils to plan the development of their respective regions (e.g. create plans for land use and regional development). This decentralized approach foresees taking into account specific geographic, physical, social and economic characteristics, as well as central development strategies and policies and coordination with other development projects (International Development Consultancy [IDC], 2001). Councils are comprised of chief regional officers and staff members.

The Communal Land Reform Act of 2002 aimed to improve communal land-tenure systems. It confirms the role of TAs in allocating and administering customary land rights for residential and subsistence farming, and creates new statutory bodies, Communal Land Boards (CLBs). CLBs primarily supervise and ratify the TAs' allocation and cancellation of customary land rights and the registration of rights certificates. With the TA's consent, CLBs may approve two types of tenure: rights under customary rule and leasehold rights. The latter generally cover all situations that fall outside customary allocations of communal land, such as the permission for an agricultural or tourist camping project to occupy. Leaseholds running more than 10 years or exceeding 50 ha must be approved by the MAWF (LAC & Namibian National Farmers Union [NNFU], 2003). CLBs are also authorized to settle land disputes in cooperation with local TAs and can serve as avenues of appeal should someone be unsatisfied with a TA's decision (Fuller, 2006).

However, commercial banks have indicated that neither communal land rights nor the 99-year leasehold obtained by resettlement farmers suffice as collateral for credit (Int. Standard Bank; Int. Agribank). Schemes offered by the Agricultural Bank of Namibia (Agribank) cannot fully compensate for this policy: it too does not recognize communal land titles as collateral (Int. Agribank). Not only do communal farmers thereby lack capital to invest in their lands (for debushing or fencing), they also cannot be sure of fully benefiting from their efforts – so they have no incentive to invest or sustainably manage their areas (Int. NAB, Int. UNAM).

Another central component of land reform in Namibia's communal lands is the MLR's promotion of commercial farming by allocating large plots of land that are considered to be underused to farmers as private leaseholds. This is expected to encourage investment in infrastructure, material and labour inputs, increase land productivity, and provide employment and income opportunities for the rural poor (LAC, 2006). Beyond that, "*[R]eform of land tenure in the communal areas is planned in order to enable the people to gain rights over the land*" (NPC, 2008, p. 321).

Other reforms permit land-use alternatives, especially but not exclusively, in communal areas. Community forests and conservancies are the most developed: they can provide local communities with rights to a variety of natural resources for commercial use and could constitute a model for more integrated community-level environmental and resource management (Permanent Technical Team on Land Reform [PTT], 2005). Similar ideas guided reform of the Water Resources Management Bill that was supported by the Community-Based Natural Resource Management (CBNRM) approach introduced in 1996 "*as a strategy for poverty alleviation*" (NPC, 2008, p. 321).

Although the forestry sector contributes little to Namibia's GDP, it significantly helps community development. Woodlands cover about 20 per cent of Namibia's total land area and savannahs 64 per cent (NPC, 2008). NDP 3 (NPC, 2008) sought to establish and strengthen the 'Woodlands Management Council' and other civil society organizations to manage and sustainably utilize natural resources. A charcoal industry that could export to Europe was viewed as a way of tackling bush encroachment for example (ibid., p. 294). Namibia is a net carbon sink, sequestering an annual total of 1,400 GHG of carbon dioxide (CO2) equivalent. The "*single largest removal agent is an increasing density of indigenous bush species, the so-called invader bush*" (Von Oertzen, 2008, p. 2). Whether or not this could also be a source of income depends on the conditions and interpretations of global climate-change-mitigation agreements (GTZ, 2005b; see Chapter 4).

The main reasons for creating conservancies have been enhancing income from tourism and bringing new sources of income from wildlife to people in communal areas. Conservancies provide an institutional frame for regulating issues related to wildlife and other ecological ecosystem services at the local level, which is crucial for developing ecotourism. Tourism is Namibia's third largest foreign exchange earner, generating 78,000 jobs; in

2007, the number of tourists rose by 11 per cent (OECD, 2009). However, the benefits from tourism are still concentrated in national parks, large private game and wildlife ranches and some cities. Questions remain about whether the proceeds per unit area in conservancies can compare with agricultural activities, and if they are fairly distributed among all members of the community. Equitable distribution is much more difficult to attain in tourism than in agriculture.

Particularly in communal areas, land rights sometimes conflict with land-use management. The MLR, as decision-maker of last resort regarding land allocation, is still waiting for line ministries to come to terms with the above-mentioned issues (Int. MLR, Int. MME). But this lengthy process is complicated by the TAs' semi-autonomy in communal areas: ministries that proceed without their consent often fail. IDC (2001) states that in the Caprivi region, for instance, many projects failed because they were imposed on the Caprivians without TA approval. Yet different ministries have demarcated identical areas in Caprivi as: 'under-used'; a 'conservancy' (Namibian Ministry of Environment and Tourism, MET); 'for small-scale commercial farming' (MAWF); and 'for mining' (Ministry of Mines and Energy, MME). Local farmers are using it for grazing at the same time that investors are approaching TAs with requests for leaseholds for biofuel production. CLB have inadequate funds and supplies – as shown by the shortage of human and material resources and the activities budget. Knowledge and skills are also insufficient (GTZ, 2004). What is more, the CLBs and TAs are polarized: some TAs feel that CLB members are disrespectful and inexperienced and could threaten their standing (Mendelsohn, 2008). Unsettled ownership and land-rights issues cause conflicts, disputes and politicization and hinder formal registration. Political affiliations, border disputes and encroachments by one community onto land held by another community have led TAs to cite technical issues as the reason they object to registration (Int. MLR Rundu, Mendelsohn, 2008).

3.2 The target groups: Smallholder farmers and farmworkers in Caprivi and Kavango

This section describes the livelihoods of the main target groups of this study, the rural poor Namibian stakeholders related to the production and processing stages of potential bioenergy value chains. It provides an overview of the alternatives available to these rural poor whose conditions greatly differ from those elsewhere in Namibia. Background information is needed for properly assessing the effect of Namibia's bioenergy options.

Our target group is the rural population of the Kavango and Caprivi regions in northern Namibia which are viewed as prime locations for Jatropha production (Interim Bioenergy Committee, 2006; NPC, 2006). Bush-to-energy value chains concern not only workers from the Kavango region but also people in the Owambo regions.[6] Some 15 per cent of Namibians live in Kavango (208,441) and Caprivi (86,437),[7] heavily concentrated along the rivers and roads, with 20 per cent of the population living in the regional capitals of Rundu and Katima Mulilo.

Schmidt (2009) uses a CBN approach to show that Kavango is the only region in Namibia where poverty deepened between 1993–94 and 2003–04, while Caprivi was one of the regions where poverty was most strongly alleviated, albeit from a very high (and possibly uncertain) level.

3.2.1 Poverty

Kavango and Caprivi are Namibia's poorest regions. If they were an independent country, it would qualify for LDC status: between 40 and 50 per cent of the population is considered 'poor', and 40 per cent of households suffer from food insecurity (Mendelsohn, 2006; see 0). As in many rural areas in SSA, almost all Kavango and Caprivi households meet their livelihood needs through a dynamic combination of economic activities and resources. Many engage in small-scale dryland agriculture and many own some livestock. But although these are the households' most frequent activities, they may not be the main sources of income. Subsistence farming constitutes the main source of income for only 33.9 per cent of all

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6 The Owambo ('four O') Regions, which account for more than 800,000 people and are very densely populated, are not discussed in detail here. They are *a priori* deemed unsuitable for extensive crops such as Jatropha due to high population and cropping density.

7 Older sources give Caprivi a much larger population. It is exceptional in many ways: for a long time, it was only weakly integrated into the country. The Germans claimed it to access the Zambezi River which was incorrectly assumed to be navigable, then after independence it gained importance because of its bridgehead function with Zimbabwe and Zambia, as well as its agricultural potential and the Trans-Caprivi Highway (IDC, 2001, p. 5), but political conflict made it unsafe. Only since the mid-2000s have separatist tensions eased.

households in Kavango and just 17.8 per cent in Caprivi (see Table 2). Wage employment, cash remittances, pensions and wild natural resources (trees, grasses, fish, nuts, fruits and medicinal plants) are other sources of income whose importance varies according to the area, household age and structure, and so forth. There are also significant seasonal and annual variations in income sources.

3.2.2 Natural resources used for livelihoods

The average farm size in Caprivi is 1.7 ha and in Kavango 1.9 ha (Mendelsohn, 2006). Only about 20 per cent of all cleared land in Kavango and Caprivi is actually cultivated. The rest lies fallow because its fertility declines after only a few years of production. Farmers mainly grow subsistence food products, particularly mahangu, but also drought-resistant sorghum, maize (on floodplains), vegetables and legumes. A typical household also owns around 30 goats and five head of cattle (Mendelsohn, 2006). Crop cultivation usually starts in November, when fields are ploughed and prepared for planting, and ends in July when the mahangu is harvested and threshed. Weeding and harvesting are the most time-consuming tasks. This calendar allows for other activities such as seasonal migration.

The main agricultural inputs are labour (particularly women's) and where available, ox-drawn ploughs. Mechanized and commercial inputs such as fertilizer are hardly used (only 0.25 kg/ha of fertilizer is currently used on arable land; NPC, 2008), irrigation and tractors are little used because of limited availability and cost, lack of credit, markets and farmers' risk aversion (Mendelsohn, 2006, p. 64; Odendaal, 2006; Mendelsohn & Obeid, 2007, p. 44). Despite the considerable efforts of the Namibian government and donors to improve mahangu production by providing improved seeds, fertilizer and ploughing services, yields are only about 300 kg/ha, even lower than 20 years ago (Mendelsohn & Obeid, 2007, p. 8). Surplus grains are sold or processed for sale or in-kind trading (Ashley & LaFranchi, 1997).

However, even in communal areas there are large variations between households and incomes. Fewer than 1 per cent of all households own or have access to as much as 20 ha of cropland and 200 head of cattle Mendelsohn & Obeid, 2007, p. 8). These households hire wage labourers for farmwork or cattle tending and realize comparatively high agricultural productivity. There is also intensive agriculture on small, mostly irrigated, farms that cultivate maize, wheat, vegetables and fruit (Odendaal, 2006).

Most livestock is cattle, with a limited number of goats, sheep, horses and donkeys, although small ruminants are important in some areas. Men traditionally own and are responsible for cattle, and drive draught animals that clear and plough the land. Under communal rules, grazing and water are free to the farmer. Full-time household or hired labour is needed to move cattle in the dry season (Mitchell, 2009). Livestock is kept for many purposes related to subsistence (meat, milk and draught power), social and cultural activities, cash income and savings. Animals are used as gifts or a bride price, and are sold to local markets and the Meat Corporation of Namibia (MeatCo). Animals typically provide 60 per cent of farm income.

For individuals with few agricultural inputs – the poorest households and often those headed by women – as well as for several smaller hunting-and-gathering ethnic groups, collecting activities are very important. Since most households live along the two rivers at the border, fishing is important for subsistence and for cash income. Wood is collected for construction, tool-making or to be sold for fuel. It is assumed that some 3,800 families earn most of their income from producing charcoal (Namibiese Houtskoolprodusente Vereniging, 2009), not just on communal land but also on commercial farms and public land, for example, while clearing strips along public roads. Wild *veld* fruits such as mangetti nuts are a seasonal staple, can supplement diets or be used as medicine and sold for additional income.

3.2.3 Wages and remittances

Many farm households in Kavango and Caprivi rely on wages and salaries as their main sources of cash income, followed by businesses, pensions and remittances (Table 2). Household members earn wage incomes as government employees in schools and clinics or at unskilled jobs like cleaning and cooking. Tourism provides most of the few formal private-sector opportunities and NGOs another few jobs. *Casual labour* such as clearing or ploughing land, building and repairing houses, herding cattle and assisting in shops or selling handicrafts to tourists is also common. Cash payment generally amounts to NAD 5 to 10 per day, but can be as little as NAD 10 per week. Payment may also be in-kind – a bag of maize or a barrel of *tombo*, locally brewed beer.

Seasonal migration to other rural regions, urban centres or neighbouring countries (the RSA or Angola) is a common strategy for diversifying household incomes. The remittances of casual labour in the charcoal industry are a case in point in a study by Dieckmann & Muduva (2011) with about 200 interviewees: 55 per cent of the charcoal workers came from Kavango (see Chapters 3.2.4 and 4). Cash remittances are the main source of income for a minority of Kavangans and additional income for many more (NPC, 2006).

In Namibia, elderly and disabled people and war veterans receive regular non-contributory social pensions that are distributed by a private company for reasons including security, the recipients' lack of bank accounts and corruption. These pensions constitute a key source of income since they were extended to black citizens in 1973 (they were established for whites in 1949). They are the main source of income for 18 per cent of the poorest Namibians, 22 per cent of female-headed households and 25 per cent of all households (NPC, 2006). Mendelsohn (2006) calculates that a typical farming household in the northern communal areas earns less than half through farming than what the annual social pension pays.

3.2.4 Farmworkers

In commercial bioenergy value chains, job creation is hypothesized as a key approach for reducing poverty. Depending on the feedstock and how its production is organized, it could create jobs for farmworkers or for woodworkers. Farmworkers do not have the same working conditions as woodworkers, but since more information is available about them, we use them to illustrate rural Namibians' motivations to work in the bioenergy sector and their conditions of employment.

About 35,000 wage labourers continue to be hired to work full-time on commercial livestock farms (De Klerk, 2004). Most of the farmworkers come from the Kavango and Owambo regions. Farmworkers on white-owned farms often live on the farm and may farm a small plot of land or keep livestock (Karamata, 2006). Male workers are mainly engaged for farmwork while women are employed for household activities (Werner, 2002). Their average age is between 20 and 29 years. The average farmworker earns about NAD 350 per month, with earnings on white-owned farms slightly higher than on black-owned farms.

The Namibian government supports the establishment of labour-intensive industries while the long-term goal is to transform the country into a knowledge-based economy with a highly skilled labour force (see above). The Namibian Labour Act No. 11 of 2007 (GRN 2007) regulates the rights and duties of employers and employees and grants employees enhanced protection and rights. The rights concern: social security regulations; the prohibition of labour hire companies[8]; on-farm food shops (no more than one-third of wages can be given as credit); accommodation (provision of adequate accommodation on agricultural land, including for dependents); minimum remuneration; work hours; leave; termination of employment; and health and safety. Stakeholder negotiations are complicated by Namibia's recent apartheid experience, making the treatment of employees and workers an especially sensitive issue. In addition, the remoteness of the rural areas and generally harsh living conditions, particularly for woodworkers, and the conditions for unskilled labour and informal employment in the agricultural sector compared to urban and mining sector conditions pose social, regulatory and enforcement challenges (Int. Expert; Ministry of Labour and Social Welfare [MLSW], 2007).

Although there is a minimum wage for Namibian farmworkers, in 2005 only slightly more than half of all farm owners had implemented the regulation (Karamata, 2006). In March 2009, a new minimum wage of NAD 2.87 per hour was negotiated in the farm sector, of which at most 35 per cent could be in-kind food payments, with an additional allowance of at least NAD 300 per month if no food is provided.

According to Karamata (2006), less than 40 per cent of all farmworkers are registered with social security. The lack of transport also makes access to food markets and public or private health facilities difficult. Farmworkers have little voice: over 60 per cent of workers know next to nothing about the existence and the purpose of labour unions. The Namibian Farm Workers' Union (NFWU) is their official representative.

8 Some provisions of the Labour Act (namely Section 128, concerning the prohibition of labour hire companies) were being legally challenged. The Supreme Court's decision was pending at the time of our research, but later decided that complete prohibition of labour hire was unconstitutional in Namibia. In 2012, a new labour act accepted labour hire but tried to give strong non-discrimination rights to employees (SAFLII, 2013).

3.2.5 Food consumption and security

Food insecurity is greater in the North than the national average, mainly because of poverty. In Caprivi, 43.6 per cent of the population spends more than 60 per cent of their income on food; in Kavango the figure is 50.4 per cent of the population (NPC, 2006, see Table 4). In 2008, 33 per cent of households in Caprivi and 16 per cent of households in the Central North regions including Kavango were food insecure (FAO & United Nations World Food Programme [WFP], 2009). Irregular floods also periodically create food shocks.

Most agricultural production is for home consumption, with very little sold on the market. Most farms do not produce enough food for the households. On average, only 42 per cent of the region's rural households' cereal was homegrown; 58 per cent of it was bought with cash (NPC, 2006). According to the NHIES, only 20 per cent of Kavango farmers are able to produce enough to satisfy their cereal requirements; 80 per cent use cash to meet some or all of their cereal needs. For many households, income and gathering food in the wild do not suffice: during certain periods they must reduce consumption.

3.3 Energy provision and bioenergy production in Namibia

3.3.1 At the national level

Namibia's total annual energy consumption was around 15 TWh, or 7.5 MWh per capita in 2008 (Von Oertzen, 2008). Energy consumption in Namibia uses a relatively high proportion of the nation's GDP because the country has a low population density and long transport routes and relies on the energy-intensive mining and agricultural industries and imports, especially fuel for transport. Liquid and gaseous fossil fuels account for 60 per cent of national energy consumption, electrical energy 25 per cent and biomass 15 per cent; in 2008, less than 1 per cent came from other sources of renewable energy (ibid.). Approximately 63 per cent of Namibian households use firewood for cooking and heating (NPC, 2008).

Less than one-third of Namibia's total energy supply comes from domestic sources. Energy makes up a large part of foreign currency expenditures, putting great pressure on the country's balance of trade and foreign currency reserves (Von Oertzen, 2008). Namibia imports 100 per cent of its fossil fuel from the RSA (NPC, 2008). Since these are short-term open-market contracts, the local fuel-consuming economy is very vulnerable to currency fluctuations (Von Oertzen, 2008). According to ESMAP (2005), Namibia has been able to reduce its oil vulnerability since 1990 – partly by increasing the share of other energy sources and partly by decoupling economic growth from energy consumption. Between 1990 and 2003, GDP grew more than the total consumption of primary energy.

As for electricity, Namibia's peak demand exceeded 500 MW in mid-2008; its total domestic electricity generation capacity was 387 MW (Von Oertzen, 2008). Almost 50 per cent of Namibia's electricity is imported from the RSA and Zimbabwe (NPC 2008). The power-supply contracts with the RSA date from when the electricity made from coal and nuclear energy in written-off power plants was cheap. Now, however, the RSA has greater energy needs, black-outs and is going to revise its generation capacity (possibly adding renewables), meaning that Namibia might get less energy at higher prices. To improve the situation somewhat, the Caprivi Interconnector recently linked Namibia with Zambia and Zimbabwe. Electricity supply sources in Namibia **include** a coal-fired power station near Windhoek (120 MW), a hydroelectric plant at Ruacana (240 MW), and smaller heavy-fuel-oil powered plants of 24 MW and 3 MW connected to the central grid. The country has a relatively well-developed 16,000-km-long system for transmitting and distributing electricity. One-third of the population is estimated to have grid access, mostly in urban and peri-urban areas (Von Oertzen, 2008).

The electricity market is regulated by the Electricity Control Board (ECB). NamPower, the government-owned generation and transmission utility, provides electricity and manages the national network. Regional Electricity Distributors purchase electricity from NamPower to distribute to final consumers.

Namibia's future energy demand is expected to expand considerably, mainly due to increased demand from the mining sector. Various energy sources are being discussed, including coal, natural gas and off-shore oil, as well as uranium. NDP 3 suggests several additional electricity sources in- and outside Namibia (NPC, 2008). The MME strives to provide all households with access to affordable and appropriate energy supplies and attracting investors is viewed as one way of reaching this goal. The MME also wants to move towards the sustainable use of Namibia's natural resources to produce energy (Joubert, Zimmermann, & Graz, 2009).

The rural population is hardly served by the national electricity grid, with a mere 15 per cent connected, compared with 70 per cent of the urban population (Von Oertzen, 2008). A Rural Electrification Master Plan, completed in 2000 and revised in 2005, identifies the need to develop on- and off-grid infrastructure (Interim Bioenergy Committee, 2006). Furthermore, NDP 2 identified a number of sites for small-scale power generation in rural areas, including 11 for the Caprivi and Kavango regions (NPC, 2008). NDP 3 (NPC, 2008) targets the increase of the electricity supply to rural households from 16 per cent in 2006 to 20 per cent in 2012.

An Off-Grid Energisation Master Plan (OGEMP) was developed in 2007 (CSA, 2007) to roll out off-grid rural electrification. But no incentive schemes have been implemented for off-grid electrification that are easily accessible. In contrast, as the MME stated in its White Paper on Energy Policy, "*[R]ural electrification using the grid is heavily subsidised, while off-grid household electrification using renewable energy is not*" (Kuemmel, 1998, p. 44).

3.3.2 Renewable energies

Namibia's general potential for renewable energy is very high. Its high daily solar radiation of 6 KWh/m² makes generating solar energy very plausible. In addition, on-land wind energy potentials in Namibia are estimated to exceed 100 MW, hydro-electric potentials more than 350 MW, geothermal over 100 MW and wave & tidal energy above 200 MW. Biomass energy for electrification, especially from encroached bush, could exceed 100 MW (Von Oertzen, 2008). Leinonen (2007) calculates Namibia's annual bush-to-energy potential to be 40.8 TWh, exceeding its current energy needs.

In view of these potentials, the renewable energies sector is seen as a major contributor to Namibia's future energy mix. This was emphasized in the White Paper on Energy Policy (Ministry of Mines and Energy [MME], 1998). One goal is securing energy supply through a diversity of reliable (Namibian) sources: The "*government committed itself to promoting the use of renewable sources of energy wherever this is technically feasible and economically viable*" (Kuemmel, 1998, p. 43). NDP 3 (NPC, 2008, p. 54) stated that the outcome envisaged for the renewable energy sub-sector is an "i*ncreased renewable energy use with increased economic and environmental benefits*". One OGEMP activity included in NDP 3 (NPC, 2008) is promoting biogas energy generation using invader bush. However, there are no policies with binding targets for renewable energies, and very limited private investment in Namibia's renewable energies sector – perhaps because of low tariffs, the absence of other incentives and the small domestic industrial base (Von Oertzen, 2008).

As it now stands, highly subsidized conventional diesel prices in Namibia and cheap imported electricity create negative effects for the viability of renewable energy solutions (Int. Solar Age Namibia). Namibian experts agree that feed-in tariffs are currently too low to attract investments (ibid.; Int. Jumbo Charcoal / CSA). Were the Namibian government to increase its tariffs, they could not compete with cheap electricity imports from the RSA, which in turn are not economically sustainable because they are insufficient to renew the energy park. The ECB (Int. Electricity Control Board) opines that South African prices for Namibia will rise in the future.

3.3.3 The National Bio-oil Energy Roadmap

The transport sector's total dependence on fossil fuel imports, as well as rural poverty and the agricultural potentials in the northern communal areas, have stimulated plans to foster a domestic biofuel industry. The most important initiative is the National Bio-Oil Energy Roadmap published by the NAB in August 2006 after an Interim Bio-Energy Committee was established to "*draw up a Roadmap for all decisions, institutional arrangements, international agreements, legislation etc. to create a conducive environment in Namibia to grow and process bio-oil*" (Interim Bioenergy Committee, 2006, p. 6). This document considers that Jatropha has the greatest potential for bio-oil production under dryland conditions in Namibia. The roadmap envisaged approximately 63,000 ha of Jatropha being planted in Namibia by 2013 in order to support an energy-intensive economy. It addresses concerns regarding bio-oil production, such as effects on food security, biodiversity and the eco-tourist economy. The roadmap also touches on the opportunities offered by the CDM.

The possibility of generating energy using lignocellulosic technology was mentioned, but without linking it to the problem of bush encroachment. Since the respective processing technologies were not deemed commercially feasible for the near future, the roadmap left further research on this topic to the Directorate of Forestry (DoF).

The roadmap set four intermediate objectives for advancing bio-oil production, and defined their objectives, activities and milestones as well as responsibilities and timelines:

1. Bi- and multilateral agreements, e.g. the exchange of scientific know-how and technology; arrangements concerning the CDM.

2. Policy environment and policy instruments, e.g. tax incentives and awareness and communication programmes.

3. Management of process, product and market risks, e.g. developing product standards and a feasibility study of potential anchor markets.

4. Technology pathways, e.g. developing best operation practices, training programmes and extension-service delivery systems.

A National Oil Crops for Energy Committee (NOCEC) was established with representatives from six ministries and stakeholders to coordinate the roadmap's implementation (MAWF, n.d.). In 2008, the Namibian government authorized a blend of 5 per cent biodiesel and 95 per cent petroleum diesel (Int. MME), but most other roadmap activities were not carried out until mid-2009. In 2008, the MME, MET and MAWF formed a committee headed by the MME to elaborate the official Namibian position, but studies designed to help the committee to formulate its position also were not made until mid-2009 (Int. MAWF; Int. MME; Int. MET). The reasons for the delay are explored in the following chapters.

4 Bush-to-energy value chains

The first case study looks at three bush-to-energy value chains: bush-to-charcoal, bush-to-woodgas/electricity and bush-to-woodfuel/briquettes. The general problems caused by bush encroachment are described in detail (for economic effects at the national level see Chapter 3.1.4) since they are the main motives to initiate bush-to-fuel value chains.

4.1 The encroachment problem

For Namibia, bush encroachment is a phenomenon of national significance that is defined as "*the invasion and/or thickening of aggressive undesired woody species resulting in an imbalance of the grass-bush ratio, a decrease in biodiversity, and a decrease in carrying capacity and concomitant economic losses*" (De Klerk 2004 cited in Lukomska, 2010, p. 13). Namibia is not the only country thus affected. More than a decade ago, Archer, Schimel, & Holland (1995) reviewed the phenomenon of bush encroachment and concluded that this phenomenon has been transforming savannahs worldwide since the second half of the twentieth century. The scientific community has also recognized that bush thickening is a major economic and ecological problem in many semi-arid parts of the world (Archer, Scifres, Bassham, & Maggio, 1988; Ward, 2005).

In Namibia, approximately 26 million ha of woodland savannahs (almost 50 per cent of the commercial ranching areas and an estimated 6 million ha of communal land) are affected. In Leinonen's (2007) case study at the Cheetah Conservation Fund (CCF; the business model is described in Chapter 4.3.3), between 1,200 and 2,000 bushes per hectare encroached on the test plots.

In Namibia, local species – not exotic ones – cause the problem. The most dominant encroacher species are *Acacia mellifera* (black thorn), *Acacia reficiens* (false umbrella thorn), *Colophospermum mopane* (mopane), *Dichrostachys cinerea* (sickle bush), *Rhigozum trichotomum* (three thorn) and *Terminalia sericea* (silver terminalia) (De Klerk, 2004). Occurrence is strongly correlated to rainfall, with the required quantity differing somewhat for each species. As for the geographical extension of bush encroachment, Epikuro, Grootfontein, Okahandja, Okakarara, Okonjatu, Otavi, Otjinene, Otjituuo, Otjiwarongo, Outjo, Tsumeb and Windhoek fall into the 'very high density' category; 77 per cent of the 'very high density' and 52 per cent of the ‘high density’ areas lie northeast of the Otjiwarongo-Gobabis axis, while most of the ‘medium’ and ‘low’ density areas are to its southwest.

Various theories exist about why bush became a problem in the first place, with representatives of the Namibia Agricultural Union (NAU) identifying excessive control of fires and overgrazing as the main reasons (Metzler, 2006). Brown and Archer (1999) argue that bush encroachment is frequent in areas with only a single layer of soil and where grazing is sporadic and light since fences were built to demarcate rangeland and changed customary herd routes. Vast areas were made impassable for game, so grass seeds were no longer trampled into the soil and the more dominant bush seeds were able to sprout. There are other interpretations such as long-term vegetation cycles. Interviewees confirmed that there is no scientific consensus about the underlying causes.

The major problems caused by bush encroachment in Namibia are:

*Negative ecological effects: A drop in w*ater-use efficiency, increasing artificial droughts, evapotranspiration and water run-off and reducing infiltration, negatively affecting the groundwater table and causing desertification. It also fosters bush thickening and changes biodiversity (De Klerk, 2004).

*Negative economic effects: B*ush encroachment diminishes the land’s carrying capacity. The total number of livestock in Namibia is said to have dropped from 2.5 million in 1958 to 800,000 in 2001, decimating job opportunities and income in the rural agricultural sector (ibid.; Hager et al., 2008). The land’s carrying capacity declined from one large stock unit (LSU)[9] per 10 ha to one LSU per 20 or 30 ha, threatening the sustainability of the beef industry (SADC, 2005). The concomitant economic loss of more than NAD 700 million per year has directly affected the livelihoods of 65,000 households in communal areas and 6,283 commercial farmers and their employees (De Klerk, 2004). Bush removal is costly and often is considered to be too expensive by the individual farmer who does not take into account externalities.

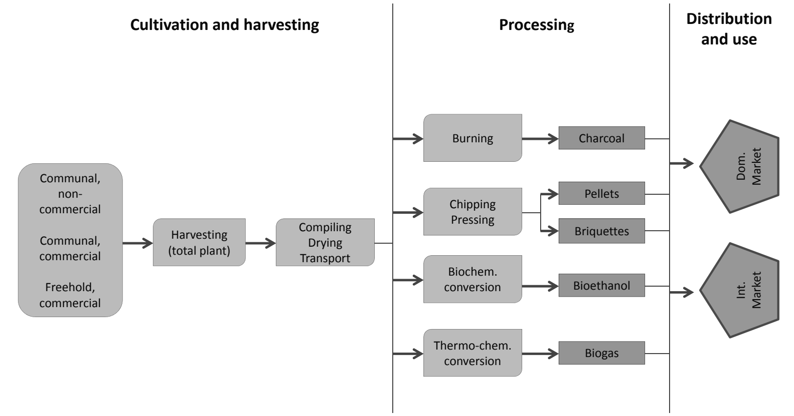
Negative effects on food security: Especially in communal areas, bush encroachment aggravates food security and malnutrition because of the reduction in meat production and the incomes of workers and smallholder farmers (see Chapter 3.1.3).

9 The large stock unit (LSU) is used to convert animals of different species and sizes into one unit in order to calculate livestock density or stocking capacity. One LSU is defined as an animal with a mass of 450 kg.

4.2 An overview

Despite all the problems listed above, bush thickening also presents a number of economic opportunities. SADC (2005) recommends the conversion of bush resources into biomass energy, either on a 'household cooking-fuel level' or a larger scale – to produce electricity, charcoal, wood chip blocks or ethanol. Figure 7 presents the numerous ways to convert bush into various forms of energy carriers, all of which are considered viable by the MET. However, most are not all materializing in Namibia – yet. The following pages describe existing, nascent and yet-to-be-established bush value chains.

Figure 7: Bush value chains



Source: Authors

The descriptions and assessments of economic viability and effects are based on the most established and most prominent value chain: charcoal production. For the others, we describe only what differs since basic issues are quite similar.

4.2.1 Bush production and harvesting

The first steps for cultivating and harvesting differ notably in the bush value chain from that of Jatropha and other agricultural crops. No seeds are needed and there is no cultivation – so questions about varieties and issues regarding seed imports, prices, and so forth are irrelevant, as are agricultural treatments such as fertilizing, and a number of other factors usually considered when talking about 'ordinary' crop cultivation. Producing bush costs nothing (except alternative opportunities) until harvest.

Harvesting is roughly divided into five processes: making strip roads, felling, compiling, drying and transporting by road. First strip roads are built to gain access to bush and facilitate compiling and drying; then the wood and bushes are cut and piled on the strips to dry in order to reduce the plant's moisture content and transport weight so that it can be processed. The harvested yield is approximately several wet tonnes per hectare (with 20 per cent moisture content) – depending on the thickness of the bush. Leinonen (2007) reports harvesting seven tonnes in central Namibia and leaving 10 to 15 per cent in the field.

4.2.2 Processing

In general, biomass from plant matter such as trees, grasses, agricultural crops or biological waste material can be converted for use as solid, liquid or gaseous fuels and can also be used as solid material. Generally, the versatility of biomass makes it the most attractive source of renewable energy. Bush, too, can either be used raw for cooking fuel or be processed into charcoal, coal-fines or wood briquettes, pellets, bioethanol or woodgas. In Namibia, value chains exist for the first four products (at least in embryonic stages) and charcoal is produced on a massive scale, but pellets, bioethanol and woodgas are at most still being studied. Other, non-energetic, uses are feasible or being investigated, for example as raw material for furniture or construction.

Namibia's Biomass Energy Conservation Strategy states that

> *[T]he use of charcoal and briquettes produced from invader bush should be widely promoted to Namibians, especially in communal rural areas, because it would reduce bush encroachment and deforestation and result in a number of other benefits* (cited in Hager et al., 2008, p. 7).

We only explain the processing steps for energy products – charcoal, coal-fines and wood briquettes and biogas.

Charcoal is produced from bush by burning woody shrubs in metal kilns under anærobic conditions, a thermo-chemical process. Heat separates volatile material from woody matter to produce four primary products: gas, various oils, charcoal and charcoal fines. In low-tech processes, the gas is usually lost (compare biogas production in modern gasifiers below). Charcoal produced in low-tech processes has about 60 to 70 per cent of the volume, 10 to 30 per cent of the weight and incorporates about 20 to 40 per cent of the latent total energy of the wood used for its production (FAO, 1999).[10] These rates vary substantially according to the quality and water content of wood and the technology. *Charcoal fines* are the 'crumbs' about five to 20 mm in size left from charcoal production that are collected, bound together with starch and compressed into charcoal briquettes (*briquettes made of fines*). They have about the same caloric value as charcoal but require additional steps of binding and compressing.

To produce *wood briquettes*, harvested bush must first be converted into chips. The woodchips are then hammermilled to 8 mm particle size, dried with hot air and put into an extrusion press that bonds the material together into long logs that are cut into smaller sizes.

Biomass gasification through pyrolysis produces *biogas*. In a pyrolysis gasifier, biomass is exposed to heat that releases the desired gases that are then captured and distilled. The gases can later be used for controlled combustion in a power plant. The waste products left from the pyrolysis and gasification of bush (which amounts to about 5 per cent of the biomass when sophisticated technologies are used) are labeled char-ash or agrichar, which can be used to bind carbon into the soil (Lehmann 2007).

4.2.3 Distribution and use

Only fuelwood, charcoal and – to a much lower degree – briquettes are marketed in Namibia. *Fuelwood* is overwhelmingly used locally only. *Charcoal* has many industrial and domestic uses related to its quality and transport costs, customer income levels and household habits, and much more. Most commercial charcoal made from bush in Namibia is exported to the RSA and European markets (SADC, 2005; Int. Experts) where it is used for *braais* (barbecues) and conventional heating, as well as for fuelling power plants and producing silicium. Namibia's domestic charcoal market

10 Although it loses a lot of energy, charcoal is frequently used instead of wood in many industrial processes and in household cooking. Charcoal's higher energy density by weight and greater end-use efficiency makes it cost less than wood to transport; it burns with almost no smoke; and produces much higher temperatures than wood (Keita, 1987; World Bank, 2011).

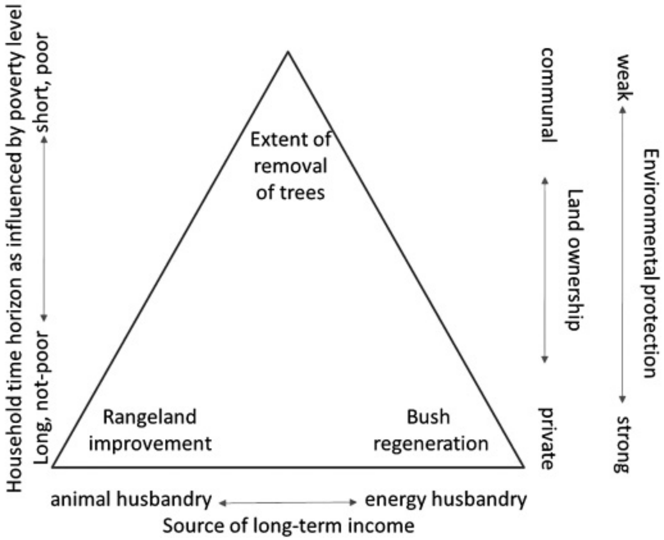
absorbs just a small amount of the total production. *Wood briquettes* are available in Namibia but are mostly sold on the European market.

Woodgas derived from bush clearing was not yet produced at the time of the study. Various technologies for using biogas in homesteads, for transportation and to generate electricity have existed for decades (Wikipedia, 2012); the local wood and processing conditions determine the optimal size and type of technology. During our fieldwork a Desert Research Foundation of Namibia (DRFN) pilot plant was in its planning stage. The idea was to generate electricity in decentralized rural power plants. Electricity can be channelled into local or national grids. The idea of exporting electricity to adjacent markets (e.g. Botswana and Zambia) has been floated but seems unlikely (see Chapter 3.3).

4.3 Assessment of bush-to-energy value chains and business models

Assessing the bush-to-energy value chains is complicated because of the various motivations in addition to earning money, including regaining rangeland or improving the quality of rangeland by planting grass after debushing. The long-term benefits of debushing vary depending on where the bush-to-energy value chains are developed and who owns the natural resources (see Figure 8). When earning short-term income is the main motivation and the debusher cannot count on any long-term benefits, little effort is made to cut down invader bushes and inhibit regrowth. Instead, debushers, in particular for charcoal production, use trees that deliver more and thicker wood and charcoal of higher quality. When reclaiming rangeland is the aim, bush regrowth is prevented by applying herbicides or manual uprooting to assure the growth of grass. For sustainable long-term bush rotation on the same field not all bushes are killed. Bush may also be used as fodder for animals during droughts, mainly in the communal areas (De Klerk, 2004). Thus, although bush encroachment in Namibia is unanimously regarded as a problem, the aim of debushing can be quite different in each case, with different ramifications for costs, technologies, effects and sustainability.

Figure 8: How household characteristics and selected environmental settings determine debushing targets



Source: Authors (2012)

If the main aim is debushing the land, the availability and viability of other options influence a farmer's decision to produce energy or not. Many farmers prefer to spray herbicides because that requires very little labour and almost immediately has an effect. On the other hand, it has high capital costs, does not generate any additional income, is not suitable for all soils, and the negative ecological consequences, particularly from indiscriminate aerial application, can be significant.[11] The practice could also create the fear of negative health effects for consumers and potentially threaten the commercial livestock sector, particularly for high-value organic beef exports – a risk that apparently has not yet been seriously considered (Int.

11 Several experts argue that occasional burning is a typical process in these eco-systems that maintains their equilibrium. Bush encroachment is sometimes said to be a consequence of too successful control of wildfires (see Chapter 3.1.4). In any case, fires destroy the carbon sink. If destruction of bush through fire is accepted as the counterfactual to debushing (in contrast to bush being a permanent phenomenon), this has important consequences for assessing bush-to-energy activities from the perspective of climate-change mitigation (compare Chapter 6.6).

Agricultural Expert). Burning bush could be another low-cost option except that Namibian bush does not always burn easily and is difficult to control when it does burn. Burning also destroys a potential source of income. The cost of land also plays a role: if land prices are low, farmers prefer to rent additional land for their cattle instead of restoring their own rangeland through debushing. Now, however, the land reform process has pushed up prices (Int. Agribank) – so debushing may be more attractive.

From the descriptions above it has become obvious that bush-to-energy value chains are very heterogeneous and closely related to ownership of land and resources and their economic use, in particular animal production. Depending on the combination of ownership and activities, very different business models can emerge, differing on issues such as who owns the natural resources, what debushing is intended to achieve, the species selected and the final density of bushes and trees, as well as the related issues of control and agency (Table 5). Three sources of bush are especially common: commercial farmers on their own land, large specialized charcoal producers on their own and/or leased land, and charcoal producers on communal land. Only on commercial farm land has woodgas and briquette production been established up to now.

Table 5: Bush-to-energy business models in Namibia as related to end products and different land / bush ownership types

		End product		
		Charcoal	**Woodgas**	**Briquettes**
Land ownership	**Communal land**	Communal charcoal producer		
	Farmer's land	Commercial farmer	CBEND pilot project	Environmental NGO pilot project
	Farmer's land and leased land	Large commercial charcoal producer		

Source: Authors (2009)

4.3.1 Charcoal

4.3.1.1 Typical business models and major transactions along the value chain

There are three business models for charcoal production:

1. Smaller commercial farmers, who tend to employ a small number (five to 10) of woodworkers and debush their own land. For some of them, producing charcoal has become a significant part of their work. Debushing is necessary for the long-term survival of cattle farming, and income from charcoal finances debushing and provides additional income to maintain the farm.

2. Farmers on communal land make charcoal, either to diversify their income or as their main source of income. Their business is not about restoring grazing land, but rather using wood to generate income. Communal charcoal producers also pay labourers to debush other people's land.

3. Few commercial farmers have made charcoal their main business. Big producers use additional land from neighbouring farms (mostly for a fee) and employ as many as several hundred charcoal workers. Despite the value of clearing bush to increase the land's carrying capacity[12], it is not common to pay for the debushing service. These farmers' harvesting and production methods resemble those of smaller commercial charcoal producers. In addition to marketing their own produce, they may also buy and commercialise charcoal from smaller commercial or communal producers.

The technology used in the various charcoal business models is fairly similar and there are only slight differences in marketing. The main distinctions are in the motivations, problems from free riders and attitudes towards tree cutting. Therefore, only a generic description of the charcoal value chain is given below, with differences in business models identified where necessary.

In each case, teams of charcoal workers (usually four to eight men) find employment through word-of-mouth in the Damara, Kavango and Ovambo regions. Workers are commonly hired orally as self-employed personnel, not employees.

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12 Leasing additional land for cattle costs about NAD 30 a head, with NAD 15-30 ha needed per head depending on the density of the bush.

Crews cut the bush with axes. Although more advanced technologies to harvest bush, such as motor chain saws or even adapted harvesters, were tested locally, they were abandoned for various technical and management reasons, including the lack of skilled manpower, high costs of repair and small markets that do not justify the development of specialized machines.

The charcoal is sold to one of the few retailers in Namibia, packaged or loose. Jumbo Charcoal, the biggest retailer, purchases about one quarter of Namibia's overall production for Europe and the RSA. Charcoal fines are usually exported to the RSA to be processed into briquettes. Large commercial charcoal producers have regular buyers, whereas small producers often rely on occasional contracts and transport opportunities. Mobile phones have greatly facilitated making arrangements.

Woodworkers are usually organized in teams but paid as individuals. The Namibian Charcoal Producers' Association has agreed with labour unions to pay labourers 40 per cent of the selling price. Whether this agreement is always kept is highly doubtful given woodworkers' lack of information and organization. Large producers and commercial farmers are assumed to adhere more strictly to the rules than communal producers.

Prices (and therefore wages) vary according to the size of the charcoal and the markets. In recent years, selling prices were between NAD 800 and 1,100 (EUR 80 to 110) per tonne of charcoal (exports to a silicium factory in RSA fetched around NAD 1,000 per tonne) compared with Namibian retail prices of NAD 850 per tonne. Charcoal fines cost just NAD 200 a tonne.

So far only the United Kingdom has demanded that charcoal imported from Namibia adhere to the guidelines of the Forest Stewardship Council (FSC).[13] Yet bigger producers who want stable buyers – particularly in overseas markets where private distributors request that charcoal must have been produced in a socially and environmentally sustainable way – tend to have FSC certification. Even if these markets are unstable and do not always absorb all the FSC charcoal, the (usually) higher prices of the CFS part justify the extra costs of certifying buffer quantities although they might end up in African markets which do not require the certificates.

13 The Forest Stewardship Council (FSC) is an independent NGO that promotes responsible management of the world's forests. FSC-certified products are supposed to be produced in ways that do not compromise the social, economic and environmental needs of future generations (see FSC, 2012).

4.3.1.2 Major factors in viability

Labour issues are a major challenge in the charcoal business, with political pressures that force charcoal producers to employ woodworkers under the Labour Act (Chapter 3.2.4). This imperative creates several fears regarding the sector's long-term viability:

- Farmers argued that the Labour Act would make employment too expensive and inflexible, citing the seasonal character of charcoal production: charcoal production declines during the rainy season and many woodworkers only stay for a limited time before returning home to tend their own fields.
- The unions are calling for a fixed wage of NAD 700 per tonne that farmers claimed would make business – with a selling price of NAD 800 to 1,000 per tonne – unviable.

Negotiations have been going on for years between the charcoal producers, unions and government representatives, including the Ministry of Labour (MoL), without any agreement being reached until the time of the research. Lack of communication between stakeholders and their limited understanding hamper the negotiations; commercial farmers criticize, for example, that their negotiating partners know too little about the realities of the charcoal business and its conditions and need to understand their constraints. Indeed, a local research institution has said that the capacities of the unions, namely the NFWU, are weak, both in reaching out to potential union members and in negotiating. Most workers do not even know about the unions. If authorities observe breaches of the labour law, they have recourse to a mechanism to force farmers to comply (Int. Experts), but the law's scope is limited (cf. MLSW, 2007).

In addition to Namibian workers, many farmers also employ foreign workers, mainly Angolans, who are valued for their endurance and hard work. They usually have neither identity cards nor work permits, meaning that they are illegally employed. Some farmers expressed the desire to regulate the Angolans' status. However, the Namibian government is primarily concerned with creating jobs for its own citizens.

The makeup of the labour force is also connected to more practical and even emotional concerns: many commercial farmers do not want to have a large number of foreigners on their land. Strangers are believed to cause insecurity through poaching, causing hygienic problems, setting fires and stealing. Farmers also must act as social arbitrators and assume responsibility for their workers – a burden that many are loath to assume. Many interviewees preferred other, non-labour-intensive methods of fighting bush encroachment.

For the communal charcoal producers, these issues are less obvious. In their areas, charcoal production is seriously handicapped by the communal land-tenure system since those who engage in debushing do not necessarily benefit from the rangeland that is reclaimed. Therefore, those who debush do not clear land to strategically restore rangeland, but rather cut down trees in order to produce charcoal as a stand-alone income-generating activity. Communal authorities lack the capacity to supervise debushing that is in line with the communities' long-term interests and are less motivated to supervise on behalf of the whole community than a single private owner would be. Charcoal producers make more quick gains but get fewer long-term returns on investment.

On the market side, price fluctuations – particularly of non-FSC-certified charcoal – cause great insecurity, especially for small-scale producers who cannot survive periods of low prices by continuing to produce and hoarding as the larger producers do. They meet demand by producing quickly when the prices are high – and have fewer longer-term benefits.

Farmers also mentioned that the lack of financial capital is a constraint to starting a charcoal business. Potential producers suffer from cash-flow problems and indebtedness due to reduced production capacities (partially due to the vicious cycle of droughts and to bush encroachment limiting their income from animal husbandry). Some farmers said that they would like to use bush productively but cannot access capital to begin debushing. In 2008, the Namibian government introduced a subsidized Agribank loan scheme (at 4 per cent interest for debushing with labour-intensive methods). Agribank (Int.) stated that that year they were unable to meet the total demand for special debushing loans, but for unknown reasons, the programme was stopped in early 2009. Accessing credit in communal areas is especially difficult because communal land cannot be used as collateral (see Chapter 3.1.5) and no special Agribank schemes address this need.

The issue of knowledge and skills transfer is particularly relevant for communal areas and emerging farmers. While the latter (usually black farmers) might get support from their white neighbours as well as from governmental support programmes, extension services have not begun to train communal farmers in rangeland management, and focus instead on food-crop production (Int. Agribank). Furthermore, research on bush encroachment is mainly done in commercial areas so in communal areas there is a gap in knowledge about bush encroachment and its control. Finally, when mechanized harvesting is promoted to increase labour productivity, the skills are lacking. Many farmers have even abandoned chain saws since workers do not know how to use and maintain them.

The high fixed costs of inspection make standards and certification a handicap for smaller charcoal producers, who are often pushed into the less attractive local markets, with repercussions for sustainable practices (see next chapter).

4.3.1.3 Developmental effects

The economic effects

Charcoal production's most relevant economic effect is the extra income and employment generated for the target groups. Estimates about producing charcoal from invader bush show that 4.5 times more labour is needed than to simply clear the land without charcoal production (De Klerk, 2004). On average, one worker can produce two to four tonnes of charcoal a month, so with a 40 per cent remuneration share at current selling prices, a charcoal worker receives around NAD 350 to 400 per tonne and earns NAD 700 to 1400 each month, which is much higher than the minimum wage. However, earnings vary considerably between workers, depending on their motivation, strength and tools, as well as the wood species and water content and the weather.

Charcoal mainly creates additional income for poor men from the rural regions of Kavango and Owambo. Small-scale communal farmers can generate additional income by producing and selling charcoal. As woodworkers in commercial areas, their remittances significantly help their families (see Chapter 3.2.3). Charcoal production also helps diversify incomes. The finding by the Labour Resource and Research Institute (LaRRI) that workers on white-owned commercial farms send home 22 per cent of their salaries was approximately confirmed by interviews with woodworkers (Karamata, 2006).

Considering that bush encroachment has become an economic threat to commercial farmers in Namibia, in the long run maintaining and regaining rangeland for livestock production will secure employment and income for farmworkers. For small-scale communal farmers, recovering grazing land would at least mean securing their livestock production.

Charcoal processing and packaging plants foster the area's industrial development, initiate and strengthen forward and backward linkages to other businesses, and create jobs, including for women (while charcoal production itself is hardly done by women). This activity also makes use of the many lorries that serve the northern areas (from Swakopmund, Windhoek and South Africa) and often go back empty.

There are also negative, or at least critical, effects from producing charcoal. Hiring woodworkers as independent contractors has been widely criticized in a country where the economically most important activities, such as mining and tourism, typically belong to the formal sector, and labour unions and formalizing contracts are important. Although people with high production outputs earn more than normal farmworkers who are paid the minimum wage, wages are still low (especially for woodworkers who have to repay loans for their food and tools during the first months) and irregular. Contracts are generally oral agreements for self-employment, and woodworkers are responsible for their own social security with none of the benefits that farmworkers are guaranteed under the Labour Act.[14] Usually a worker's 'independent' status implies that the payment was negotiated with the employer and the contractor has to provide all the equipment. However, here this is not the case: workers are provided the use of kilns with no charge, but they remain the employer's property, while most other tools are bought from the farmer, usually on loan. This means that a worker only starts to earn after repaying the initial expenses – usually after a month or two. Work arrangements are insecure and seasonal; workers are not ensured year-round cash income. At current productivity and wage levels, being a woodworker is no way to escape poverty; for most people it is a second-best, temporary option.

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14 Under the Namibian Labour Act, an agricultural employer has specific obligations regarding social security (registration and payment), the provision of food (no more than 1/3 of the wage can be given as credit in employer-owned food shops), accommodation (adequate accommodation, including for dependents, must be provided), and general obligations concerning minimum basic wages/remuneration, work hours, leave and termination, as well as health and safety (GRN, 2007).

In addition, woodworkers usually work and live in very remote areas, with the nearest villages with commercial activities or social services dozens or even hundreds of kilometres away. That makes woodworkers dependent on farmers for services and goods. Usually food from the farmer's shop, medical expenses and sometimes transport both to and from the farm are deducted from wages. In such situations overpricing and debt traps are a real threat.

The possible introduction of mechanized bush harvesting that is being discussed in the Charcoal Producer's Association (Int. Charcoal Producer's Association) illustrates the trade-offs between productivity and job quality on one hand and employment and poverty alleviation on the other. Harvesting bush mechanically requires only a fraction of the labour for the same area, meaning that employment opportunities for unskilled persons are reduced. The other jobs are highly skilled and well remunerated. If, however, the serious concerns of many farmers concerning labour-intensive manual debushing are overcome and significantly more area is debushed, good jobs and other positive effects could be multiplied.[15] This indicates the precarious balance between the number and quality of jobs that can be influenced by labour legislation (see Chapter 6.4).

The ecological effects

By reversing the negative effects of bush encroachment, whether for charcoal production or other uses, debushing has many positive ecological effects. However, the size of the ecological effects depends on the degree of bush removal. Complete clearing, for example, leads to the loss of soil nutrients, seed production and biodiversity. The usual goal should be thinning bush-infested areas not removing all bush (Joint Presidency Committee [JPC], 2008).

Debushing improves water tables by significantly reducing evapotranspiration from trees. Water is crucial for agriculture and livestock – especially in a drought-prone country like Namibia.

15 A similar debate has been raging in Brazil since the government and the private sector announced that they would abolish manual cane cutting by 2017, making half a million cane cutters redundant while creating fewer – albeit high-quality – jobs in mechanized harvesting and machinery services, and improving air pollution, extraction rates and sugarcane energy efficiency (Rovere, Pereira, & Simoes, 2011).

Mammal biodiversity of species that need browse or dense cover to avoid predators is likely to decrease as a result of extensive bush control. On the other hand, species that must be swift to be able to flee from predators could benefit from clearing. Some predators also benefit from bush clearing: for instance, the CCF deems debushing essential for cheetahs to survive. Over 70 bird species, including several game birds and endemic species, are negatively affected by bush control, while birds with different habitat requirements benefit from clearing. Debushing is likely to increase plant diversity. In any case, the effect for each species is a function of the extent and purpose of the bush-control measures (De Klerk, 2004).

Replacing coal-fired industries with charcoal from invader bush is expected to have positive climatic effects because it is a renewable source. One interviewee mentioned that European companies have, for example, expressed interest in Namibian charcoal using the CDM. Yet destroying invader bush also destroys carbon sinks. No calculations have been made about the total GHG effect of utilizing bush that takes into account regrowth and the replacement of other fuels and materials.

Positive ecological effects can only be expected when bush is utilized sustainably. Inappropriate short-term economic incentives, and problems that result from institutional gaps and inadequate supervision, as well as failure to implement environmental law, can cause adverse effects that far outweigh the positive ones, especially if older and protected trees are felled or bush is completely eradicated. Once charcoal production is allowed in a region, it is difficult to control the legal and illegal origins through road inspections. The huge distances limit on-the-spot inspections by forest authorities. In fact, charcoal production all over the world has negatively affected sustainable forest management (World Bank, 2011). Namibia, too, has had bad experiences with uncontrolled charcoal production, particularly prior to independence (Dieckmann & Muduva, 2011). Low incentives and inadequate controls and sanctions for excessive cutting are especially problematic in communal areas.

The sociopolitical effects

Additional income generally improves the sociopolitical situation of workers. Commercial farmers said that the bulk of woodworkers' income (after food) is spent on health services, school fees, remittances and clothing. This means that their income benefits a broader part of their community and helps to enhance local capabilities. For young adults in Namibia, alcoholism is a severe problem that is linked to unemployment and idleness. Several interviewees mentioned that job creation could help to reduce this problem by giving people tasks and meaning in their lives. Furthermore, formally employed workers benefit from Namibia's social security schemes.

Charcoal mostly provides men with work although some women are employed in charcoal packing. If debushing opens new grazing land in the communal areas, increased cattle herding can enhance social well-being because of the value attached to livestock ownership.

On the other hand, the migration of young men to charcoal production areas also has some negative effects. Most workers cannot move with their families. Generally, HIV/AIDS is transmitted in SSA through migrant workers (United Nations [UN], 2001), which might also be true for charcoal migrant workers, although the risk is higher for migration from rural to urban areas (Ashton et al., 2009). Migration reduces the labour force in communal areas and increases the workload of the rest of the family, especially the women. Woodworkers are exposed to large health risks through low wages, remote locations, extremely harsh working conditions sometimes with no protective clothing and little control by labour inspectors.

The effects on food security

The economic effects regarding access to food are relevant for food security since poor households spend a larger share of their incomes on food (see Chapter 3.1.3, particularly Table 4, and Chapter 3.2.5). Karamata (2006) found that workers on white-owned commercial farms spent over 50 per cent of their wages on food and sent home another 22 per cent. Interviews with woodworkers confirmed this pattern. Accordingly, the additional income from charcoal production can be assumed to positively and significantly affect food access for poor households or migrants from such households.

On the other hand, food availability depends on factors related to market functioning and the broader institutional and economic setting and is not directly influenced by bush-to-energy production; in Namibia, the market seems to work well (see Chapters 2.2, 3.1.3 and 3.2). Increasing carrying capacities in commercial areas through rangeland restoration can also enhance the availability of meat and increase national demand for farmworkers – creating food-security effects similar to those for woodworkers. At the local level, increased cattle production in communal areas positively affects food security. Woodworkers also benefit from in-kind payments such as meat and milk. Workers employed under the Labour Act must be partially paid in-kind.

As to the negative effects, in remote rural areas the charcoal-producing commercial farmer is usually the sole supplier of food, which means that workers must borrow from farm shops and often become heavily indebted to the farm owner. Not only are prices in farm shops higher than market prices because of transport costs, but farmers also sometimes try to make a profit from their food shops. Since cattle production is valued culturally and socially in communal areas, it may not increase the availability of meat at the household or regional levels because producing, buying and selling are not always done in the most economical fashion. When labour capacities in rural areas are reduced because of migration, household food production is compromised.

4.3.2 Woodgas and electricity

4.3.2.1 The value chain

The bush-to-woodgas value chain in Namibia is still in the experimental phase. Funded by an EU anti-poverty-programme grant, the local DRFN has initiated the CBEND pilot project for producing electricity from bush. Potential independent producers have been identified; during our research stay, the tender for the gasifier was being reviewed. The project aims to transform the problem of bush encroachment into an economic opportunity, test the viability of producing electricity from bush while rehabilitating rangeland, and create employment for the unskilled rural labour force. The project thus corresponds to several national goals (see Chapter 3) and propositions from research on bush encroachment and rural development.

The full business model is currently being developed. The plan for each site so far is to manually chop the bush and each week feed about 50 tonnes of dry, chipped woody biomass into a 250-KW-electricity generator. Harvest methods that create bush-regrowth rates of five to eight years are being propagated to ensure the power plant's reliance on the local long-term provision of bush without the need to move the generator after some years (Hager, n.d.). Ultimately, many independent power generators will be built.

The gasifiers will produce electricity non-stop (Int. DRFN), meaning that a connection is needed to feed it into the national grid. Such a gasifier would be a major part of an enterprise to produce electricity from bush, separating debushing and charcoal/electricity production to two independent entrepreneurs seems to be unfeasible under Namibian conditions. Investment costs are considerable as well as managerial requirements to organize the wood supply. It could also be working alongside charcoal production – thereby diversifying income and risk. It is unlikely that a farmer's own land could supply enough biomass for an electricity production plant, even less for a combined electricity/charcoal production, so additional bush would have to be bought.

4.3.2.2 Major factors in viability

There are still a few technical questions to be solved (at the time of our study; in 2013 a study (STEAG, 2013) confirmed the feasibility of the concept and the technology, yet in 2015 more feasibility studies were announced, Namibia Economist, 2015). According to Hager et al. (2008), the gas obtained could be burnt but not used in the combustion engines that power turbines because as it cools it produces condensation water and tars that clog piping and combustion chambers. Other challenges in the gasification process come from the various moisture contents of the different types of bush. The higher the moisture content, the more vapours accumulate, exacerbating the tarring problem. While using charcoal instead of bush biomass could abate the tarring problem bush is much more energy efficient than charcoal (see Chapter 4.2). Possible solutions include a drying process to lower the moisture content in the woody shrubs and procedures to reduce the production and/or effect of tars.

Interviewees expressed doubts about local technical and managerial know-how to run a gasifier plant: there is little expertise on the subject in Namibia and it is especially difficult to attract experts to a rural environment. On the other hand, there is a new generation of young Namibian professionals and not enough formal jobs for them in urban areas. The demand for multifaceted practical know-how and theoretically oriented skilled labour and managers risk being mismatched, however. If commercial farmers with skills and experience in managing rural workers and bushland are to run the units, there will have to be a trade-off between farming capacities and the time needed to manage a gasifier plant. Operating a gasifier could well be a full-time job, meaning that the operator would have less time for cattle farming, thereby contradicting the original goal of enhancing cattle production. Development cooperation and enterprise support from local governments do not suffice to train, service, and possibly finance farmers to run larger businesses.

The challenges for the production and harvesting processes are similar to those described for the charcoal value chain. Since the technology and size of the individual units require a minimum amount of debushing, formal worker arrangements, standardization and mechanization are likely to be needed, so it will also be necessary to develop skills. If the model proves viable and entrepreneurs and skilled managers are found, there might be greater demand for training low-skilled workers to use debushing machinery. However, since some farmers do not want masses of workers on their land (see Chapter 4.3.1), it might be difficult in some locations to secure the minimum amount of bushland around the plant.

The most crucial factor in terms of the output market's economic viability is an appropriate feed-in tariff. The NamPower feed-in tariff is NAD 0.11 per KWh (see Chapter 3.3). An independent power provider, such as a gasification plant, could sell electricity to NamPower or a regional energy distributor (Int. ECB). While the relevant feed-in tariffs for the pilot project have not yet been officially agreed, there are indications that the basis for negotiation will be about four times higher than NamPower's current tariff. Tariffs from six to eight times higher are needed to make the production of renewable energy viable in Namibia according to one interview (Int. REEEI). To replicate the project, the revenue must cover the cost of commercial investments. Not only are tariffs crucial but the financial base of an independent power provider must also be stronger and more stable than that of a subsidized project. Calculations for the CBEND project show it breaking even after 13 years only, quite long for an agro-business investment (Int. DRFN). If the successfully scaled-up production makes bush a valuable resource, triggering a rise in debushing and feedstock prices, the original cost calculations will be too low and, again, higher output (electricity) prices are required to maintain profitability.

4.3.2.3 Developmental effects

The economic, sociopolitical and ecological effects and the effects on food security would resemble those described in the charcoal business model.

One major difference could be that there would be no immediate risk of environmentally harmful tree cutting since unlike charcoal, large pieces of wood are a problem for chippers. Thus, the technology protects to a certain degree against this risk.

4.3.3 Woodfuel briquettes ('Bushblok')

4.3.3.1 Description

The third bio-to-energy value chain and business model analysed in this study is a donor-funded pilot programme carried out by the CCF near Otjiwarongo in central Namibia. CCF was founded in 1990 and is the sole owner of CCF Bush Pty Ltd, an implementing agency that harvests, manufactures and markets wood briquettes for fuel under the 'Bushblok' label. The CCF's primary objective is not producing Bushblok, but rather ensuring the cheetah's long-term survival in Namibia: the CCF designed a habitat improvement programme with donor funding. Worldwide, wild cheetahs are seriously threatened; Namibia is one of the few places where a large population lives outside of natural parks. However, cheetahs in Namibia suffer from bush encroachment that reduces their prey and hinders their hunting, while bush thorns injure their eyes. The CCF is seeking to create a market for high value, emotionally priced biomass products as a way of making habitat-rehabilitation projects economically viable, thus helping to restore the cheetahs' bush-encroached habitat (Cheetah Conservation Fund [CCF], 2009).

The CCF business model (see Leinonen, 2007; CCF, 2009) involves leasing a fairly large (40,000-ha) farm that is heavily encroached by bush, thus of low productivity for cattle rearing. The briquettes production process generally relies on manual labour. A contractor permanently or temporarily employs workers who do not necessarily live on the farm (a bus service is provided). Their work is like harvesting charcoal wood, except that they target smaller trees, while larger trees are exempted. After the bush has dried, five to 12 people go through the strip roads with a tractor hauling a drum wood chipper. The shrubs are manually fed into the chipper and the woodchips are blown into a trailer attached to the chipper. The CCF currently employs about 20 local workers either directly or through a sub-contractor (Int. CCF). The chipper crew is sub-contracted so CCF Bush Pty Ltd buys the bush from them.

In contrast to other business models, the CCF does not convert harvested biomass into the end product on the spot but transports it to a processing factory, located about 45 km from the farm, that produces the briquettes. Contrary to electricity and charcoal, no weigh reduction is realised, the Bushbloks are simply compressed chips. A heavily promoted, special "Cheetah friendly" label makes the transport costs and relatively high price acceptable. FSC certification is integral to the business model. However, the CCF does not want any bush to re-grow (Int. CCF) and poisons most cut bushes because labour-intensive manual uprooting is costly. How the poison affects soil fertility is not yet clear. Up-rooting and use of poison conflict with FSC standards, revealing that global and local concepts of ecological sustainability can be in (partial) contradiction. It is difficult to adjust a global standard like FSC to exceptional local conditions.

The CCF factory produces about 25 containers per year and theoretically has a daily production capacity of 30 tonnes. Thus far, CCF has been producing 6,000 tonnes of FSC-certified wood fuel briquettes annually (Int. CCF). The farm is estimated to have 410,000 tonnes of woody biomass.

Most of the briquettes are destined for the international market, with retailers and organic niche markets the targeted buyers. Bushblok's most promising output markets are considered to be Europe (UK and Germany) and South Africa. These markets are believed to have high potential for products that follow sound environmental and socioeconomic standards and trigger an emotional response at purchase. In Namibia, the CCF sells Bushblok, raw chips for high efficiency chip-burning stoves and logs for *braais*. It sees great potential in the Namibian market because of the extensive use of wood for cooking and heating in rural areas (CCF, 2009). In the short run, however, low market demand for Bushblok (due to its high price and yet low publicity) makes the economic viability of this business model uncertain (Int. CCF).

Running the chipper and transporting both woodchips and workers make up the biggest chunk of overall production costs. Manual harvesting, on the other hand, is comparatively cheap. The general manager estimates an average market price of NAD 850 to 1100 per tonne.

4.3.3.2 Major factors in viability

Low market demand is currently the biggest problem for CCF Bush Pty Ltd. FSC certification was expected to open up a larger (European) market but that has not yet happened. The CCF manager opines that once the right buyer is found, Bushblok will become viable without donor support. Furthermore, plans are being made to move the processing plant to the CCF farm in light of the high costs of transport and rent. That, however, would make some workers redundant and could create negative social effects. Lastly, the CCF cannot deliver industrial level quantities (more than 1,000 containers per year) (Int. CCF), which is what power plants, for instance, would require if they could afford to buy the product. This industrial scenario would require production costs to shrink (possibly viable due to economies of scale) and the positive environmental effects to be marketable for the industry.

The CCF business model manages to attract customers for environmental services related to the final objective of cheetah conservation, which is a global public good. Were the CCF model to become viable, it nevertheless has limited reproducibility. Consumers probably only feel justified paying top prices for briquettes because of the project's exotic conservation targets, the supervising agency's excellent reputation, conscientious production methods and superior standards – FSC certification alone is not enough. This does not call into question the value of the initiative, but puts it into perspective in terms of its potential contribution to rural development and food security on a wider scale.

4.3.3.3 Developmental effects

The economic, sociopolitical and ecological effects of briquettes and its effects on food security resemble those of the charcoal business model, but are generally more positive:

- This value-driven business model is more likely to avoid negative effects and foster positive ones. For instance, an 'eco-friendly' Bushblok package that is burnable, biodegradable, recyclable or has a secondary use is very appealing (CCF, 2009). The management is also very concerned about employment effects.
- If production were to be scaled up for bigger buyers, the CCF would need raw material that would require leasing additional farms or establishing supply chains with other debushers. Functioning input and

retail markets, clear land-tenure arrangements and a good transport infrastructure are vital.

- The risk of environmentally negative tree cutting is very low since not only does the technical process (chipping) not accept large wood pieces, but the company also demands high ecological standards that the NGO is likely to observe. Furthermore, burning Bushbloks is better for the environment than burning wood or charcoal.
- Recalling the CCF's initial aim of supporting the long-term survival of the cheetah and its ecosystem in Namibia, the local community may become more accepting of predators, thus improving human–wildlife relations.

As for negative sociopolitical effects, it can be argued that human–wildlife conflicts might increase assuming that more habitat for the cheetah leads to a larger cheetah population, and more cheetahs lead to more cattle – or even people – being hunted and killed. From a European perspective the situation seems theoretical: environmental activists do not pay even attention to this tragic African reality.

Perhaps the CCF's most important contribution to overall developmental goals is showing that debushing is good for the environment. A general limitation is that the model is not easily reproducible and depends on the support of a competent and reputable sponsoring organization such as the CCF. This dependence creates higher risks of failure – for example through the loss of reputation or withdrawal of the NGO. However, if the business manages to open up the domestic market, helping Bushblok replace firewood (as unlikely as that seems), it could reduce the depletion rate of forest resources.

4.4 Comparison of effects and institutions of bush-to-energy value chains

Table 6 summarizes the findings from the various bush-to-energy value chains and business models. It shows how the three models affect the economic, sociopolitical and ecological dimensions of rural development and food security. Each dimension also includes the most important and visible effects.

Table 6: Bush-to-energy value chain effects – synopsis

Effect	Specification	Charcoal	Woodgas	Briquettes
Economic	Income	• Demand for unskilled labour to debush and produce charcoal, load, unload and pack • Demand for semi-skilled labour along the value chain (truck drivers, supervisors) • Potential demand for semi-skilled labour for mechanized harvesting • More income from restoring rangeland • Remittances to Kavango and O-regions	• Demand for unskilled labour to debush and chip, load, unload and pack • Demand for semi-skilled labour along the value chain (truck drivers, supervisors) • Potential demand for semi-skilled labour for mechanized harvesting • More income from restoring rangeland • Skilled labour needed to operate the plant and related service deliveries • Remittances to Kavango and O-regions • Electricity prices could rise if renewable energy becomes widespread and costs are put on consumers	• Demand for unskilled labour to debush, chip and transport • Demand for semi-skilled and skilled labour in the production factory • Less un- and semi-skilled labour needed than for charcoal and woodgas
	Land	• More leased land might be needed for charcoal production or cattle placement • The ‘problem of the commons’ hinders debushing in communal	• More leased land might be needed to ensure enough feedstock • The ‘problem of the commons’ hinders debushing in communal areas	• No significant changes expected

Table 6 (cont.): Bush-to-energy value chain effects – synopsis

Effect	Specification	Charcoal	Woodgas	Briquettes
Economic	Opportunity costs	• Subsistence farming (labour force debushes instead)	• Subsistence farming (labour force engaged in debushing instead)	• Subsistence farming (labour force engaged in debushing instead)
	Special risks	• Market uncertainty (exchange rate, demand for FSC vs. non-FSC charcoal)	• Economic viability unsure (donor-funded) • High capital costs, especially when scaled up	• Economic viability unsure (donor-funded) • More cheetahs might increase cattle or game loss
Sociopolitical	Health & education	• Increased expenditures on education and health of woodworkers and families, but ongoing problem of access	• Increased expenditures on education and health for woodworkers and families, but ongoing problem of access	• Increased expenditures on education and health, possible access due to proximity to urban area
	Social structure & power relations	• Social problems due to unemployment are reduced • Farmer is more responsible for his workers' belongings • Work opportunities mostly for men; women must stay behind in the rural communal areas	• Social problems due to unemployment are reduced • Farmer is more responsible for his workers' belongings • Work opportunities mostly for men; women must stay behind in the rural communal areas	• Limited social effect given the scale of production and employment generation • Work opportunities mostly for men; women must stay behind in the rural communal areas
Ecological	Biodiversity	• Bush–grassland equilibrium is restored • Protected tree species risk being harvested for economic gain	• Bush–grassland equilibrium is restored • Sustainable harvesting methods are envisaged to establish a regular harvesting cycle. • Risk of complete debushing	• Species that depend on trees (birds) are threatened by possible bush eradication

Table 6 (cont.): Bush-to-energy value chain effects – synopsis

Effect	Specification	Charcoal	Woodgas	Briquettes
Ecological	Water	• Reduced evapotranspiration and restoration of water tables	• Reduced evapotranspiration and restoration of water tables	• Reduced evapotranspiration and restoration of water tables – though less than from charcoal and woodgas
	Soil	• Loss of nutrient supply of woody biomass • Effect mitigated if FSC standards are applied • Aftercare herbicides could harm soil quality	• Loss of nutrient supply of woody biomass • Effect mitigated if FSC standards are applied. • Aftercare herbicides could harm soil quality	• Aftercare herbicides could harm soil quality
	Carbon sink	• Entirely or partly destroys carbon sink with aftercare herbicides	• Partly destroys carbon sink, though partly restores it by revolving 'cultivation' and harvesting	• Partly destroys carbon sink
Food security	Availability	• Increases through farm shops • May decrease if lack of workforce affects production in communal areas	• Increases through farm shops • May decrease if lack of workforce affects production in communal areas	• Increases with kitchen/ restaurant on the farm
	Access	• Limited by low wages and possibly by farmers' limited lending	• Limited by low wages and possibly by farmers' limited lending	• Increased as a result of more cash income
	Stability	• Dependent on farmer's service • Seasonal work	• Dependent on farmer's service • Seasonal work	• No significant changes expected

Source: Authors

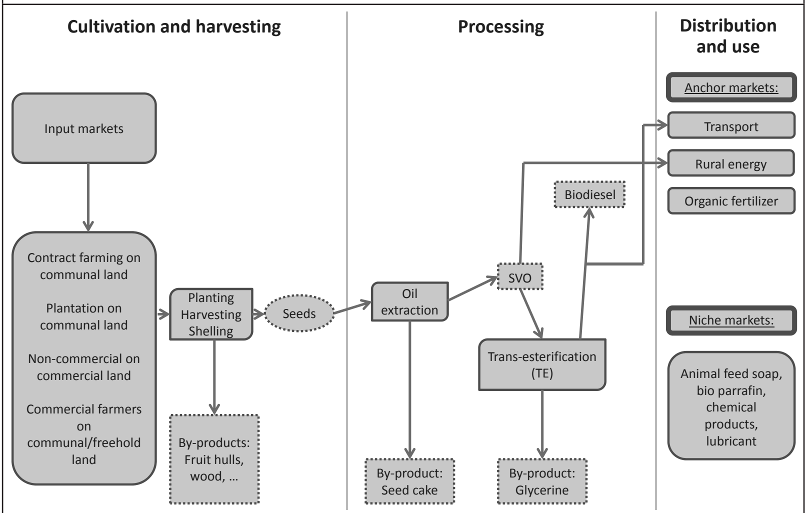
5 The Jatropha-to-biodiesel value chain

Here we describe potential bioenergy value chains in Namibia with respect to business models that are based on Jatropha, and assess their expected effects on development. Mindful of agro-climatic restrictions and imperatives for development that require the careful utilization of scarce resources, the National Bio-oil Energy Roadmap (see Chapter 3.3) identified Jatropha as the most suitable bioenergy crop for Namibia. Since Jatropha can grow on marginal land with little rainfall, it is also said to cause less competition for resources with food production and fewer negative ecological effects than conventional energy crops. We discuss some of the limitations of this initially very optimistic assessment below, but want to emphasise that this study did not endeavour (if only for lack of data) to make an evaluation of these assessments or an economic assessment of the viability of Jatropha production.

5.1 The Jatropha value chain

Figure 9 shows the basic incipient value chain for Jatropha, a small oil-bearing tree from Central America that is found today throughout the

Figure 9: A Jatropha value chain



Source: Authors (2009)

developing world (Henning, 2000). The Jatropha seed's high oil content (25 to 35 per cent) Jatropha and the oil's specific properties make it suitable for the production of biodiesel and SVO for transport, lighting, cooking and mechanization (Jongschaap et al., 2007).

Jatropha projects in Namibia were begun along with the National Bio-oil Energy Roadmap (Interim Bio-Energy Committee, 2006) commissioned by the NAB. Whereas a National Oil Crops for Energy Committee was stablished to coordinate implementation of the National Bio-Oil Energy Roadmap (see Chapter 3.3), the roadmap has not been adopted as policy. The various ministries involved state that development of a Namibian biofuel policy is hampered by questions of food security, land, the global biofuels debate, by whether or not Jatropha is an 'invasive' species, local and national politics and political parties (Int. NAB; Int. MAWF; Int. MET). A moratorium has been placed on Jatropha production until the cabinet committee on biofuels (comprised of the MME, MAWF and MET) has studied the environmental and food-security aspects of Jatropha (Int. MET; Int. DoF).[16]

The next sections will analyse the steps and consider the obstacles and effects of organizing the Jatropha value chain in form of concrete business models.

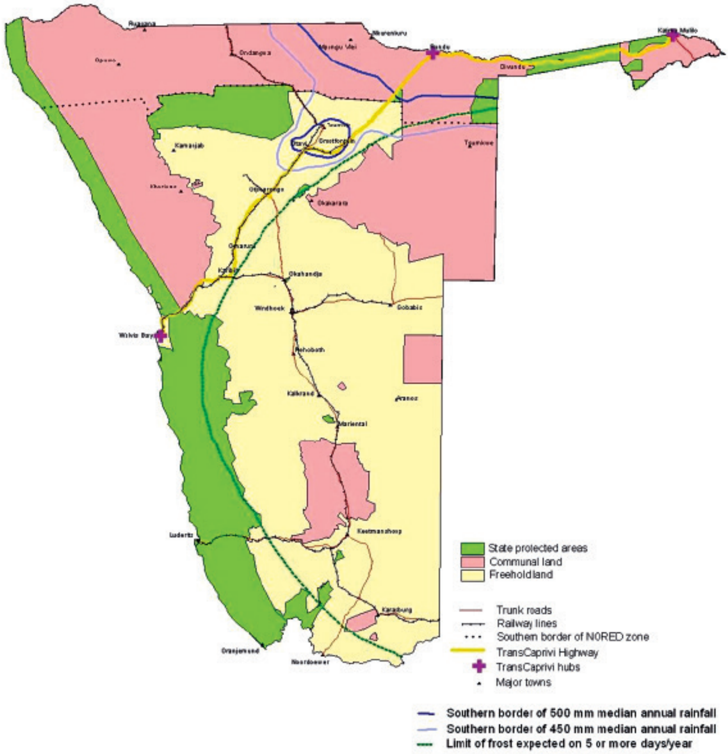
5.1.1 Cultivation and harvesting

Jatropha is often considered a low-input crop that requires little water, nutrients or labour, making it suitable for arid and semi-arid regions. The plant has been promoted for conserving soil and water on marginal, degraded land in various countries (Wiesenhuetter, 2003). However, doubts have recently surfaced about whether these assumptions should be extended to situations where Jatropha is planted to produce high yields of seeds and oil (Jongschaap et al., 2007; Int. Polytechnic). Jatropha can survive with as little as 250 mm annual rainfall (Wiesenhuetter, 2003) but for reasonable production yields a minimum of 450 to 600 mm rainfall per year is required. High yields need even more water and good soil (Henning, 2003). Chemical and organic fertilizers stimulate Jatropha growth (Jongschaap et al., 2007).

16 In June 2011, the government "*banned jatropha biofuel projects in the north east area of the country in both the Caprivi and Kavango regions, until such time as a study can be completed, addressing a number of issues*" (Biofuel Digest, 2011).

Considering Namibia's comparative advantages suggests that the country's scarce water for irrigation should be reserved for high-value production[17]; only rain-fed production is considered rational for Jatropha. In Namibia, suitable rain-fed conditions for Jatropha cultivation are found only in the communal areas of the Kavango and Caprivi regions, and in the commercial farm region of the Maize Triangle (see Figure 10).

Figure 10: Map of Namibia with rainfall and frost borders significant for Jatropha



Source: Interim Bio-Energy Committee (2006)

17 This view would argue against producing maize, which is frequently irrigated in northern Namibia, in the name of food security and more importantly, the lack of good market access for higher-value crops. In the South, irrigating grapes, oranges and other fruits destined for national and international markets is consistent with the assumed comparative advantages.

Since annual oil-seed crops like the sunflower require irrigation or more rainfall, they have not been proposed for Namibia's biodiesel industry (Interim Bio-Energy Committee, 2006), with the possible exception of a few sites that are well suited to sunflower cultivation. Since Jatropha is highly sensitive to frost – at least in the initial growth phase – cultivation in the Maize Triangle appears to have limited potential (Int. Commercial Farmer). Figure 10 shows that suitable ecological conditions coincide mainly with regions with communal land tenure, and to a small extent only with freehold land (Maize Triangle, see Figure 6).

The toxicity of Jatropha and its fruits is said to protect the plant from browsing animals. Traditionally planted as hedge in parts of Caprivi and Kavango, Jatropha protects food crops (Int. MTCT). However, in the Maize Triangle wild animals have been found browsing young Jatropha trees (Int. Commercial Farmer). Crop pests such as the golden flea beetle attack Namibian Jatropha, requiring sporadic applications of organic or chemical pesticides (Int. Polytechnic).

One frequent concern about Jatropha is the risk that it will overwhelm other species if planted outside its natural habitat (Interim Bio-Energy Committee, 2006). Whereas the invasiveness of other oil crops such as castor beans has been proven in Namibia (Int. NBRC), there are no such indications for Jatropha. Single plants or hedgerows had already existed for a long time in gardens and in the wilderness in Caprivi and Kavango without having proliferated (Int. Polytechnic). However, other countries, such as Australia and South Africa, have declared Jatropha to be invasive (Interim Bio-Energy Committee, 2006).

It is said that the shrub's minimal labour requirements make it easy to integrate Jatropha into existing production systems without neglecting food production. However, especially at the beginning – starting the nursery, preparing the land, applying fertilizer and weeding – and during harvesting, Jatropha cultivation requires a lot of labour (Jongschaap et al., 2007). Under dryland conditions, Jatropha is expected to reach its full production potential after three to five years, and sooner with fertilizer and irrigation (Metzler, 2006). Since mechanical harvesting methods are not (yet) available, Jatropha is harvested manually. Seed ripening on individual plants takes place over several months, making several harvesting passages necessary. When Jatropha is cultivated on a larger scale, wages for hired labour are important cost drivers Alternatively, smallholders can grow

Jatropha on their own plots using family labour, which usually reduces the opportunity cost of labour. However, when both labour and land are scarce, cultivating Jatropha might lead to lower capacities for food-crop production. Intercropping can overcome this problem by integrating Jatropha and food crops – and increase food production (Int. Namib Bioenergy Ltd.).

Reliable information is needed about potential yields and market prices in order to assess the viability and income potentials of Jatropha cultivation. In the cited literature, a wide range of figures for yields is found, from 0.6 to 15 tonnes per ha. Seed yields depend on a number of factors such as plant variety, soil conditions and agricultural practices. There is no reliable data for yields on marginal land or in sub-optimal conditions (Jongschaap et al., 2007). Whereas commercial farmers and investors in Namibia seem to perform research on different Jatropha varieties more or less systematically, no public research has been conducted on the seed varieties that are best suited to the different soil conditions and agricultural practices of smallholder farmers (Int. Polytechnic). Since there is no regular market in Namibia (yet) for Jatropha seeds as biodiesel input, there is no information about potential seed prices. The current prices paid to purchase Jatropha seeds for nurseries tend to be higher than the projected prices for seed for oil extraction (Int. Polytechnic). Seed prices will eventually reflect the prices paid for biodiesel minus the costs and profit margins of processing plus transport costs. While future prices for seeds in a mature market mainly destined at oil extraction are likely to be lower than at present, high costs for transporting normal fuel to remote areas (opportunity costs for Jatropha based biodiesel) could still assure interesting prices (Int. Namib Bioenergy Ltd).

Carbon credits for the perennial shrubs could be sold as part of the CDM or voluntary carbon markets to raise farmers' income. However, such credits come with a string of conditionalities regarding procedures and content, and are hard to get in Africa (see Chapter 1.1).

5.1.2 Processing

Processing comprises two major steps, the first of which is oil extraction to produce SVO. This can be done using a variety of machines that differ in terms of the quantity of seeds processed in a given time and the efficiency of extraction. Small-scale presses with an extraction efficiency of about 60 per cent can be used locally; mechanized extractors or extraction based on organic solvents can have 100 per-cent efficiencies (Interim Bio-Energy

Committee, 2006; Jongschaap et al., 2007). With between 25 and 35 per cent oil content, and a mechanical extraction rate of 60 to 80 per cent, four to six kilograms of seeds produce one litre of oil, or 0.2 to 5 tonnes of oil per hectare depending on yield assumptions.

The second processing step, transesterification, usually takes place in centralized plants where SVO is converted into fatty acid methyl esther (FAME) or biodiesel. Methanol, a highly toxic and flammable chemical, is added to SVO as a catalyst (Heller, 1996), causing Jatropha oil to first separate into three free fatty acids and glycerin, then combine with methanol.

At this stage, competitiveness of biodiesel depends on the conventional cost of procuring diesel and biodiesel. The size of the plant used to produce FAME strongly influences unit costs through economies of scale. According to the Interim Bio-Energy Committee (2006), a small FAME plant (for on-farm use) that requires 200 ha of Jatropha plantation costs USD 0.84 to produce one litre, while a medium-sized production plant with a 20,000-ha plantation produces FAME at USD 0.62 per litre.[18] Thus, with conventional diesel prices at USD 0,60 to 0,70 per litre, both medium and small plants are profitable, but when diesel costs less than USD 0,50 a litre, a small plant is not competitive.

5.1.3 Distribution and use

A commercially viable Jatropha industry largely depends on three different potential output markets: national and international markets for transport fuel, and the local rural-energy market. Each market presents different choices for basic production because of its standard requirements and each has potential additional uses for its by-products, such as producing seedcake or soap. Aviation bio-kerosene, a very suitable use of Jatropha oil, is a recent innovation that will probably rise in demand because aviation is scheduled for inclusion in several 'cap and trade' schemes (Rosillo-Calle, Teelucksingh, Thrän, & Seiffert, 2012).

Both SVO and biodiesel can replace diesel fuel in engines. Although there are various methods for using SVO in diesel engines for transport, not much research has been conducted on its use (GTZ & The Energy and Resources Institute [TERI], 2005; Takavarashara et al., 2005). SVO's high

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18 If seedcake could be sold, biodiesel prices would drop to USD 0.69 (small plant) and USD 0.52 (medium plant) per litre.

viscosity and flash point cause incomplete combustion (GTZ, 2005a), but successful trials by public-transport services that use 10-per-cent-SVO blends have been reported in India (GTZ & TERI, 2005). If this blend would be introduced to Namibia, given the country's total diesel consumption of 454 million litres in 2005, the national annual wholesale market would amount to 22.7 million litres.

SVO can also be used in rural diesel generators to produce off-grid electricity. According to the Interim Bio-Energy Committee (2006), there is some 9 MW of diesel generator capacity on farms and in Katima Mulilo, the capital of the Caprivi region, and at several other sites in Caprivi and Katango. Jatropha oil can also be used for lighting (Henning, 2000), cooking and heating, and could replace paraffin, which is currently used by 70 per cent of the population (Metzler, 2006).

Biodiesel, on the other hand, can be used straight in diesel engines in any blended proportion. 'Splash blending' is accomplished by pouring conventional fuel and biodiesel into a fuel tank (Interim Bio-Energy Committee, 2006). Blending usually requires a change in the legal definition of diesel properties. However, most engine warranties are only valid for up to 5 per-cent blending (B5), so the potential minimum market size can be derived by assuming that 5 per cent of all fuel consumption will be supplied with biodiesel (Takavarashara et al., 2005). But this size could rapidly increase as more and more warranties cover the B20 blend. The international market, and especially the EU, offers attractive opportunities because of their compulsory mandates for blending, although evolving EU assessment of indirect land-use change as part of biofuel certification makes the standards of sustainability high and uncertain, creating larger risks for investors. Certification has only started recently.

Requirements for standards and quality and control certification can be quite different in the various value-chain business models, depending on the final-consumer market. This has important ramifications for many technical aspects of the value chain, institutions such as regulatory, certification and control agencies, costs and economies of scale. All the business models that foresee producing biodiesel for formal markets must be quite large in order to ensure quality standards and certification at affordable prices; otherwise they will not be commercially viable. It is easier to sell SVO in bulk than biodiesel since the final processing and quality assurance is controlled by the fuel industry. Quality remains a concern in SVO markets if it is directly used in engines and, except for very robust diesel engines, generally requires compliance with industry standards, an infrastructure for quality control, serious surveillance of the value chain and certification.

Jatropha seedcake created as a by-product during the oil-extraction process is toxic. Although it can be used as an organic, nitrogen-rich organic fertilizer without damaging plants, it could contaminate water. Under low-input conditions, it might be advisable to use seedcake in Jatropha production to maintain the soil's fertility when seeds or branches are harvested and withdraw nutrients (Jongschaap et al., 2007). This seems to suffice only on fertile soils; for poor soils and for achieving high productivity levels, using conventional fertilizer might be unavoidable. Seedcake must be detoxified for use as animal feed. At present, detoxification has been proved successful only at laboratory scale; the costs of fulfilling quality requirements make it generally unprofitable (ibid.).

SVO can be mixed with water and soda to produce soap (Heller, 1996). The Interim Bio-Energy Committee (2006) finds soap production to be a suitable activity in Namibia, especially for micro-enterprises to sell on local markets where imported soaps can be very costly.

Carbon credits for replacing fossil fuel could be sold within the CDM or voluntary carbon markets to increase the benefits in the value chain.

5.2 The Jatropha value chain and business models tested in Namibia

At the time of our field study, commercial farmers had already made trials in the Maize Triangle, while large foreign and national investors had initiated outgrower schemes (the Contract Farming Model) or tried to acquire large pieces of land for growing Jatropha in huge monocultures (the Plantation Model). Plans to implement Jatropha schemes in communities for their local use were also underway (the Community Model). For an overview of these Jatropha business models in Namibia see 0).

The following sections present the various business models for producing, processing and using Jatropha. It is helpful to examine each model since different ways of organizing the value chain cause very different effects and institutional challenges. Key differences come from the scale of operation – large-scale (Plantation Model and processing in Contract Farming Models) versus small-scale (Community Model and production in Contract Farming

Models) – and are based on the ownership structure of the land selected for production – community ownership (Community and Contract farming Models) versus private ownership (Plantation and Commercial Farmer Models). For example, farm size determines the suitable technologies, labour, harvest collection method, commercial ties between actors along the chain and the most accessible markets. Cooperative structures could allow certain options of large scale models with regard to processing and marketing for smaller farmers, but organisational challenges exist. The Commercial Farmers Model has the clearest structure regarding land ownership and is midway between the other models with reference to size, potential markets and the technological options.

<table>
<tr><th colspan="4">Table 7: Jatropha business models in Namibia</th></tr>
<tr><th colspan="2" rowspan="2"></th><th colspan="2">Scale of operation</th></tr>
<tr><th>Small-scale</th><th>Large-scale</th></tr>
<tr><th rowspan="3">Land ownership</th><th>Community-owned</th><td>Community model</td><td>Contract farming model</td></tr>
<tr><th>Investor-owned</th><td></td><td>Plantation model</td></tr>
<tr><th>Commercial-farmer-owned</th><td colspan="2">Commercial farmer model</td></tr>
<tr><td colspan="4">Source: Authors (2009)</td></tr>
</table>

5.2.1 The Plantation Model

5.2.1.1 Description

In the Namibian Plantation Model, an investor leases an ample piece of communal land to grow Jatropha on a large scale and employs farmworkers for its cultivation, harvesting and processing. Jatropha oil or biodiesel and by-products are sold on the national and/or international market.

Several projects with this business model have recently been started in Namibia. The German company MAN attempted to set up a plantation in Kavango (and a contract farming scheme in Caprivi) but abandoned its efforts. At the time of the study, two investors wanted to establish plantations in the Caprivi region: Lev Leviev Biofuels (LLB) and Caparo Investment. The core business activities of the investors' mother companies are not agricultural:

The Lev Leviev Group is active in the Namibian and Angolan diamond industry and Caparo Group Ltd is a global manufacturer of steel, automotive and general engineering products (Etango, 2008; EnviroDynamics, 2009).

LLB's first step was to secure a 5-year-leasehold from the Katima Mulilo town council to start a test farm to determine the varieties of castor-oil plants, Jatropha and food crops that are most suitable for the Caprivi region. LLB built a pump station near the Zambezi River that irrigates all the test farm plants, including Jatropha. The company then approached communities for a leasehold for communal land. LLB is reportedly seeking to cultivate between 20,000 and 300,000 ha. At the time of our fieldwork, the company was still piloting both tasks.[19] It will select crops depending on the potential revenues (based on yields, costs and prices). For the plantation, mechanized harvesting is favoured over more labour-intensive methods, which would require developing technology based on grapepicker or similar technologies (Etango, 2008; Int. Caparo Investment).

Caparo Investment was also still in its planning phase, and wanted to obtain a leasehold on about 150,000 ha to cultivate Jatropha. Initially Caparo envisaged growing food crops on 10 per cent of the land, then in early 2009, the allotment was increased to over 40 per cent, partially to appease Namibia's concern for food security, but mainly due to rapidly rising food prices. The current plan is to irrigate 25,000 ha of land with water from the Zambezi River; except for young seedlings, Jatropha would mostly be cultivated on non-irrigated land. In the long-term, 2,000 to 2,500 skilled and unskilled jobs should be created. Caparo has conducted the compulsory social impact assessments (SIAs), and put social projects for the communities in their business plans (Caparo Investment, 2009).

Both companies envisage selling their food crops on local markets and markets in neighbouring countries. They are also planning to process Jatropha oil and biodiesel in the Caprivi region that they envision selling both nationally and internationally. The CDM market has not yet been included in the investors' calculations (Caparo Investment, 2009; Int. Caparo; Int. Samicor/LLB).

Most of the TAs and communities interviewed wanted to participate in this model (mainly by leasing land), stressing the unemployment and alcoholism that plague rural youth. TAs want the investors to create jobs for their

19 LLB received its licence for 300,000 ha in April 2010 (Biofuel Digest, 2011), but the 2011 moratorium has halted further development.

families and communities – the Mashi TA, for example, was assured of 5,000 jobs. Some communal farmers agreed to the leasehold because they were promised developmental projects, water pipelines and the debushing of some of their fields to increase productivity (see Chapter 4.1). Some members of the affected communities consider the land in question to be 'unused', so they do not see any competition over the land and welcome the new opportunities offered by the investors. Farmworkers currently working at the LLB-test farm also cited the new knowledge and income diversification to be advantages of their employment. (Int. Farmworkers; Int. Ngweze Community; Int. Mafwe TA; Int. Mashi TA). But not everybody in these communities favours the plantations; their reasons will be explained later in this section.

The land administration procedures for Jatropha projects in the Kavango and Caprivi regions were opaque, sometimes with land allocated that had already been gazetted for other projects. Middlemen offered land that they had no rights to, and the local headmen and communities were not sufficiently involved in the decision-making process (Int. Chief, Kavango; Int. Nambwa community).

The Namibian government had an unclear position towards the Plantation Model: interviewees gave varying assessments and investors complained about the lack of straightforward support. Although the government has expressed interest in creating employment, especially in the rural areas, and finds the business plans interesting, there is no unanimity about whether a plantation is really the best way to create jobs. Furthermore, the regional government of Caprivi is more interested in food-crop production to help the region to become self sufficient (Int. Regional Council). In addition, having been blamed for major bankruptcies in the textile industry[20] the national government fears similar or worse problems should the Plantation Model fail. Particularly in the disadvantaged Caprivi region with its remnants of separatist notions, such problems easily become politicized.

The MET plays a crucial role in large Jatropha schemes. Its Department for Environmental Affairs which is responsible for reviewing and approving SIAs for large agricultural projects, is currently preparing one on Jatropha cultivation in Caprivi and Kavango (Int. MET).

20 In the biggest case the Malaysian textile producer Ramatex abandoned Namibia after five years, leaving behind extensive environmental damage and unemployed workers.

5.2.1.2 Major factors in viability

One of the major obstacles for the Plantation Model is land tenure. Large tracks of land suitable for Jatropha are only found in communal areas and some of the land promised to the Jatropha investors was already gazetted for community conservancies and a governmental initiative for small-scale farmers. Some of the gazetted activities were old and obviously abandoned, but degazetting is not automatic; the process is slow and often contested, for instance when a project's financing has not been secured. The Communal Land Reform Act of 2002 was also violated in some cases because communities were not included in the decision-making process with negotiations only conducted between the investor and the TAs (Mitchell, 2009). Although the area promised to the investors is generally considered to be 'unused', the whole community does not agree with that categorization: some small farmers and herders feel threatened by the plantations (see below).

This indicates a huge lack of communication between the TAs and their communities and the TAs and investors. Furthermore, stakeholders in Caprivi are in the dark about the Namibian government's opinion on Jatropha (Mitchell, 2009; Int. Mashi TA), which makes long-term planning impossible. LLB already had to change their plans when castor-oil plants were not allowed because of their invasiveness. Now the investors must await a government decision on Jatropha that requires intensive study and the agreement of various ministries (Int. Samicor/LLB).

Some of the factors mentioned above have created community resistance. Communities are not always involved enough in the allocation of communal land and often feel that they lack information about Jatropha: they have seen no examples of best practices in- or outside Namibia. Some communities have already had bad experiences with other cash-crop projects such as cotton and worry about the project's viability and possible hidden objectives of the investors (particularly in mining). Communal farmers are also concerned about losing rights to their land for many decades (Int. Communal Farmers).

Technical issues were also pending when we visited. Agro-climatic factors such as the golden flea beetle are regarded as a minor problem because it has known treatments although they increase costs. The Zambezi River floods that inundated the pump stations in early 2009 caused major unanticipated problems (Int. Caparo; Int. Samicor/LLB). However, it was believed that the key issues of Jatropha – yields and labour costs – could be solved in due time through access to international agro-service providers in India, Israel and Brazil.

In 2009 a lack of capital due to the global economic crisis constituted a problem because Namibian enterprises were having more difficulty obtaining money from their mother companies and financial partners.

5.2.1.3 Developmental effects

The economic effects

There is hardly any commercial agriculture, industry or manufacturing in Caprivi. For this reason, the positive effect of the Plantation Model that is most often mentioned is creation of employment on plantations and in processing factories that will encourage the young and/or economically active to remain in Caprivi (see Mitchell, 2009). The investors also promised to improve the labourers' agricultural skills and develop the area by building roads, pump stations, pipelines, and so on, and it was expected that the companies and their workers would pay taxes which could directly benefit the communities (Int. Samicor/LLB; Int. Caparo).

The opportunity costs of a plantation must be considered with regard to its potential negative economic effects. If the investors get the leaseholds they are seeking, a large area in the Caprivi will not be available for livestock, conservancies (tourism) or other activities. Some land, particuarly that close to the rivers, is annual pasture, while more remote areas are sporadically used as grazing buffer. Although the lack of water often hinders a more permanent use, in many places groundwater reserves could be tapped for livestock and semi-commercial farming: this was one of the (inoperational) gazetted project ideas in Caprivi. Furthermore, conservancies in the communal areas of northern Namibia often attract tourism investors who create jobs and incomes for some communities.

If a plantation were started, people would mostly work on the plantation and might have to reduce other income-generating activities. What is more, the region would be exposed to the risk of project failure. If the investors pulled out for any reason, Caprivians would be left with the enormous task of restoring their fields. With only two investors planning to occupy large shares of the regions, this would create huge gaps that could not easily or quickly be filled by others. Some interviewees also argued that positive impacts would stay behind possibilities if the biofuels generated would not be used inside Caprivi or even inside Namibia, but this argument was not shared by others and should not be used when evaluating the projects.

The ecological effects

Although the investors promise to make provisions for intercropping and to include natural vegetation and wildlife in their plans, these efforts can only alleviate the plantation's negative ecological effects, not create any additional benefits. Since the land to be used for plantations had been partly gazetted for conservancies, the decreased biodiversity that results from debushing and monocropping are *de facto* negative. Furthermore, irrigation changes natural water cycles and fertilizers can pollute the water. While using water from the Zambezi River in Caprivi doesn't seem to pose much of a problem, taking water from the Kavango River directly and strongly affects Botswana's Okavango Delta. Apart from large government- and donor-assisted water projects, international investors with their the enormous capital reserves would be the only ones able to tap these scarce water resources at scale – but while official water projects are thoroughly scrutinized, private investors tend to be less controlled.

There is no evidence that Jatropha is an invasive species in Namibia; a commercial farmers' cooperative had imported Jatropha for several years. However, since large-scale plantations are a completely unknown model in the area and large investors are better able than small planters to access gene material from abroad (including genetically modified varieties), Namibian authorities are more reluctant to give official clearance for the Plantation Model than for the other business models.

Additionally, a plantation reduces available land, leaving less grazing area for the cattle of small-scale farmers and herders, negatively affecting the natural vegetation of areas that are already considered to be overgrazed, partly because of bush encroachment and partly inducing it (see Chapter 4.1).

Given the Plantation Model's large capital and technological capabilities careful monitoring of its effects on soil, biodiversity and water resources is imperative.

The sociopolitical effects

Having more cash income helps employees of a plantation to pay for their children's school fees and for medical care, thus enhancing both education and health. One company even promised free schooling, medical support and investments in the region's social development. The TAs repeatedly stressed that they hope youth alcoholism would decrease when young people have jobs (Mitchell, 2009; Int. Mashi TA).

In Africa, large formal industries trigger relatively strong labour unions, which could also happen with the Plantation Model, especially if permanent instead of just seasonal jobs are created.

Negative sociopolitical effects could result from the radical change of lifestyle and livelihoods of the former subsistence farmers; the fact that the initiatives come from outside Namibia increases scepticism. Conflicts could arise between communities and TAs because of nepotism and opaque leasehold allocations: some government actors are accused of being connected to project shareholders. More conflict potential comes from fencing off the land for the plantation and the greater numbers of migrant workers from neighbouring countries (Int. MAWF; Int. Ngweze Community). In Caprivi, conflicts about the projects have been politicized.

The effects on food security

Already an essential part of the business plans, food crops could gain significance if the market for Jatropha products is weak or if food prices continue to rise internationally. Then large irrigated plantations would quickly become important players on Namibia's relatively small food market and boost food self-sufficiency and food security at the regional and country levels. Earning cash income to buy food helps farmworkers and their families become food secure.

If the mentioned business plans to integrate food production into Jatropha schemes do not materialise, Jatropha and food production would compete especially for labour (and land if the areas were alternatively brought under food crop cultivation through irrigation). However, since compared with most other African countries, Namibian food markets have high shares of imports and a good distribution system, reduced food self-sufficiency is not generally seen as risking food security. Namibian trade policy actually keeps food prices high for some period in the year in order to support local production (see Chapter 3.1) and this policy could easily adjust to reduced food production for domestic markets. However, a food security risk could arise if subsistence farmers go to work on plantations and reduce their subsistence production and then suffer wage cuts (due to project failure, liquidity problems or redundancy), or if food-markets would fail or international prices increase dramatically. While these threats exist for all non-subsistence-based livelihoods, plantations in Namibia have a special responsibility to be economically viable because so many people in remote areas depend on them.

5.2.2 The Contract Farming Model

5.2.2.1 Description

'Contract farming' refers to "*a system where a central processing or exporting unit purchases the harvests of independent farmers and the terms of the purchase are arranged in advance through contracts*" (Baumann, 2000, p. 7). The contract terms usually specify how much produce the contractor will buy, at what price or how the price is to be determined. The contractor may provide credit, various types of specialized and general inputs and technical advice. Contract farming provides scope for very diverse forms of business relationships.

In Namibia, 'contract farming' schemes mainly exist in the form of Green Scheme irrigation farms and intensive agricultural projects (see Chapter 3.1.4), but first steps have also been taken to establish contract farming schemes for producing bioenergy.

The most elaborate project might well be from a Namibia-registered company called Prime Investment (Pty) Ltd that is financed by South African- and UK-based investors. Their plan is to contract 8,000 to 13,000 farmers in Kavango to plant Jatropha on 70,000 to 130,000 ha of land along the Namibian section of the Okavango River and the neighbouring areas of Katwitwi, Rundu and Divundu. The project seeks to limit the cultivation of biodiesel and seedcake for regional, national and European markets on land cleared before 1990 in order to receive (voluntary) carbon credits. Seedcake would account for 19 per cent of the income, biodiesel, 33 and carbon credits, 48 (Colin Christian and Associates CC, 2006). All three income streams are deemed necessary for the project to be economically viable.

The sites that were cleared before 1990 must be identified in order to claim carbon credits for the project; in Namibia this can be done relatively easily using old satellite and aerial images. Farmers with such land qualify to participate in the project. Farmers who wish to cultivate Jatropha are contracted to grow on average 10 ha of the trees (ibid). The TAs and CLB in Kavango would help farmers to map their farm boundaries and register them with the MLR. This way, farmers will maintain control over their land in accordance with the Kyoto Protocol.

A contracted farmer mainly contributes land and labour for planting, maintaining and harvesting Jatropha and agrees to sell the harvest to the investor. The investor creates nurseries, provides seedlings, fertilizer and other materials and trains the farmers to plant. Farmers tending Jatropha plants would probably not be able to grow the same amount of staple crops as in the past, and since Jatropha takes several years to mature, the investor would have to subsidize the farmer with food and cash during this period. The company will build and operate a factory in Rundu to extract the seed oil and a factory in Walvis Bay to process the oil into biodiesel. Nurseries, tractor services and factories will provide additional employment opportunities, especially for families who lack access to land that qualifies for carbon credits.

Box 1: The benefits and opportunity costs of producing Jatropha in a contract farming model

In Kavango, mahangu yields are about 300 to 330 kg/ha; mahangu fetches approximately NAD 3.00 to 4.00 / kg. Therefore, one hectare yields NAD 900 to 1,320 a year, or NAD 75 to 110 a month. In the proposed model, Jatropha growing farmers are paid NAD 100 per hectare per month until the value of their seed yield exceeds that amount. The investor provided the following figures regarding the expected yields of seed per hectare and the anticipated incomes of participating farmers beginning in the seventh year: At NAD 0.35/kg, with an annual yield of 4,200 kg/ha, a farmer could earn NAD 1,470/ha/year. If 65,000 ha are cultivated, then all the participating farmers in Kavango could earn over NAD 95 million/year.

Source: Mendelsohn & Obeid (2007)

A farmers' association would be formed to represent the interests of the farmers with shares in the project companies. After 2014, these shares would increase until the association holds 100 per cent of the farming company and 49 per cent of the processing company (Colin Christian and Associates CC, 2006).

Another contract farming scheme in Namibia that plans to cultivate Jatropha is not counting on carbon credits. Its hub is the Shankara commercial vegetable farm in Kavango, whose operator founded the Namib Bioenergy Investments company with Namibian and foreign investors and opened a nursery. The plan is to supply small-scale farmers with seedlings, inputs, training and financial assistance for weeding (labourers, tools, herbicides). In the first years before production starts, assistance will be provided as sponsorship; once the farmer starts to sell Jatropha seeds, assistance will be provided on a commercial basis. The farmers will intercrop Jatropha trees with food crops and use their cattle manure for fertilizer, harvest the seeds and sell them (per contract) to the commercial farmer and the investors. The seeds will then be transported to Walvis Bay and processed into bio-oil. Both the oil and seedcake will be exported (Int. Namib Bioenergy Investments).

With reference to contract farming with carbon credits, another of the MET's important roles must be mentioned here: its Department for Environmental Affairs is home to the Designated National Authority (DNA), which must approve all projects and certify that all Namibian legal requirements have been met before project proposals can be submitted to the CDM Executive Board in Bonn, Germany.

5.2.2.2 Major factors in viability

A contract-farming scheme for producing Jatropha faces a variety of obstacles. Here we list some that have emerged before even starting production.

Land tenure is a very sensitive issue in Namibia (Chapter 3.1.5, compare Plantation Model). Investors want to formalize communal farmers' customary-use rights on land where Jatropha is planted in long-term leaseholds (Colin Christian and Associates CC, 2006) in order to prevent conflicts over tree ownership. But interviewees (members of the community and the government) have reservations about this procedure. Jatropha farmers' associations believe that such leaseholds will make farmers' land rights less secure (Int. KJFA; Int. NJGA): already recognized by law, customary rights are largely undisputed. But converting them into leaseholds threatens a farmer's rights since the land becomes state property if a farmer is unable to pay the lease (e.g. in case of project failure). Formally registering communal land now appears to be impossible since TAs do not support the registration process (Int. DED; Int. MLR). Furthermore, it is not clear if Jatropha planted on unregistered land can claim carbon credits (Int. KJFA).

The government's position on the Contract Farmer Model for Jatropha is probably less critical than that towards the Plantation Model, but many interviewees mentioned its lack of strong engagement. There appears to be general distrust of people from outside the community, especially foreigners. The communities and regional government first want to be assured that an investor is genuine and committed before committing any land to a project, especially if it involves a formal lease. Local authorities seem to hesitate about supporting the project because "they have not seen any examples" of similar Jatropha projects (Int. MAWF; Int. NDC).

The technical problems of cultivating Jatropha in Namibia are compounded in Contract Models because of the need to inform and train not just the investor but also many smallholders. Farmers cite insects and wild animals (the golden flea beetle, grass hoppers and porcupines) as threats to young plants, some of which are more difficult to combat on plantations than on smaller plots of smaller farms (Int. Commercial Farmer).

Finally, it is unclear whether the project costs have been properly calculated. Very little reliable data is available, but for example the Jatropha yields mentioned in Box 1 seem difficult to achieve on a large scale with conditions in Kavango unless good water is available by irrigation or from groundwater. However, it might be possible on a small scale: the research group saw well-developed Jatropha fields in the region (see Chapter 5.2.4)

5.2.2.3 Potential development effects

The economic effects

As described above, Kavango farmers have difficulty making a living because of the shortage of fertile soils and water, lack of inputs and know-how, poor crop yields and limited markets for surplus farm production – which forces many to migrate including to bush-to-energy regions (see Chapters 3.2 and 4). They mainly participate in Jatropha projects in order to have an alternative source of cash income at home – and to not have to migrate for work. Jatropha incomes are expected to richly compensate for the loss of mahangu farming. Farmers also mentioned the advantages of Jatropha as a perennial: they need not worry about sowing each year and can build up assets for future generations. They also expect to benefit from other employment opportunities related to the project such as working in the factory, and from training in farming and business provided by the investor (Int. Communal Farmers; Int. Village Headman; Int. KJFA). TAs (both *hompas* and chiefs) acknowledged the potential benefits as their reason to agree to the project (Int. Chief Kavango; Int. Headman Kavango).

The motivations that smallholder farmers, families, TAs and communities name for participating in a contract farming scheme to produce Jatropha are the same as its potential positive economic effects. A key motive is the diversification and stabilisation of incomes in numerous ways: compensation is paid to nurture seedlings; sale of seeds can be sold at a guaranteed market price; employment opportunities are created for working in the factory and nurseries or operating tractors. Farmers who cultivate Jatropha will have additional demand for local hired labour.

However, such projects also present challenges and risks. The greatest threat is of failure due to market failure (global price changes), mismanagement or much-lower-than-expected Jatropha yields. Most of the capital risks in the Outgrower Model are borne by the investor and not the individual farmers, so there is no immediate risk of an individual farmer losing land or assets because of project debts (Colin Christian and Associates CC, 2006). But farmers could become indebted to the investor for inputs and services (Dubois, 2008) and be left with useless Jatropha plots should no other buyer be available if the project fails. In that case, farmers would have to remove the trees before putting the land to other uses – which requires a lot of labour and probably also mechanical input. One company had indicated its willingness to create a fund for such cases.

Fears of leasehold regulations weakening land rights have already been cited as important obstacles in negotiations; they could also later affect the project. However, if no leaseholds or formal land registrations are issued, disputes could arise over land. Farmers and TAs stated that land-use rights are well understood and largely undisputed, and that disagreements can always be resolved through village headmen and land boards (Int. Chief, Kavango; Int. KJFA). But determining rights to many tracks of land that have lain fallow or been abandoned for a long time is likely to overwhelm the TAs and CLBs of Kavango. Namibia is ill prepared to respond to massive interest in communal lands.

Another risk borne by the farmers is crop failure. Inadequate rainfall, insect infestations and diseases can cause low yields in the short term, while climate change could have a long-term effect on yields (Colin Christian and Associates CC, 2007). These risks already exist for mahangu and other dryland crops, but they could be more severe with less-familiar perennials such as Jatropha.

Farmers and community leaders expressed fears that the company might be unreliable or exploit its monopsony position to not make good on its promises or even abandon the project.

The company, on the other hand, risks the farmer selling outside the contract ('side selling'), although currently this is a low risk for Jatropha because of the lack of processing plants), or diverting inputs supplied by the company to other purposes, thereby reducing the quantity of the product that is available for processing.

The contractual modalities linking companies to smallholders and the mechanisms to ensure that both parties respect them greatly influence the economic effects. Pricing systems must be fair and transparent, and independent buyers must be regulated and controlled. A good mechanism for resolving disputes that is accessible to smallholders is also important: neither the communities nor the TAs have the capacity or experience to draft or review highly detailed formal contracts. They also lack reliable, independent information about the project's advantages and disadvantages and about the investors (Int. Polytechnic).

Planting Jatropha on a large scale, even on scattered plots, can lead to the loss of grazing area for cattle and small livestock on fallow and abandoned fields as well as on cultivated fields where animals browse the mahangu leaves and stalks that are left after the harvest. Grazing area can also be lost as a result of clearing woodlands to grow more mahangu to compensate for fields converted to Jatropha. On the other hand, if Jatropha seedcake could be detoxified, a large amount of fodder could be made available. But since seedcake is detoxified in large centralized factories the fodder produced might not be equally distributed.

The ecological effects

Like the Plantation Model, the Contract Farming Model requires research on Jatropha's potential invasiveness as well as on the plant's effects on soil, biodiversity and water resources. One special characteristic of typical Jatropha Contract Farming schemes is (due to economies of scale in processing and in consequence the usually large size of the projects) the large number of independent producers, which makes potential plant invasion and water contamination especially hard to control.

Unlike the Plantation Model, the Contract Farming Model with carbon credits uses land in Kavango that has already been cleared and used for agriculture – thus only creating a carbon sink.

The sociopolitical effects

The Contract Farming Model creates fewer formal jobs than the Plantation Model, but offers more labour to more (semi-)independent farmers, with possible sociopolitical repercussions. Farmers who form associations with representatives can help to give voice to communities about other issues.

However, a project of this scale can be expected to add pressure to Kavango's social and political structures. Some of the additional cash income might be used for undesirable purposes, for example it could increase alcohol consumption. HIV/AIDS infection rates could also rise in connection with greater economic activity (Colin Christian and Associates CC, 2007), but could be offset by reduced seasonal migration. Instead, increased economic activity might attract Namibians from other regions and foreigners to Kavango, creating additional demands for and competition over natural resources.

Since not all families have access to land cleared before 1990 and the rich have more land available for Jatropha, inequality could increase through the Contract Farming Model. On the other hand, second round effects in the longer run could create growth and distribute incomes widely and reduce inequality.

Furthermore, should the project fail and be abandoned by the investor, communities will lose interest in cooperating in projects like this for years. Community leaders and TAs are pressured to support the project and 'convince' people to participate (Int. NDC; Int. MAWF) – so if the project fails, the authorities' credibility will be undercut by their prior support.

The effects on food security

Not every field envisaged for Jatropha production in the Contract Farming Model is fallow land. It is expected that some farmers who participate in the project will convert part of their mahangu fields into Jatropha cultivation, which cause a reduction in food production and food self-sufficiency in Kavango. How that might effect food security has been discussed in terms of the Plantation Model. However, in the Contract Farming Model smallholders have more autonomy to decide what is best for them. No larger plots need be agglomerated and few workers (in processing plants or the like) are tempted to give up farming altogether. In addition, allowing farmers to use their improved farming skills and apply Jatropha seedcake as fertilizer on land reserved for food production, as well as the possibility to intercrop during the first years, can help to mitigate negative effects on food security or even create win-win situations. In this model, the risk to food security is significantly lower.

5.2.3 The Community Model

5.2.3.1 Description

In the Community Model, Jatropha seeds are not sold to outside markets but rather processed and used locally to provide energy and improve livelihood activities for remote communities. Whereas Community Models have been successful elsewhere in SSA (FAO, 2009), at the time of our research no such model existed or was undergoing field trials in Namibia. One university had conducted laboratory research and planned to conduct field trials and one NGO had started to promote Jatropha among disadvantaged women in the North of Namibia to improve their livelihood options (see Box 2).

Interviewees stressed the Community Model's potential for Namibia.[21] Locally extracted SVO can power generators for pumping water, grinding or providing electricity. It can also be used in improved cooking stoves, for lighting or to produce alternative products such as Jatropha oil soap.[22] Interviewees also mentioned that biomass-gasification plants make it possible for a community to use Jatropha residuals to produce additional energy (e.g. Int. Baumann & Meier Workshop CC; Int. MTCT). The National Bio-oil Energy Roadmap (*Interim Bio-Energy Committee,* 2006) mentioned that Jatropha oil could be used as a biodiesel component in a hybrid off-grid system, an option that was also discussed for the Tsumkwe off-grid electrification project (Int. Solar Age Namibia).

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21 One scheme run by an NGO, which could be classified as an 'outgrower' or 'simple group farm' model, proposed a slightly different model: Women were encouraged to plant Jatropha trees – not necessarily with local seeds – and sell them to a third parties (independent buyers) (Correspondence with Angelica Bergmann 2009).

22 Although this model did not include any plan to also produce biodiesel from SVO, it is possible but would require some hundred tonnes of Jatropha per year. The model's technical feasibility is demonstrated by a bio-diesel production plant in Bothaville, RSA that was established by a Public Private Partnership of German development cooperation, a German enterprise and a local farmers' association (ISEEP, 2012).

Box 2: Current community-based Jatropha initiatives in Namibia
Current initiatives include a pilot research project by the Polytechnic of Namibia, the Integrated Renewable Energy Solutions for the Rural Namibia (IRES), in which farmers in an off-grid community are encouraged to plant Jatropha hedges for local energy provision (Int. Polytechnic). Technical feasibility tests are being conducted in the lab and a hand-operated press is being developed for community use. The next stage of research will focus on the *ex-ante* analysis of the model's economic viability and field-testing. One community in Kavango uses a diesel generator to power a water pump to irrigate a vegetable field (Int. Communal Farmers). But the cost of conventional diesel is 60 per cent of the final output price (and the largest cost of growing vegetables), significantly reducing the potential benefit of cultivating vegetables to the community. The Polytechnic plans to partner with the village development committee (VDC) to plant Jatropha in order to replace the expensive conventional diesel. Another NGO-run project for women was promoting planting Jatropha as hedges to enhance livelihoods in rural and urban Caprivi and Kavango (Int. MTCT Caprivi; Int. MTCT). The basic idea is to set up 5-ha pilot farms from Caprivi to Omusati and produce SVO for the communities to pump water and cook, use the seedcake as fertilizer and increase food production and processing. Women in Kavango had been convinced to intercrop Jatropha with their main crops, mahangu and beans (Int. Women's Group). A member of the women's group said that as many as 1,000 women were interested in growing Jatropha (ibid.).
Source: Authors

Once harvested, Jatropha seeds are sold or provided to a local enterprise or a community extraction facility for producing SVO. Communities that do not have enough seeds to process sell their seeds to a mobile oil extractor that serves various communities (Int. Polytechnic). The seedcake is then made available locally to be used as fertilizer on food crops.

One possible use of SVO is for rural electrification through local mini-grids. Larger solutions require a certain population size and density of energy-consuming productive activities (Roedern, 2007) and an adequate production of feedstock. The National Bio-oil Energy Roadmap (Interim Bio-Energy Committee, 2006) identified several potential sites for off-grid solutions using Jatropha, including "*approximately 9 MW of diesel generator capacity already spread across farms and at Katima Mulilo*" and additional "*sites in the Kavango and Caprivi regions for off-grid power generation development*". Further potential is mentioned for pre-grid regions (regions without access to the national grid) as a component of "*hybrid systems to deliver off-grid power, and potentially sell electricity into the grid at peak times*" (ibid., p. 32). But there does not seem to be any hard information and data on the potential of mini-grid sites (Consulting Services Africa [CSA], 2007).

Besides the various local value-chain actors (producers, processors and users), an external facilitator (an NGO, academic institution, governmental institution or private company) is needed to set up and coordinate the Community Model. Since local value-chain actors are presumed to lack the capital and know-how to initiate and run such a project, the external facilitator must support the community through training and finding capital (Int. Polytechnic; Int. MTCT). A Community Model requires sizeable start-up investments. Funding organizations such as donors, governmental organizations or subsidized private companies could help to fill the financing gap. External facilitators and funding organizations must be guided by the possible developmental outcomes for the community. The Namibian government aims to provide off-grid solutions for regions without grid connections (Chapter 3.3). Once the model of a community-based initiative has proven successful, it might garner governmental support.

5.2.3.2 Obstacles to viability

The Community Model presents special institutional challenges in addition to the technical problems of Jatropha production already mentioned. In the literature (cf. Dubois, 2008; FAO, 2009) and our field work we learnt the two major challenges: economic sustainability at the local level and scaling up to the national level. The first refers to coordinating all the interdependent steps and actors in the context of a target group that lacks capital and know-how; the second refers to the need for this to be accomplished under varying local conditions, usually with different promoters.

The Community Model requires the know-how and participation of many independent value chain actors, who are often linked through non-commercial (unprofessional) ties. At least in the early stages, extensive external support is needed, but local communities must participate in order to make the model sustainable. Our research in Namibia revealed the necessity of having a clear vision and a viable project proposal, good and ongoing communication with and within the community, and serious long-term commitment to implementing the project. Without these factors, success is unlikely. For instance, one NGO had promised to distribute seeds that never reached the communities and in other cases the communities sold the Jatropha trees they received from the NGO instead of planting them. Such actions are generally difficult to anticipate, but they often mean failure of the entire project.

So far, no government money can be spent on activities related to Jatropha cultivation, although "*[W]e* [the MAWF] *would love to include it in the green scheme*" (Int. MAWF, italics added). Interestingly, many farmers did not praise the extension services for food crops, leaving us to assume that the system is plagued by inefficiencies. AGRA Co-operative Ltd (Int. AGRA) has recently set up a department for 'agricultural advice' and has about 8000 kg of Jatropha seeds in stock. But they provide no subsidies for their services: they must be paid for. All this hampers independent small-scale producers in contrast to large investors (and contract farmers) who can afford their own research and extension services.

Using biofuels to generate electricity for local grids presents major challenges. One crucial problem is the high cost of investment for the inputs, machines and human capital required for set-up – either as a hybrid system or a stand-alone solution. The target communities' limited purchasing power and size make it unlikely that they would be able to recover the start-up and running costs by themselves. Becoming financially viable thus requires most or all investment costs to be covered by public funding (Int. VO Consulting).

There do not appear to be any Namibian government financing mechanisms for a Jatropha-based off-grid system. The Off-Grid Energisation Master Plan for Namibia (CSA, 2007), which is not yet governmental policy, focuses on solutions for households not mini-grids. A feed-in policy may be introduced as an incentive for pre-grid regions within the next years but nothing is planned yet for Kavango and Caprivi (Int. NORED).

5.2.3.3 Potential developmental effects

The economic effects

The types of incomes generated by the Community Model are similar to those in other models, although the aggregated effects will be certainly much lower due to the smaller scale, because the considerable investment costs will hamper reproduction at scale and because Community Models are likely to have higher transaction costs and greater efficiency losses than models run by the private sector.

It is often argued that the Community Model has a variety of additional developmental effects because feedstock production, processing and use remain in the community. SVO and biodiesel can be used in generators to provide electricity or fuel for transportation and machines. For off-grid communities, locally produced biodiesel or SVO that is economically competitive with other energy sources can contribute to rural energy security by providing a decentralized, reliable and affordable energy supply for electrification. Increased availability of energy and electricity on demand increases living standards and allows the time once spent collecting fuelwood to be used for other productive purposes. The reliable provision of electricity is indispensable for the productive purposes and services needed for local development (e.g. irrigation using SVO-powered water pumps, higher productivity from using electric light and better health through refrigerating perishables or vaccines). Additional community income can also come from the CDM or voluntary carbon markets (Interim Bio-Energy Committee 2006). Experience in Mali (Box 3) shows that these effects can be generated.

The straightforward calculation of opportunity costs for buying or creating alternative (fossil or renewable) fuels or energy would not be a good counterfactual since the main obstacles to creating such alternatives are more complex. Not needing to purchase costly fuel or services and spare parts, for example, for photovoltaic panels, would reduce the liquidity problems that often make investments in poor economies unsustainable. Community spirit and self-esteem from success could be other non-monetary benefits (see below).

Whether the great effort required to create these effects is justified, or whether other ways might prove to be more effective and efficient cannot be discussed here. That requires a complex analytical framework that thoroughly considers sociopolitical issues. Empirical evidence for a large range of circumstances is needed to indicate the proper approach to sustainable rural energy systems in Namibia.

Box 3: Examples of a community model of Jatropha biofuel production in Malian villages
Mali is one of the poorest countries in the world with a highly unequal distribution of income. The country is land-locked with 65 per cent of the land area desert or semi-desert; 99 per cent of the rural population lacks energy services. Mali seriously needs electricity to pump water for irrigation, operate agricultural processing equipment, chill vegetables and provide for lighting and refrigeration services in small shops and restaurants. Jatropha is well known in Mali, where it is used for protective hedges and erosion-control lines. Women also use it to produce traditional soap. A 15-year developmental project in the village of Garalo that aims to reduce poverty by setting up Jatropha-fuelled electricity generators for 10,000 people in the community exploits this knowledge: 1,000-ha of Jatropha and other oil-producing plants have been created to cover the electricity needs, and capacity building is conducted for the community. The environmental benefits include saving 9,000 tonnes of CO_2 emissions each year over the life of the project as well as protecting against soil erosion to combat deforestation and desertification. In the village of Tiécourabougou, the Malian NGO Mali-Folkecenter Nyeeta (MFC) introduced the idea of 'energy service centers' built around Jatropha. Some 20 hectares of plantations grow seeds for Jatropha oil, which is used to power activities like millet grinding and battery charging. Villages in a 20-kilometre radius also benefit from these services. The money spent on locally-grown fuel stimulates the local economy; on a macroeconomic level, this reduces Mali's budget for imported fossil fuels, saving hard-earned foreign currency reserves (UN Energy, 2007; Dubois, 2008).
Source: Authors

The sociopolitical effects

With a technically viable model, communities are able to build up the expertise in processing techniques, management and self-organization necessary to run the project. This way of empowering the community gives the Community Model a significant advantage over the others, which mainly offer low-skilled employment and create few jobs (Int. Polytechnic).

Control over the land and a large share of value addition remain within the community – giving it a high degree of ownership of the project (Int. MTCT) while community participation and incentives for collective action enhance social capital. Moreover, using Jatropha oil for cooking and lighting instead of firewood and kerosene can positively affect health and the energy can support education and health facilities. These positive impacts require high investments far beyond technical issues (see above).

The ecological effects

Large-scale environmental effects cannot be expected from individual community schemes. However, experience in other countries shows that replacing traditional energy sources reduces in-door air pollution and local deforestation (FAO, 2009). Depending on the land-use changes induced, replacing conventional diesel in stationary engines may reduce carbon emissions.

Effects on food security

If the model works as designed, food security will be increased as a result of the availability of Jatropha residues (seedcake) for use as fertilizer, water pumps to irrigate food crops powered with biodiesel or SVO, and especially through access to food via higher incomes. How much these benefits extend to all community members depends on community solidarity: those who were marginalized or harmed when Jatropha or other crops are planted on land they had previously used must be included. Compared with other models, the chances are much higher that benefits in this model will be inclusive, but there is no guarantee.

5.2.4 The Commercial Farmer Model

5.2.4.1 Description

The fourth model for Jatropha value chains in Namibia involves commercial farmers who plant Jatropha on their own land then use the Jatropha seeds or sell them to off-grid generators or other markets (Interim Bio-Energy Committee, 2006). In the SSA it is quite rare to find a large number of commercial farmers with technical skills, mechanization and good access to formal credit and input- and output-markets. The National Bio-oil Energy Roadmap (ibid.) estimates that 500 commercial farms in Namibia could plant between five and 10 ha of Jatropha on freehold and communal land. When we conducted our research, there were already trial plots on freehold land in the Maize Triangle. In addition, extensive areas in Kavango and Caprivi had been assigned for small-scale commercial farming units (2,500 ha), primarily for livestock, while growing Jatropha as a cash crop was being considered (Int. Communal Farmer; Int. MLR).

Some of the commercial farmers in Namibia had started to plant Jatropha early. One interviewee had begun growing Jatropha in order to replace conventional tractor diesel with Jatropha SVO (Int. Commercial Farmer). Long truck transport, cost and occasional gaps in the availability of diesel make Jatropha SVO attractive. Quality standards are less of an issue since the producer is the consumer. Also other farmers in the Maize Triangle had started to plant Jatropha on a trial basis, with the idea of eventually selling it on the domestic market or to potential foreign buyers (Correspondence with German Farmer 2009). Currently, the largest plots are on a government farm in Kavango that mostly produces irrigated food crops: in the very first year, 14,000 Jatropha trees produced seeds with very high oil yields, possibly because of groundwater streams (Int. Commercial Farmer).

5.2.4.2 Major factors in viability

Despite the relatively straightforward potential effects on development including the need of less external assistance for cultivation than the Community Model, there are some obstacles to this model:

Farmers had underestimated the frost sensitivity of young Jatropha trees. At one farm we visited, Jatropha trees suffered badly in their first year and did not become sturdy enough to withstand the frost of the Maize Triangle's exceptionally cold winters (Int. Commercial Farmer). One farmer mentioned, however, that in the Maize Triangle frost is mainly a problem in valleys, not on farms at higher altitudes (Int. Commercial Farmer).

Belying earlier beliefs of the plant's toxicity, wild animals were discovered to have survived eating young Jatropha trees that had not yet become toxic (Int. Commercial Farmer). Insects and termites were also reported as having destroyed Jatropha plants (ibid.).

Another problem of commercial farmers were labour costs for harvesting the trees due to the lack of appropriate mechanical harvesting devices and of local workers who were available to work short-term.

Whereas large-scale Plantation and Contract Farming Models can produce and access markets at the same time, commercial farmers must depend on on-farm utilization or selling to external markets (which do not yet exist). The national AGRA co-operative sells seeds for crops with dual and triple uses, such as sunflowers, to commercial farmers and guarantees them a market (Int. Communal Farmer). There is no guaranteed market for Jatropha yet, it would have to be created in parallel to production.

Jatropha cultivation in communal areas by small-scale commercial farming units (Chapter 4) could face problems regarding leaseholds. From the interviews it was not clear whether this group of farmers would be authorized to grow Jatropha. This shows the limits to farmer self-determination in state-driven programmes, partly because many new medium-scale farmers are inexperienced in commercial agriculture and start off with debts.

5.2.4.3 Developmental effects

Compared with large-scale Plantation or Contract Farming Models, direct developmental impacts of the Commercial Farming Model on rural development and poverty are presumed to be quite limited. The relatively few commercial farmers have low capacities and higher opportunity costs for creating large output because of their high production intensity. But they could attain reasonable economies in Jatropha processing cooperatives. Were Jatropha technically viable, it would be a welcome option for crop diversification with several synergistic on-farm linkages (fuel, seedcake, permanence of crops, etc.) – but few community linkages.

Despite this model's limited potential to create direct effects, commercial farmers can play an important role in developing a biodiesel industry by introducing and spreading innovations (Int. NDC). Commercial farmers are less risk-averse than small-scale farmers and relatively independent in their decisions, at least when producing under freehold land conditions. A public good could be created if farmers were given incentives to conduct field trials of Jatropha and their research results were made accessible to the wider economy (positive externalities). It could be used to support governmental research and decision-making, thereby saving government resources and perhaps eliminating risks for late adopters. The Commercial Farming Model could play an important role in applied research and the dissemination of innovation, with processing industries or co-operatives transferring knowledge to other farmers and communities. Growing Jatropha on commercial farmland could also help to grow a critical mass of Jatropha seeds, needed for independent processors.

Commercial farmers' dominance in the development of the National Bio-oil Energy Roadmap and the early dynamics of Jatropha cultivation shows not only their agility but also their political organization and influence.

Finally, unlike foreign investors, commercial farmers are familiar with the local terrain and subject to increased control because of their Namibian citizenship. These factors reduce the risk of moral hazard.

5.3 Effects and institutions related to the Jatropha value chain and business models

The potential effects of various business models of the Jatropha value chain are summarized in 0, like those for bush-to-energy in 0. Each dimension presents only the most important and visible effects.

Figure 11 summarizes the institutions and policy fields related to the viability and effects of the major elements (actors and effect channels) of the Jatropha value chain and its business models. First it shows how the large number of institutions and institutional arrangements, including various government organizations, TAs, labour regulations and land-tenure rights, affect the viability of different models. The value chain arrangements and production decisions pre-determine the effects, but policies and institutions (some identical to those shaping viability, others different) can strongly modify them. For instance, the low profitability of alternative crops or livestock activities could induce farmers to produce Jatropha, perhaps by reducing food crop activities (and the availability of local food). The resulting incomes of farmers and wages of workers improve food security as long as food-purchasing power (a function of income and food price) is not reduced and food price spikes do not cancel out income increases. Price spikes can be influenced by price and trade policy.

Table 8: Jatropha value-chain business-model effects

Effect	Specification	Plantation model	Contract farming model	Community model	Commercial farming model
Economic	Income	• Lots of (permanent and seasonal) unskilled wage labour in production and processing (1,000–15,000 workers) • Some skilled labour in production and processing • Remittances to neighbouring regions and countries	• Cash income from subsidies and selling seeds (8,000–13,000 families in Kavango) • Wage labour in factories, nurseries, etc. • Community gets a potential share in production company	• Long-term upgrade of livelihoods (access to energy, increased productivity) for selected communities	• Wage income for additional farmworkers? (Direct effects of this model on target groups are expected to be minimal)
	Opportunity costs	• Subsistence farming (heavy competition for labour) • Alternative land uses (forestry, conservancies, livestock, small-scale commercial farming)	• Subsistence farming (some competition for labour and land) • Pasture (former fallow and mahangu land used for Jatropha plantation cannot be used for grazing)	• Conventional crop cultivation (mahangu, with little competition for labour and land if Jatropha planted as hedges)	• Commercial food production? (some competition for labour, land and capital)
	Spillovers & trickle-down	• Potential productivity increase from greater know-how and access to inputs • Increased employment on subsistence farms • Increased purchasing power	• Potential productivity increase from know-how and access to inputs (seedcake sold or used as fertilizer) • Increased employment on subsistence farms • Increased purchasing power	• Potential productivity increase from know-how and access to inputs	• Contribution to R&D • Innovation diffusion to late adopters (small-scale farmers)

Table 8 (cont.): Jatropha value-chain business-model effects

Effect	Specification	Plantation model	Contract farming model	Community model	Commercial farming model
Economic	Land	• Community loss of customary ownership/ control through long-term leaseholds for investors	• Farmers keep customary ownership of land but conflicts may arise from conflicting claims	• Customary ownership remains within community.	• Cultivation on freehold or long-term leases
	Special risks	• Risk of project failure: market uncertainty (conventional fuel price, biofuel policies), poor harvests • High costs of project failure (recovery of cultivated land, redundancy of wage labourers, market failure)	• Risk of project failure: market uncertainty (conventional fuel price, biofuel policies, future of CDM), poor harvests, conflicts about land rights • High costs of project failure (but land can be immediately restored for alternative uses)	• High costs of setting up and coordinating scheme • High costs of scaling up	• No significant changes expected
Sociopolitical	Health & education	• Reduced (youth) unemployment • Increased expenditures on education and health • Reduced/increased alcoholism	• Increased expenditures on education and health • Reduced/increased alcoholism	• Energy for education and health facilities	• Possible know-how transfer to resettlement farmers and farmworkers on new crops

Table 8 (cont.): Jatropha value-chain business-model effects

Effect	Specification	Plantation model	Contract farming model	Community model	Commercial farming model
Sociopolitical	Social structure & power relations	• Conflicts between TAs and communities • Very dependent on investors due to workers' weak negotiating powers • Changing gender relations as a result of employment policies • Risk of long-term loss of confidence in external projects due to failure or conflict	• Very dependent on investors due to farmers' weak negotiating powers • Possible self-organization of communities • Risk of long-term loss of confidence in external projects due to failure or conflict	• Self-organization and empowerment of communities	• No significant changes expected
Ecological	Biodiversity	• Almost complete clearance of natural vegetation • Monoculture threatens biodiversity • Risk of invasiveness	• Quasi-monoculture threatens biodiversity • Difficult to control seed spread (high risk if invasive)	• Deforestation reduced if Jatropha planted as hedges and oil replaces firewood	• Small risk to biodiversity if invasive
	Water	• Intensive irrigation • Pollution from fertilizer	• Some irrigation	• Some local irrigation fuelled by SVO	• No significant changes expected
	Soil	• Pollution from fertilizer	• Restoration of degraded soils?	• Restoration of degraded soils?	• No significant changes expected

Table 8 (cont.): Jatropha value-chain business-model effects

Effect	Specification	Plantation model	Contract farming model	Community model	Commercial farming model
Ecological	Carbon sink	• Initial loss of carbon sink through debushing • Possible replacement of conventional fuels	• Carbon capture if planted on already cleared land • Possible replacement of conventional fuels	• Carbon capture if planted on already cleared land • Possible replacement of conventional fuels	• Possible replacement of conventional fuels
Food security	Availability	• Net effect greatly depends on food markets and food production on the plantation	• Net effect depends on food markets	• Second-round effects from increased productivity	• No significant changes expected
	Access	• Increased cash income • Household self-sufficiency reduced	• Increased cash income • Decrease/increase of household self-sufficiency (intercropping?)	• Increased cash income (from second-round effects)	• No significant changes expected
	Stability	• Cash income partly seasonal • Depends on food-market stability	• Depends on food-market stability	• Depends on food-market stability	• No significant changes expected

Source: Authors

6 Conclusion: Policies and institutions challenged to ensure pro-poor bioenergy development

As formulated in our research question, this study sought to find out how Namibia can make bioenergy production support pro-poor rural development and food security. These imperatives set the rules of the game, provide incentives and disincentives and can help to regulate the dimensions of the developmental effects of any bioenergy initiative.

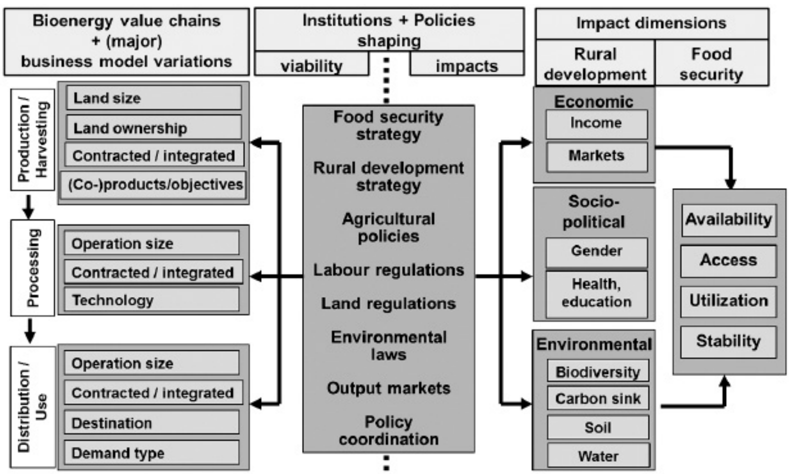
The institutional and policy environment for agriculture, rural development, food security and bioenergy in Namibia was presented in Chapter 3, and the policies and institutions that shape the two bioenergy value chains were identified and discussed in Chapters 4 and 5 and summarized in figures and tables. Below we combine and analyse both areas more generically in order to derive recommendations about how policy-makers can direct, regulate and support bioenergy value chains that are pro-poor and enhance food security and rural development.

This institutional and policy perspective is particularly relevant to bioenergy value chains since their introduction usually is not a matter of slightly modifying existing practices and economic activities but rather innovating many areas (technologies, products, institutions, attitudes, practices, etc.) – often at the same time. One crucial missing element can inhibit the whole chain; if one or several elements are incorrectly described, very undesirable effects can be created for some stakeholders or the whole society.

Policy-making only influences government institutions governed by formal policies (see Chapter 2.1) so we have concentrated on them and have taken traditional or informal institutions more or less for granted. This approach has limitations and leaves out important factors. For instance, the role of TAs in their communities is much broader and deeper than what is attributed to them in the Community Courts Act, and local attitudes towards foreign investors handicap new investments. In any case, the distinction between formal and informal institutions is unclear since modern institutions are increasingly trying to overrule traditional and informal ones. But the latter remain very powerful and resistant so manifold overlaps exist, especially because many formal institutions in rural areas are only partially implemented and respected. This creates hybrid regimes that render policy-making in SSA – especially for rural areas – extremely difficult (see Chapter 2).

Discussions and recommendations are grouped in eight key policy fields based on the obstacles and problems we encountered while analysing the different business models (see Figure 11). The key areas are: food security, rural development, agriculture, land, labour, environment, output markets and policy coordination. Institutional challenges to bioenergy production exist in each area because policies and regulations are lacking or do not function well enough to shape pro-poor bioenergy production. These challenges and the respective institutions are not only designed for bioenergy, but also for many aspects of rural development, food security and other areas. Although the challenges have often been known for a long time, because of the economical and political neglect of rural areas they did not become strongly visible and felt. Now that with new production and commercial options a massive wave of investments "hits" the rural areas in northern Namibia, the challenges are becoming acute. We acknowledge that reforming such important policy areas requires addressing more than just bioenergy, which can be only one aspect of the mentioned key areas. We do not claim to have developed complete concepts for each of the complex recommendation domains – just some aspects derived from our analysis of bioenergy.

Figure 11: Major policies and institutions affecting bioenergy value chains and their effects in Namibia



Source: Authors

Power relations were found to strongly influence the shapes and effects of some business models because they involve actors with very unequal economic standing and political influence. Institutional overlaps and incomplete implementation of laws in rural settings facilitates bargaining and power plays. Good institutions, such as protective labour laws, clear land rights or easily accessible litigation mechanisms, can attenuate power imbalances, but the institution building itself depends to some degree on power relations.

6.1 Food security concept and strategy

Policies for food security must address its various dimensions (Chapter 2.2) with a coherent concept and strategy. As we explain in the Chapter 3 overview and repeat in our analysis of bioenergy value chains, Namibia's current food policies exhibit certain incoherencies. Although most key national documents explicitly reject a strategy for food self-sufficiency in favour of a food-security strategy based on income, open food markets, some food-market stabilization and transfers (when needed), the desire for "Namibia being able to feed itself" has not been abandoned in these and other policy documents and was voiced by many interviewees. One major reason often given was the ongoing global food crisis and the fear of being dependent on international food markets. But inconsistencies date from well before the food crisis, and Namibia's conditions and external settings have not fundamentally changed.

Biofuels are difficult to defend in international debates when it comes to enhancing food production due to incorrect but tempting simplifications ('food vs. fuel') and the Namibian government appears to no longer wholeheartedly support this kind of agricultural activity. In the past, Namibia also tried to support other cash crops such as cotton which were expected to have similar effects on food production. With regard to food security, major differences are found in the various types of bioenergy production examined here:

Bush-to-energy value chains exhibit hardly any negative effects on the local availability of food. In fact, removing invader bush restores grazing area and having more cattle contributes to national food security and food self-sufficiency. At the same time, the new cash income for migrant workers – passed on to communal areas through remittances – enhances their economic access to food. The extent of the positive effects largely depends on wages, food stores and markets (and their prices), as well as on the opportunity costs of labour, which are assumed to not be very high.

Concerning Jatropha, the business models have substantially different effects on food security. In general, they offer strategies for diversifying from subsistence farming through the farmer's own cash-crop production or employment. Yet any improved access to food is overshadowed by some degree of competition for land, labour, capital, and perhaps most importantly, irrigated water, which causes great scepticism against Jatropha production on the part of the Namibian government and influential individuals. With the exception of water, we think that many concerns are poorly justified in general, although some risks and guidelines are needed (Other scepticism, in particular concerning economic feasibility, is most likely more justified, but these arguments do not play a major role here). Food production is a part of all of the Jatropha business models we studied – possibly in reaction towards governmental scepticism, yet showing that the 'food vs. fuel' simplification is untenable.

The official stance towards food security, especially the extent of food self-sufficiency, remains unclear. Namibia has no explicit food-security strategy that is in line with Vision 2030 and NPD 3 – two documents that express the government's long-term perspective but have no legally or politically binding effect. If food-price crises have led officials to favour greater self-sufficiency, it still must be incorporated into a food-security strategy. That would have spared the investors a lot of uncertainty and possibly caused them to channel their efforts into more promising and appreciated activities.

Bioenergy texts and many decision-makers are quite unclear about how to address the question of large-scale cash crops (including bioenergy) versus food crops. Size plays a role here. Whereas efforts were made to support cotton, the Green Scheme Initiative and Jatropha (as long as it was seen as a niche crop), there was great discomfort when it became clear that Jatropha cultivation might occupy very large tracks of land. Bioenergy apparently has been a game changer – creating new economic interest in agriculture and natural resource management. Since the 2008 food-price crisis, there has been renewed attention to the use of natural resources for agriculture and biomass production. Large-scale investments for all kinds of biomass production can become attractive and provide another argument in favour of a food-security policy that takes into account the new opportunities and challenges. A food-security strategy should, for instance, clarify whether the selected crops and natural resources are subject to governmental guidelines, if non-foods should and can be limited or their local production be (compulsorily) combined with food crops. The authors believe that income-based food-security strategies with a safety net are best for Namibia.

Competition with the conservation of nature as an income-producing activity and a food- security activity (see Chapter 6.6) could factor into the political ambiguity around biofuels. While nature preservation in itself is valuable and also attracts tourists to Namibia, tourism is a minor employer in the northern regions, where its employment effects for the local population are lower than those of agriculture; tourism is also biased towards better-educated people. Agriculture will continue to play an important transitory role in securing local livelihoods in the North for quite a while.

In any case, a clear and coherent strategy for food-security would create transparency and would bind individuals and sections within the government to talk with one voice regarding land use, including for bioenergy, limits to entrepreneurial action, and so forth. Such an orientation should guide policies in rural development, agriculture and other areas (see Chapter 6.8 on policy coordination).

6.2 A strategy for rural development

A Namibian policy for rural development hardly exists; instead there are a whole bunch of initiatives that could add up to one. The role of bioenergy in Namibia's rural development depends on the country's goals and strategies for its rural areas and how it integrates the production of bioenergy feedstock. As a form of commercial agriculture/forestry, bioenergy production is only one potential land use among others that must be assessed in the context of alternative uses and their effects on rural development. Whatever strategy Namibia chooses will have significantly different implications for bioenergy production because of trade-offs between different land and water uses and strategies to develop livelihoods.

Because most of Namibia's population – especially the poor – is concentrated in rural areas, rural development is crucial for reducing poverty and food insecurity, at least in the medium term. With Namibia's long-term aim of becoming an industrialized knowledge-based society, the inclusive growth of rural areas may not be important, meaning that long-term costs for development could be reduced. But this perspective is a result of the extreme income inequalities and dichotomies between North and South, rural and urban, black and white, mining and non-mining sectors, capital and labour – which are partly heritages of apartheid, but also reflect the weakness of the countries' urban economy and industry. There is insufficient pro-poor, job-creating urban development in Namibia. But even if more dynamism in urban development existed and rural-urban migration was further boosted, an overly hasty urbanisation could jeopardize the country's political stability. Achieving a fundamental transformation of the country's economic, demographic and structural nature will require decades, a smooth transition process and intelligent policies in order to avoid short- to medium-term problems such as major rural unemployment, food insecurity and the large-scale irreversible destruction of nature.

It is not clear which immediate and medium-term strategies Namibia prefers to use to stepwise reach the goals set out in Vision 2030 for the population and land use in rural areas. There are no sound guidelines about how to transform the rural areas, especially in the North, with a long-term vision and timelines. The general uncertainty regarding urban and rural development translates into unclear signals for land use, including the production of bioenergy. A comprehensive assessment is needed that cuts across various sectors, policies and a large but heterogeneous share of the Namibian population, which is divided into many different stakeholder groups. Such an assessment exceeds the capacities of this study. Below, however, we briefly address the major trade-offs.

The biggest and most controversial competition for land in Namibia is between productive land uses and nature conservation. Preserving natural habitats is a goal for rural development in its own right (see Chapter 6.6). While tourism and wildlife also provide income to local communities, interviewees indicated that their benefits to communities have been rather limited; agriculture, livestock and forestry are likely to be more productive and provide greater effects for food security and rural employment. At the same time, they may have more negative effects for the environment, depending on the specific kind of productive use: livestock versus agriculture, small-scale versus large-scale agriculture and food-crop versus cash-crop production (see Chapter 6.3). With careful debushing, bush-to-energy is theoretically a win-win situation in terms of economic use and ecological sustainability. In contrast, any large-scale monoculture Jatropha cultivation that replaces ecologically high-value ecosystems could severely stress the environment. Different stakeholders have a range of preferred uses for land in Caprivi and Kavango – from leaving the natural resources 'untouched' to engaging in large-scale intensive agriculture. The ministries, in particular the MAWF and the MET, have different views and lack coordination, as demonstrated by multiple gazetting of land in Caprivi. Any long-term strategy for rural development must insist on close coordination of many sectors (see Chapter 6.8) with consistent national, regional and local land (and water) use planning.

The main issue in Namibia's rural development is water, arguably the country's most scarce and therefore valuable resource, which presents bottlenecks for not only agriculture and nature but also urban development and mining. Water must be a cross-cutting issue in many policy areas (compare various sub-chapters within this Chapter 6). Permanent surface water, which is only available from the rivers at the borders, is also the subject of international interests and agreements – in particular the Okavango water. Any new, large-scale activity in rural areas that affects water availability and use must be carefully screened. The bioenergy effects range from saving water through careful debushing to high water consumption for irrigating Jatropha production. Irrigating relatively low-value energy crops makes no sense in Namibia.

The long-term rural development of northern Namibia requires improved governance of communal land or a concentration of lands or land-use rights and planning (see Chapter 6.5). So far, there is no comprehensive strategy – and no integrated, inclusive land-use planning for rural areas.

In the sparsely populated regions of northern Namibia, developing infrastructure represents high costs per inhabitant and requires a careful cost-benefit analysis. However, the transport infrastructure is already quite well developed and often serves multiple goals (tourism, agriculture, food trade, etc.). Since transporting bulky biomass is costly – although investors calculate that it is not prohibitive – there are advantages to producing SVO and biodiesel for local use. Larger-scale bio-based electricity needs grids, mini-grids and feed-in structures. When consumers have reason to hope that they'll be connected in the near future, they are less willing to accept non-grid solutions, so a solid plan for rural electrification is needed for generating electricity from biomass development (see Chapter 6.7).

Bioenergy could also play an important role regarding employment and migration. While the typical pattern of migration in Namibia is rural–urban (or rural–mining areas), successful bioenergy value chains would make it possible for people to migrate from one rural area to another. No other option promises to create similar levels of employment in the vast arid and semi-arid lands. For both commercial and communal rural areas it is important to create the proper incentives, regulations and training opportunities to improve migrant workers' employment opportunities (see Chapter 6.8) and make better linkages to their home areas, for example, by facilitating remittances.

Since the structural transformation of individual rural areas largely depends on local particularities, management must be flexible, with adaptable planning and implementation of investments and programmes – above and beyond a consistent institutional and policy framework. This is not possible from top down: the local population's participation is essential (see again Chapter 6.8).

6.3 Agricultural policies

6.3.1 General aspects

Agricultural policy is usually a set of policies for the various sub-sectors rather than one monolithic block, hence our use of the plural. Various agricultural policies and institutions set incentives for agricultural actors and activities and provide or facilitate access to input, service and output markets. They may also support stakeholder organizations, decision-making and governance. The various bioenergy value chains and business models are linked to and depend on these agricultural policies to varying degrees.

The various sub-sector price incentives and services for competing crops generally influence the entire bioenergy sub-sector. For some strategic crops (maize and more recently, mahangu), partial import protection boosts self-sufficiency – even if it leads to slightly higher prices, thereby reducing access to food (see Chapter 6.1 on food-security strategy and self-sufficiency) – and reduces the likelihood that other crops and value chains such as bioenergy crops can compete. However, diversifying would be very helpful, especially switching to rain-fed crops adapted to low and erratic rainfalls. Although agricultural policy has partly acknowledged this, previous efforts to introduce sugar and cotton as cash crops in communal areas failed because of market problems, the lack of domestic processing, high transport costs and low world-market prices.

Jatropha has greater chances of success because large export markets already exist and foreign investors can develop local processing. But Jatropha's productivity and economic feasibility are still unproven: the experience of the few producers who have cultivated Jatropha has been very varied. Since the government has not been involved in breeding or cultivation trials, it must rely on industry and third-country reports, which have often been overoptimistic, to evaluate investor proposals (see Chapter 5.1.1).

Bush-to-energy value chains seem worthy of support, and some aspects regarding its primary production are found in policies for livestock, land management, desertification, natural-resource degradation and forestry. These aspects, which we group under 'agriculture', need bolder and more systematic support in the form of research, extension services, land-use management and the development of local organizations.

Our research revealed the institutional and capacity weaknesses of Namibia's agricultural sector with regard to the introduction of new crops and processes. A local NGO was left to develop bush-to-electricity technology as part of a poverty programme and Jatropha was allotted to the private sector and given little public support. Bioenergy value chains span various sectors and require the cooperation of different ministries and agencies, with the MAWF in charge since that is where most of the crucial decisions must be made and the effects will be felt.

The place of agricultural institutions and policies, regulations and services in developing bioenergy largely depends on the particular business model: with a few crucial exceptions large investors are nearly independent of government, while smallholders are highly dependent on it.

6.3.2 Direct support to and regulation of small-scale farming systems

Direct support to small-scale farming systems includes measures to enhance productivity and boost access to markets by overcoming various market failures. Small- and medium-scale farmers must be able to access financial capital in order to increase the yields of existing fields, efficiency or the size of their farms. Interviewees cite the lack of capital for acquiring inputs such as fertilizer, irrigation and other equipment as the main obstacle to agricultural development in the Caprivi and Kavango regions. The farms that have recently been established on redistributed land also lack capital and guidance.[23] For bush-to-energy systems there is a double handicap because farmers lack capital not only to pay for debushing but also to purchase more animals to make use of their increased grazing capacities.

Most credit policies that require conventional collateral such as land, houses or other fixed capital do not consider the realities of small communal farmers who have only customary land-use rights and few assets (see Chapter 6.5). Other challenges to developing financial markets in rural areas are the long distances and poor infrastructure, which serve to make lending and repaying more costly and difficult than in urban areas. Microfinance, which does not require traditional forms of collateral, usually fills in this gap, but in Kavango and Caprivi no microfinance schemes operate. Trust or group-based systems and interlocked input/output product markets (e.g. Contract Farming Models) might provide alternatives to asset-based collateral and increase access to finance. But such alternatives rarely develop by market forces alone: government facilitation is crucial.

The desired effects can be supported. For instance, labour-intensive debushing increases pro-poor effects. Thus, measures can be designed to support labour-intensive methods while also creating incentives for labour enhancements such as the Agribank's subsidized debushing loan schemes, which offer better conditions for labour-intensive methods. This could also reduce the use of chemical sprays on encroachment bush and their negative environmental and economic consequences. Conditionalities like these must be carefully applied because they can easily lead to inefficiency, improper allocation – and loan defaults.

Credit is not necessarily a domain of agricultural policy; in fact nowadays, agricultural credit is viewed as belonging to financial and general economic policies to prevent contradictory and biased financial incentives across sectors. But specialized credit markets do exist. Renewable energy technologies are mainly funded through the Solar Revolving Fund (SRF), which is not, however, currently assisting bioenergy. Public and private-sector lending that is earmarked for poverty reduction is a financial segment used in bush-related initiatives, and microfinance is another possible source of small-scale funding for bioenergy.

23 Since off-farm income often finances major farm investments, it is a major determinant of farm size (Mendelsohn, 2006, p. 16).

The CDM mechanism for small-scale renewable energy projects could also provide financing for sustainable agricultural projects. Until recently, hardly any CDM projects were approved for Namibia; new capacities will have to be built within the MAWF for smallholders to support such bioenergy projects (see Chapter 6.7). Finally, in recent years the steadily diminishing value of carbon credits has also reduced the CDM's effect.

Apart from finance, access to know-how about agricultural practices, suitable crop options and markets is needed in order to enhance smallholders' productivity and commercialization. The farmers' lack of formal education, low risk-bearing capacity and other obstacles prevent them acquiring totally new knowledge and capacities on their own, although many smallholders could well conduct low-cost adaptive trials and low-risk innovations. Interviews revealed that small-scale farmers lack support from the extension system and government research: the various areas of extension, research and training to support agriculture appear to be poorly integrated. In commercial areas, established farmers train newcomers to fill the knowledge gap and prevent their new neighbours failing and negatively affecting their own farms through fires, destitution and instability. The introduction of new crops such as Jatropha to small farmers is stalled because of their deficiencies; similarly, better training for woodworkers could boost efforts to increase debushing (see Chapter 6.4 for a discussion of labour issues).

While individual smallholdings have much less potential to damage the environment than large farms, their aggregate effects can be huge. This risk justifies regulation, for instance, in water and pesticide use, on-farm forest and wildlife management, and so forth. Often a combination of agricultural and environmental regulations is needed, and thus good policy coordination (see Chapters 6.6 and 6.8).

6.3.3 Direct support for and regulation of medium- and large-scale farming systems

Generally, larger farms should and do need much less support for their economic activities. Unlike most smallholders, the relatively well-developed conditions of Namibia's forward and backward markets for agriculture allow big farmers to access finance, know-how, expertise, capital, input goods and output markets.

However, for medium-size commercial farms (which are rare elsewhere in SSA) there are certain limitations that are also found in the two bioenergy value chains. While some of the more ingenious, entrepreneurial and internationally connected farmers adopt and adapt existing 'medium-scale' technologies and practices – such as importing Jatropha seedlings through the cooperative system and conducting simple variety trials, adjusting debushing techniques to meet the requirements of special management situations, improving charcoal kilns or researching new market outlets for new products such as Jatropha oil or high quality charcoal – there are limits to such activities. Usually, activities as systematic breeding, adapting gasifier technology for local raw materials or processing beyond simply mechanically pressing Jatropha seeds, are beyond their scope.

The larger commercial farmers' well-developed cooperative and self-help system is able to overcome some of these limitations. In addition, some commercial farmers in Namibia are very well connected internationally, although the connections are often of an *ad hoc* personal nature. Medium-size commercial farmers have less need of direct support for services from agricultural policies and institutions than of clear guidelines, an enabling environment and stable investment conditions. Access to credit, more systematic access to knowledge and technology and help in organizing collective action are also useful. The National Bio-oil Energy Roadmap (Chapter 3.3.3) gives a good example of how the private and public sectors have defined a medium-size farmer's support needs.

Corporate agricultural investors are able to overcome some of the capital and access constraints, for example, by using Indian engineering to import and conduct systematic trials with several hundred Jatropha cultivars, installing large pump stations to distribute water over an extended pipeline net or financing Environmental Assessments (EAs). Any future production of Jatropha industrial by-products, which could be the only way to make market-oriented business models viable, requires large investors to finance industrial transformation. But even their corporations need support as well as regulations, such as political directives regarding food-crop versus cash-crop production that stem from food-security strategies (6.1) to help to reassure and harmonize the various administrations that are responsible for land acquisitions and guiding large investment projects. Not just large-scale but all operators need institutional support for getting varieties and seeds approved, and decisions regarding Jatropha's invasiveness (see Chapters 6.6 and 6.8).

Namibia's unfortunate experience with some FDIs seems to have created suspicion towards private investors and slowed the pace of FDIs, although most of the investments that went bust were not in agriculture. However, problems with Jatropha plantations seem to have resulted from systemic failure. The creation of trust funds (like those in the mining sector) to cover the risks of large-scale investment failures that cause social and economic hardships for communities, and to pay for the environmental damage and reparations has been proposed. FDI could be regulated in bilateral investment treaties by establishing special rules for agriculture to boost national food security. This, however, is a lengthy process, particularly if existing plurilateral treaties such as the SACU or EPAs must be revised, and would not cover the numerous investments by local actors or joint ventures in Namibia.

Environmental regulation (Chapter 6.6) must specifically apply to large-scale farms, which have greater means to degrade the environment, especially the risks that large monocultures will destroy wildlife corridors and use toxic products. On the other hand, they are usually managed by qualified staff, reducing some risks of environmentally hazardous practices. Technically they are also easier to control, but on the policy level they might be very influential and thus resistant to legislation and control. Their effect is more obvious, however, especially the risk that large monocultures will destroy wildlife corridors. Very large farms must submit EAs with clear plans for avoiding, or mitigating and repairing negative environmental effects.

6.3.4 Linking small farmers to large companies: The Contract Farming Model

One important business model of Jatropha production focuses on integrating small-scale farmers and/or the rural unemployed into value chains coordinated by large private companies (using FDIs or domestic investments). This approach helps to simultaneously overcome market failures and social risks and brings many potential benefits to communities, while also avoiding many disadvantages of large-scale plantations. Here, too, there are risks involved (such as the dependence of farmers and investors, project failure from broken contracts, crop failure, moral hazard and the cumulative environmental damage of many smallholdings) and high transaction costs for negotiating contract farming arrangements.[24] These problems and the model's ability to overcome weaknesses in both the pure smallholding and the pure large-scale models may justify the introduction of policies of public support for combination models.

One fundamental problem is that the business partners are highly unequal and partially incompatible. Smallholders are economically under-resourced, often belong to no interest groups, are unprofessional regarding formal contracts and usually have diverging needs, risks and expectations, whereas the large corporations that increasingly are in competition with other land investors have large formal capacities but often are unaware of the local reality and conflicts – but expect that the high benefits will compensate their high risks and pioneering engagement. Both sides have political connections that tend to amplify rather than dissipate tensions and mistrust. No formal fora exist for negotiations, largely because large agro-investors are a new phenomenon in northern Namibia, but also partly because policy coordination has been neglected (see Chapter 6.8).

The Jatropha Contract Farming Model demonstrates these problems: communication difficulties between the investor and the communities, opaque governmental decision-making and general uncertainties regarding legal land-use rights. All these create uncertainties and the fear of moral hazard on the part of investor and smallholders. The investor's domestic risks must be reduced by creating transparency and certainty, benefits promised to the community must materialize, and risks to it and to rural areas must be minimized. A major problem seems to be the lack of an appropriate body to mediate between investors, the government and the communities, a body that can incorporate Namibia's priorities for development, supports community decision-making and understands how to attract FDI to rural areas. An authority created by the government and funded by taxes and/ or a revolving fund financed by successful partnerships could play such a role – although this is not an easy endeavour since the various government authorities often belong to the conflicting parties or have incompatible goals. NGOs that are trusted by both parties could assume this role. A trust fund for involving smallholders in large-scale investments would also be helpful.

24 Although these problems partly transcend agricultural policies and institutions they are treated here.

FDI does not eliminate smallholders' need for extension services. While extension services for Jatropha would probably be privately organized, additional support from governmental services should help farming communities to boost the management capacities of farmers and farmer organizations, and to maintain or create a few sound options for diversification in order to limit dependence.

6.4 Labour regulations

Most bioenergy business models rely on the availability of unskilled workers, and effective labour policies are important for attaining the desired development outcomes. A growing bioenergy industry could serve as a catalyst for putting to work the many low-skilled labourers in rural areas – a step towards realizing Namibia's long-term Vision 2030. However, this solution is not without hurdles.

6.4.1 Economic viability vs. decent working conditions

The general dilemma of labour regulation is that international human-rights standards entitle every employed person to decent working conditions that do not endanger their well-being, but guaranteeing decent working conditions may be associated with additional costs for the employer that jeopardize the enterprise's economic viability. Yet it is clear that safe and economically attractive working conditions foster employee commitment and boost output. Since Namibia is a developing country, the use of cheap labour has particular relevance: unemployment rates are high and most of the unemployed are unskilled. From a global perspective, cheap labour is seen as a comparative advantage for foreign investors.

Therefore, the Namibian government policies must meet two imperatives which may partially conflict – creating favourable economic conditions for enterprises while also protecting employees' interests and well-being.

Namibian labour legislation is attempting to ensure special protection for farmworkers in rural areas, taking into account their very low educational levels and very high poverty rates, the remoteness of commercial farms and their limited independence regarding access to food and other goods and services. However, it does not account for the farming sector's different work requirements and arrangements (e.g. seasonality, piece work, foreign labourers) that are relevant to bioenergy production.[25] As elaborated in Chapter 4, woodworkers are not formally protected under the Labour Act – due to the nature of the work and the farmer's (or, more generally, bioenergy producers') economic and social situation, limited flexibility in legal provisions, a lack of agreement with, and even knowledge of, the other stakeholders' situations, as well as the relatively low total number of such jobs. It is not clear how seasonal Jatropha work would be and how labour conditions would correspond to standard provisions in the Labour Act. In any case, it is certain that the costs of barely-mechanized labour constitute a relatively high share of production costs, making these value chains labour-cost sensitive.

When debating the proper degree of formalization and standardization of labour regulations for workers in bioenergy value chains, it is important to consider differences in the size of the various enterprises. It is much more difficult for a small-scale communal farmer to abide by labour legislation than for a big commercial farmer or an investor. Informal labour often (but not always) results from an employer's economic need to by-pass strict labour regulations. Informal employment is often a coping strategy for both parties. In Namibia's communal areas, family or community members are often casually employed to help in the fields by weeding or ploughing. Such arrangements apply to Contract Farming Models and any small-scale farmer who wants to employ casual labour. Regulating such informal arrangements is not in the interest of the employer, who is unlikely to have the financial and administrative capacity to comply with labour regulations. Nor is it in the short-term interest of the employee who needs to earn additional income through casual labour.[26]

Even if labour legislation took the realities of labour in the bioenergy sector into account, it would still need to be controlled and enforced. The MoL does not have the personnel and financial capacities to implement the Labour Act and carry out labour inspections. Although complaint mechanisms do exist, most farm- and woodworkers do not have the means to make use of them and labour unions who could act as arbitrators and representatives, are not very active in rural areas. Hence, farm- and woodworkers remain more or less at the mercy of the farmers and bioenergy enterprises.

25 Exceptions exist for some businesses such as the hospitality and the building sectors.

26 After many years of negotiations, in late 2011 the MLSW proposed special regulations for the charcoal industry (MLSW, 2011).

One must also assume that there is a dynamic interrelation between formal and informal employment in poor countries. The more lenient the regulations, the more workers will be formally employed – with low benefits. But when regulations are strict, formal employment shrinks at the cost of informal arrangements or, if the economies of scale are significant and smaller units with low informal wages are not viable, enterprises simply close.

6.4.2 Bridging short- and long-term employment goals

While in the long-term, Namibia aspires to become a knowledge-based economy with large-scale agricultural production in the short term it must promote labour-intensive value chains to create employment for its many unskilled labourers. Labour policies must provide the proper incentives for investors *and* potential employees in the short term while collaborating with the relevant educational and training institutions in order to assure the long-term supply of skilled labour. But even with Namibia striving to become a knowledge-based economy, its need for unskilled labour will not disappear quickly, which means that labour migration policies are very important. If, in the long run, a workforce from outside the country is to substitute for the in-country workforce, adequate migration and work permit regulations must be developed in accordance with regional agreements (Chapter 3).

For the bioenergy value chains, skills for using and maintaining light machines for debushing (e.g. chain saws) could be enhanced. For business models that have no big investors, more know-how, skills and attitudes must be developed by the public sector (see Chapter 6.3). Bioenergy issues could also be integrated into the energy, agriculture, forestry and engineering curricula in higher education.

6.5 Land regulations

Land tenure plays a crucial role in ensuring that benefits materialize and risks and disadvantages are minimized in most bioenergy business models (with the possible exception of very small-scale Jatropha production models in integrated smallholder farming systems, in particular the Community Model). Land tenure issues affect bioenergy projects in two different ways. First, insecurities about land rights can prevent investors (and contract farmers whose ownership of planted and wild trees and bushes is unclear) from implementing a project and second, land rights and their allocation shape how a project affects rural development and food security.

Farmers in communal areas face three main problems: insecurity regarding lease rights that prevents them accessing credit; uncertainty about their rights to the land under planted trees and tree ownership and the risk of losing leaseholds should they be unable to pay leasing fees which inhibits contract farming for Jatropha and CDM projects; and the 'problem of the commons' which makes it harder to exclude free riders and moral hazard, thereby reducing incentives to invest in communal land improvement.

In commercial areas farmers are uncertain about which farms might be expropriated since the areas earmarked for resettlement are not clearly defined. This doubt reduces incentives for freehold farmers to invest in their land. As a result, few farmers in communal and commercial areas are able or willing to allocate resources for sustainably clearing their land from invader bush. Worse, continued bush encroachment threatens the success of the entire land reform programme by leaving less productive land available for redistribution so that each new farmer needs a larger area in order to create a viable farm unit.

Not only weak land rights but also the lack of consistent land-use planning hamper bioenergy (and many other land-based) projects. The need for a coherent strategy to develop rural areas is explained in Chapter 6.2. Crucial to this strategy is accommodating alternative – and sometimes conflicting – objectives for using limited land resources. Debates about possible uses for land are mined with controversial topics: Namibia's food self-sufficiency; the future of small-scale farmers and communal land tenure (which touches on issues of cultural identity and the TAs' autonomy); and protecting wildlife habitats. Accommodating these different interests is not only about determining land rights but is also about setting political and social goals for Namibia in various government departments like ministries and counties and for land with different owners and qualities (water is discussed in Chapters 6.2 and 6.6). Stakeholders obviously have divergent goals and different risks for the various options that must be addressed in national policies and strategies with regard to specific sub-regions and even plots. Planning instruments and processes for land, water and other natural resources are key to balance these interests. However, the lack of such planning seems to have put the brakes on the implementation of bioenergy (and other) projects in the Kavango and Caprivi regions. It is not clear which areas might be available for cash-crop and/or biofuel production and which are just earmarked for nature conservation or food production (in Caprivi and Kavango it concerns not just local consumption but feeding the entire nation), and also who will decide.

This lack of coherent planning for land (and water) use puts decision-makers under tremendous pressure regarding the allocation of local land. TAs and CLBs receive multiple requests for unprecedented amounts of land and must mediate different interests in the same areas. TAs in Kavango and Caprivi lack expertise about other forms of use rights such as leaseholds, and technical capacities such as trained clerical staff and equipment for administering formal land allocation processes. Factors like the availability of water and pastures are usually not considered when applications are reviewed. Conflicts, the lack of capacities and policies that have not been harmonized make it possible to exploit land allocation processes for political and personal agendas.

6.6 Environmental regulations

Bioenergy production in Namibia has been demonstrated to produce positive and negative environmental effects, with sharp differences based on the respective value chain, business model, production and harvest technologies and ownership of resources. Environmental policies have specific environmental focuses and regulate activities that may be noxious for the environment. The most relevant policies are the Environmental Management Act, the National Agricultural Policy, the National Drought Policy and Strategy, the Soil Conservation Act, the National Land Policy, the various Land Reform Acts, the Forestry Strategic Plan for Namibia, the Forest Development Policy and the Namibia Forest Act. The MET shares the task of dealing and coordinating environmental affairs with other ministries such as the MAWF, which also includes the DoF, which is important for regulation of various aspects of many bioenergy value chains (Ministry of Environment and Tourism [MET], 2008).

A key instrument for controlling bioenergy's environmental effects is the Environmental Management Act of 2007 (EMA), which is not yet fully in place although it is now generally accepted that all investment projects must submit Environmental Assessments (EAs). Environmentalists argue, however, that compared with the financial interests in implementing a project, EAs have little influence on a project's realization or adjustment.

With the investor financing the agency that conducts EA analyses, truly independent results are unlikely. Furthermore, EAs are only conducted for single projects. Although the EMA compels state agencies to conduct Strategic Impact Assessments of the aggregate impacts of many similar projects, some interviewees feared that the complexities are overwhelming and the agencies lack the capacity to gain sufficient understanding at that scope. Not only is there a lack administrative capacity and political will regarding EAs, there is also a time lag between the project's initiation and the measures taken to protect the environment.

Timely decision-making regarding the environmental effects of crops is required to avoid misplaced investments and the influence of politicians or pressure groups. There is no established process for declaring new crops invasive or environmentally harmless.

International conventions that could interfere with bioenergy strategies and options must be taken into account. It is expected that heftier debate and new international agreements on climate change will affect Namibia's bioenergy options in two ways: First, the CDM will become an increasingly attractive way of financing new value chains in the bioenergy sector (provided that the price of carbon credit does not drop too far) and second, donor funding will increasingly depend on a project's compliance with international climate-change-mitigation requirements. The current policies and political discourse hardly mention these topics. CDM is seen as a financing option for some Jatropha projects but investors are reluctant to count on it because of the dearth of pilot projects; it has not yet been used to combat bush. Adding the concept of sustainability of bush harvesting to national guidelines could help to mitigate climatic effects but preserving (or increasing) biodiversity and being concerned about climate change conflict with the (temporary or permanent) destruction of bush, which serves as a carbon sink. Similarly, FSC production ensures sustainable harvesting but is not fully compatible with the aim of eliminating bush regrowth (see Chapter 4.2). These complex and conflicting ecological interests hamper the advancement of bioenergy production.

Repairing or remediating the environmental degradation that is caused by productive land use often has negative economic effects for local communities. For example, wildlife conservation in the North of Namibia has shown that human–wildlife conflicts can cause local communities to seriously misapprehend nature conservation. However, resource management and conservation is key to the effectiveness and sustainability of the major economic developmental option that tourism presents for a region that lives off its natural resources.

Knowledge generation, distribution and management are needed to convince communities of the importance of protecting the environment, an issue that is particularly relevant for new bioenergy value chains. Research is required for making informed decisions, but in Namibia scientific research on the environmental aspects of agricultural land use at universities and other research bodies seems to be widely disconnected from practitioners like the agricultural extension services. Furthermore, the capacities of governmental agencies such as the MET and the MAWF are too weak to conduct research in new fields like bioenergy production. Better use could be made of the information contained in EAs but that cannot substitute for improving exchanges on the environmental effects of bioenergy value chains between researchers and practitioners.

Enforcing regulations is not just a challenge for bioenergy production. The size and remoteness of the sites where bioenergy is produced, and lacks of capacities, implementation and control make it difficult to monitor, assess and punish breaches of environmental regulations. Since a new value chain usually introduces more and unknown risks and does not just control the existing ones, cases like Jatropha need to be very closely monitored. EAs can indicate where to look. While large investors can bear the costs of such exercises, at least during the decisive early years, smallholders and small-scale projects cannot. Fortunately, taken individually the latter are also less risky. Enforcing environmental regulations and protecting public goods are tasks for the state, which needs intelligent institutional setups, including multi-stakeholder steering fora.

6.7 Bioenergy output markets

Declaring that bioenergy output markets constitute a policy and institutional challenge implies that Namibia can influence them. Here ‘output markets’ refer both to the national and international market for Jatropha (nuts, SVO/biodiesel, seedcake and other by-products) and bush products (charcoal, briquettes and electricity). Three problem areas related to policy aspects of output markets are discussed below.

6.7.1 The domestic market

Although an explicit goal of Namibia's energy strategy is to support renewable energies, there are no effective policies to promote it: No targets have been set for renewable energy production or feed-in quantities and there is little specific support for renewable energies, which hampers the development of a large domestic output market. There is also only minimal support from the government for bush-to-energy and Jatropha. While the private sector and donors seem to be interested in these markets, public measures are needed to address the multifaceted challenges of establishing such new value chains. The costs of producing such energy should be studied since it is clear that developing countries cannot afford to subsidize energy the way developed countries do, although some conventional energy options are subsidized – hampering the development of renewable energy. Those subsidies could be revised in order to develop sustainable renewable energies. The question is whether Namibia wants cheap imported electricity or more expensive locally produced renewable energy, and which option better promotes the country's rural development and food and energy security. Were Namibia to actively support bioenergy production and value chains catered to the domestic electricity market, price and tariff-related initiatives as well as (other) incentives and risk-reduction activities for investors, would all play important roles.

Similar considerations should be made for the local biodiesel market. While certain business models mainly target local off-market use (the Community Model or commercial farmers who only produce for use on their own farms), larger models could produce for local and national markets. Fuel standards, blending quotas and subsidies are the main instruments that have been used worldwide to promote biofuels. The National Bio-oil Energy Roadmap presented these and other important issues, but so far little has been done about them. Apparently the frustration of commercial farmers in the Maize Triangle (see Chapter 5.2.4) has caused the whole country to lose interest in Jatropha, although large-scale (mainly foreign) investors have continued and even accelerated their engagement. But even these large players require certain non-financial support and policy guidelines for their production.

A major drawback when liquid bio-energy (SVO and biodiesel) is introduced on the domestic market is likely to be the lack of standards regarding technical quality. Warranty schemes exist for conventional fuels, but there is no protective regulation for users and consumers if a machine, engine or other device using SVO and bio-diesel breaks down. Specifications are needed regarding the technical standards and the maximum amount of fuel blending. There also is no answer yet about who is responsible for assuring and monitoring quality standards and how this can be practically carried out. Obviously, in some business models such standards are not an issue because the producers use their own fuel, but know-how that may exceed local actors' capacities is needed for checking machinery quality.

Technical standards are also important for bush-to-electricity initiatives, for instance, to help manage fluctuations in the grids of independent power providers. The latter should be obligated to follow governmental standards.

6.7.2 The international market

Charcoal, briquette fines and briquettes are currently being exported from Namibia. Since the country is a net importer of electricity, exporting electricity is not a realistic option. On international markets, Jatropha is highly appreciated and is being widely tested for use in the aviation industry. Even if Jatropha oil were available in Namibia to eager international buyers, attaining the necessary economies of scale to satisfy international market demand would be difficult (especially for smaller production units; see Chapter 6.3) and would require still other developments, especially if new port facilities e.g. for liquids had to be constructed. Jatropha oil degrades with time and cannot be stored indefinitely. Small farmers often do not find a direct market for their product because they cannot deliver large enough quantities to attract traders; as often happens in the charcoal industry, smaller Jatropha processors have extra costs when selling to traders, which lowers their profit margin. SVO, in contrast, is relatively easy to store.

The failure to deliver international quality and adhere to social and environmental standards can hamper market access, not only through official regulations but also because of consumer perceptions and private standards. One example of regulations is the European Union Renewable Energy Directive (see Chapter 1.1). The criteria set there might ensure that the biofuels do not cause more environmental harm than they reduce GHG emissions, but they pose problems for producers in developing countries, particularly with regard to measuring environmentally relevant data and obtaining certification. As for 'private standards', there is a noticeable trend in Western markets to opt for products with 'a social and environmental conscience'. If an international campaign were to draw attention to the harsh labour conditions in bioenergy production, it could adversely affect marketing opportunities, even if correct under local legislation. FSC certification for forest products is a case of considering both social and environmental standards, requiring for instance briquettes to fulfil high consumer expectations and higher than the legal requirements in order to succeed as an environmental niche product. EU standards and certification schemes aim at fulfilling RED standards for liquid biofuels, thus creating a close link between public regulation and private standards. The governments of many developing countries view these developments as new barriers to trade – beyond the WTO disciplines – but many civil society organizations applaud them for being more rigorous than private standards. Obviously, Namibia cannot change international norms on its own but must figure out how to deal with them at the level of trade policy and by facilitating local adoption.

6.7.3 Additional revenue possibilities

In the production processes of both Jatropha and bush, additional revenue could be generated by efficiently marketing by-products and carbon trading, by using CDM or voluntary carbon markets, for example. The benefits of bush-to-energy by-products have been discussed; meat is ready to market nationally; meat from commercial areas could even be sold internationally. Beyond fulfilling national and international standards and regulations, the environmental effects can enhance the image of existing products or even create a new brand (Bushbloks). In addition, since some by-products such as water availability and biodiversity are public goods, they can attract government and public support.

Since only about one-third of the Jatropha fruit is oil, the rest could be processed for by-products. For investors and farmers in Namibia, however, this is still a theoretical issue. By-products that have been tested internationally include fertilizer for home-farm use or local markets, feed and ingredients for pharmaceuticals. All of them (except green manure) require large-scale industrial detoxification, chemical extraction and processing.

As for the carbon credit market, bioenergy projects in Namibia theoretically exhibit vast potential. However, interested investors reported that the potentials of the carbon market and the procedures that must be followed to reap the benefits appear to not be well known or understood. It is not clear whether it is possible to seek carbon credits with bush since permanent debushing destroys carbon sinks. But in light of the revenues that can be reaped from carbon credit schemes, Namibia would be wise to develop this market.

Most likely Jatropha and bush-to-energy will only become competitive for market production (beyond on-farm or community use) by combining several uses, as in the case of soy. This will be particularly relevant if the expected high yields fail to materialize.

6.8 Policy coordination

The last policy and institutional challenge to be mentioned – perhaps the most important one – is policy coordination. Once policies regulating diverse issues are in place, they must be coordinated to be mutually enhancing – or at least not be at odds with each other.

> *As in the case of any new instrument, where they have an innovative character, their major implementation constraints have to do with policy and institutional weaknesses, such as missing policies or regulations, insecure stakeholders' rights over the resource at stake, unclear and/or anachronistic institutional arrangements, conflicting policy signals, lack of information or misinformation, and weak implementation capacities.* (Dubois, 2008, p. 1).

Most of the bioenergy options that we assessed present new characteristics and require adapting – or drafting – regulations. Developing this innovative complex niche requires very careful coordination.

We have described and analysed the numerous stakeholders involved in bioenergy production in Namibia, many of which are authorized to make policy – meaning that policy coordination is essential for guiding the country's bioenergy initiatives. Three related problem areas that hamper policy coordination are discussed below.

6.8.1 Bioenergy as a cross-cutting issue

The fact that bio-energy is a cross-cutting issue complicates policy coordination. No single institution in Namibia regulates the bio-energy sector: many ministries and local institutions are supposed to play active roles and it is not clear who takes the lead and who has the final say.

Namibian policy-makers have acknowledged this by establishing the Cabinet Committee for Jatropha and the Woodland Management Council. But these institutions either are not functioning properly or are too weak to develop the value chains.

In the case of Jatropha, within the cabinet committee the MME is assumed to take the lead role for support and regulation. It is, however, not very pro-active but waits for the MAWF and the MET to take the lead, probably because they do not feel competent to deal with the key bottlenecks of the value chain – land acquisition, production, food security and environmental issues. The MAWF and the MET are mostly involved in the ecological and agricultural aspects of debushing, and the Woodland Management Council is a (largely inactive) advisory council. Bush-to-electricity should require the MME's involvement but the ministry does not appear to take this seriously. There are no external mediators to facilitate stakeholders' communication – nor are there any at the local level.

Considering the urgent need for the field to be regulated, ministry-level procedures are quite slow. This could be due to the notion that "*[I]n most cases regulation of Bioenergy can be seen to be in a state of flux as competing interest groups argue over the correct direction for different types of Bioenergy development*" (Practical Action Consulting, 2009, p. 31). Although competing interest groups do exist in Namibia, they are not arguing much, which indicates the need for the decision-making process to be formally organized. Probably because of the 'power vacuum' despite Namibia's vast potential and serious investor interest, there is no explicit bioenergy policy. Although provisions for renewable energy development are found in several strategy papers, only a non-binding national commitment has been made.

Liquid biofuels in particular show the problem with coordination and policy decision-making that is both too fast and too slow. Despite the fact that the National Bio-oil Energy Roadmap shows how to get started in the emerging bio-economy, it has never been made policy, and has not been pursued very actively from the public side. The government has not developed an official opinion – nor did it officially publish the moratorium on Jatropha cultivation in a timely manner. Although numerous government officials claim that not enough is known to take a decision about bio-energy, this perception is not reflected in the initiatives made to close this information gap. As the Renewable Energy and Energy Efficiency Institute (Int. REEEI) put it, "*[T]he challenge with biofuels is that there is a lot of talk and not much* *action*". However, given the big technical and managerial problems, it is fortunate that quantitative targets were not established. As a first step, a forceful move was needed to provide a better basis for taking a decision across the sectors.

6.8.2 A scattered national policy framework

In order to coordinate specific bioenergy policies, a series of more general guiding policies or 'strategies' must be drafted and implemented first (see previous sub-chapters). One of the reasons why many decision-makers said that they do not know enough to develop a bioenergy policy is because some crucial guiding policies are lacking: they mentioned, for example, the possible negative effect on food security from bioenergy production. But there is no comprehensive food-security policy. Bioenergy is a renewable energy yet without a policy for renewable energy it is difficult to establish (coordinate) a desirable national energy mix. Another practical point is the lack of a policy on bush encroachment. A 'Namibian rangeland management policy and strategy' is "*being developed*" (Int. DoF), suggesting that so far there has been little coordination of the competing interests and mechanisms for tackling them.

6.8.3 Support for bioenergy value chains

Another problem for 'policy coordination' is the insufficient secondary support for bioenergy value chains. Within existing policies, incentives for bioenergy production are quite limited despite the presumed potential of the value chains. It is not even clear if this potential is supposed to be developed. Arguably, partial support is provided within programmes and projects that are not part of a coherent bioenergy policy – like the few that are oriented around bush-to-electricity or Jatropha activities. But even with a comprehensive bioenergy framework, secondary support might still be required for its implementation.

Capital is one important area of support that is repeatedly mentioned, particularly for small and medium-scale farmers in communal areas. If Namibia decided to seriously foster bioenergy value chains, it would have to revisit policies regarding access to capital in both commercial and communal areas (see also Chapters 6.3 and 6.5).

Government extension services are not geared to supporting bioenergy production, probably due to the lack of an official bioenergy policy as well as the agricultural sector's hesitancy to embrace new opportunities (Chapter 6.3). Interviewees cited the need for mediators to support negotiations and manage conflicts between investors and communities and between investors and contract farmers, as well as between other stakeholders.

Support for bioenergy value chains must come from several sides and be targeted at the relevant bottlenecks of the various chains and business models. In addition to efficient policy coordination, this requires analysis, monitoring and knowledge management.

While pleading for harmonizing policies, public opinions and attitudes towards bioenergy, we acknowledge the limitations of a top-down planning approach. The extremely complex and heterogeneous field of bioenergy has been politicized. Official regulations will not be able to iron out all the risks, divergent perceptions and positions of the many stakeholders; as with many issues regarding rural development, solutions must be adapted locally, which can mean very different things in different locations. Furthermore, ideal solutions may change over time with the emergence of new information and technologies and changes in internal and external circumstances. When starting to produce bioenergy, public debate and case-to-case decision-making based on local circumstances are indispensable for finding solutions.

7 Recommendations

Our recommendations correspond to the eight sections of policies and institutions for developing pro-poor bioenergy. Many of the recommendations are far-reaching, with bioenergy issues only minor elements in some of the larger policy fields. Obviously not everything can be done in the short term, and there is need for more reflection and information about bioenergy than this study can provide.

Food Security

Conduct a nationwide study on food security and related factors (self-sufficiency, modes of production, food market properties and transfer programmes such as food packages, income patterns and migration) as announced in the MAWF Strategic Plan 2008/09 – 2012/13. Continuously **monitor the status of food security**.

Design a national policy for food security as foreseen in the MAWF Strategic Plan with:

- Clear concepts for food security and food self-sufficiency at the national, regional and household levels that incorporate the needs of communal areas and small farmers;
- A critical assessment of the strategic, political and economic need for **food self-sufficiency;**
- Agriculture's role in food security – as a provider of food and a source of income.

Specific considerations for food security for different population groups that take into account dependence on a single food provider with monopolistic power in the remote rural areas where bioenergy is likely to be produced.

Using the food-security strategy, **clarify the government's position on cash crops** (particularly in communal areas), especially cash crops used to produce bioenergy. This must include:

- Reviewing and harmonizing other policies in terms of possible synergies and contradictions: the Poverty Reduction Strategy (PRS), National Agricultural Policy, Social Security Act and Draft White Paper on the Energy Policy of Namibia;

- Clearly defining the minimal requirements (if any) of large agricultural investors regarding food security, while also taking into consideration the competitive links of large and small food providers;
- Promoting spill-over effects from cash-crop to food-crop production;
- Widely propagating the strategy to sensitize all stakeholders and policy-makers and harmonize their public positions.

Rural development

Clarify how land can be used to develop rural areas (agriculture, livestock, forestry and conservation for tourism) economically, ecologically and sociopolitically, and **assess how migration can help** to reduce rural poverty within realistic time horizons.

Derive a realistic strategy to alleviate poverty and develop rural areas, including options for income generation versus transfers and migration:

- Clarify the (transitional) role of rural areas in the long-term 2030 Vision, including job creation (especially for youth), food production and nature conservation;
- Derive strategies to integrate the long-term vision and short- to medium-term needs;
- Assign agriculture a realistic role in rural development – as a provider of livelihoods, income and food security – in light of alternative sources, including migration, and the cost of developing options;
- Clarify the role that bioenergy and cash crops play in rural development.

Agricultural development

Align agricultural policy with food security, priorities for rural development and government resources.

Clarify the role of bioenergy feedstock within priorities for agricultural development. This will require:

- Increasing the information base for assessing potentials and threats by conducting public research on yield potentials and environmental risks.
- Integrating the private sector (commercial farmers and private investors) in research and development on bioenergy;

- Comparing bioenergy feedstock with other crop options in the context of rural livelihood challenges and strategies;
- Deciding on how to start a bioenergy industry, beginning with government trials and the continuous monitoring of private actors' small plots, only later starting large-scale cultivation.

Adapt agricultural support systems to the needs of the rural poor for each model. It will be important to:

- Improve the rural poor's and medium size economic actors access to capital, for example by designing microfinance schemes for rural livelihoods and financing schemes for renewable energy projects, clarifying the CDM's potential for small-scale applications and designing support mechanisms;
- Improve access to know-how and information about bioenergy and other options for crop diversification by enhancing the interplay of extension services, agricultural research and training based on communal farmers' needs; increase extension services and agricultural capacities.

Design a clear strategy for FDIs (or large national investments) in rural areas, especially for bioenergy. Some points must be to:

- Clarify the opportunities and threats of FDIs;
- Consider adding/amending national food-security issues to investment treaties;
- Design incentives and regulations to lower social costs and risks, for example a trust fund to alleviate environmental damage;
- Create instruments to mediate between investors, communities and the government in order to balance Namibia's developmental priorities with investors' needs.

If deemed a useful element, actively **support new agricultural value chains** in Namibia to boost value addition and diversification.

Create **incentives for commercial farmers to use labour-intensive debushing techniques** that respect environmental and labour standards.

Labour

Design labour policies that take account of the particularities of rural economies (seasonality, piecework wages, remoteness, internal and trans-boundary migration) and carefully balance employment opportunities and job characteristics.

Build up and support communication channels for the unemployed and the informal sector to make their concerns heard when labour policies are being formulated.

Enhance union capacities – especially outreach – to deal with matters of special concern to woodworkers. Alternatively, support the establishment and functioning of formal representations (associations) of certain classes of workers, e.g. woodworkers.

Improve communication between stakeholders – workers, unions, employers and government. Operationalize bodies like the Woodland Management Council to host discussions. Deepen political stakeholders' understanding of realities on the ground so they can debate with informed arguments.

Improve the financial base, quality and quantity of **labour inspections** by the MLSW (Ministry of Labour and Social Welfare) and dispatch them to rural areas.

Prepare a strategic plan for long-term employment goals including: training workers to access 'new' jobs in the emerging bio-economy and related sectors that demand higher qualifications; bringing training opportunities to rural areas; offering relevant university courses for highly qualified employees and entrepreneurs; and facilitating employment for and better controlling foreign labourers.

Land

Clarify the disadvantages and advantages of communal land rights for the rural poor. **Design policies that remedy the disadvantages** and bridge the gap between the economic opportunities on freehold as opposed to communal land while respecting traditional sociocultural norms as much as possible.

Design an inclusive, integrated policy for using land and natural resources that also defines the space for bioenergy projects. The policy should support cross-departmental and inter-agency cooperation at the national, regional and local levels to ensure a transparent allocation process and accelerate decision-making and implementation. This might include technical, procedural, communication and financial cooperation.

Clarify the role of TAs and CLBs in planning and managing natural resources at the local level. Support and invest in capacities at all levels of land administration in order to accelerate land registration processes and help TAs and CLBs to deal with new kinds of requests, such as large-scale bioenergy projects and requests from foreign investors.

Beef up local structures for communication and dispute resolution to prevent conflicts and enhance the legitimacy of decisions made by local communities.

Defend economic and ecological principles when implementing land reform.

Support sustainable debushing initiatives to increase the quality and amount of land available for redistribution.

Ensure farmers' security of tenure and **support resettlement farmers** with regard to sustainable land use and natural resource management.

Environment

Conduct independent research on the environmental issues of bioenergy value chains such as invasiveness, toxicity, water and biodiversity.

Introduce knowledge management systems to allow political decision-makers, the public, farmers and investors to make informed risk assessments.

Design and implement **clear regulations for the productive use of natural resources**, such as producing bioenergy or for nature conservation.

Ensure adequate compensation to the rural population for the negative economic effects of environmental regulations (**such as** transfers or benefit-sharing).

Design integrated land- and water-use planning taking into account the environmental effects of bioenergy (and other) projects.

Develop the capacities of local communities in sustainable resource-use planning and implementation.

Strengthen forestry and environmental authorities to implement and enforce regulations and provide permits and authorizations. Enable them to control the application of chemicals (e.g. for debushing) and their effects.

Bioenergy output markets

Develop a National Renewable Energy Policy. Establish targets for producing and using renewable (bio-) energy in Namibia with the goal of creating a suitable, reasonably priced mix of conventional and renewable energies. For instance, targets could be reached by establishing minimum feed-in quantities of renewable energy, or mandatory blending requirements, with due attention to costs and flexibility.

Design incentive schemes to achieve the economies of scale needed on national and international markets. Schemes could include loans, high feed-in tariffs, guarantees, tax rebates, support for coordinating research and development and Public-Private-Partnerships, facilitating contacts, legal and contract assistance and subsidies. All these should be made as cost-efficient as possible, for instance by gradually reducing funding, differentiating by the scale of operations or including actors' own contributions.

Design standards for bioenergy products (e.g. sustainability criteria, and technical and quality standards) that correspond to regional or international standards to create trust and respectability and **establish a monitoring system** to assure implementation. Regional cooperation may be most efficient in this area.

Facilitate access to carbon markets, such as the CDM and voluntary markets, by developing the necessary institutions and capacities in Namibia. Lobby for rules to be adjusted to the needs and capacities of developing countries. Ensure access and benefit-sharing systems.

Policy coordination

Include bioenergy in a National Renewable Energy Policy and monitoring system by streamlining procedures and negotiations and effectively informing stakeholders. Identify one ministry to guide policy implementation and formulate incentives and obligations for other ministries to cooperate.

Develop an inter-agency bioenergy knowledge base. Cooperate with regional bioenergy initiatives on research and development, policies and standards.

Appoint or strengthen mediators to reconcile different interests and facilitate communication between stakeholders, at the inter-ministerial and local levels.

Coordinate the formulation and implementation of coherent policies around bioenergy value chains – food security, rural and agricultural development, land, labour, environment and energy.

Overarching considerations

Our study has shown that promoting and regulating bioenergy is a very complex undertaking that generates many effects beyond its specific value chains. The key issues regard the production of feedstock and food, especially the ownership and use of natural resources. Theoretically, these issues should be separated from food security but that is often not done or even possible. Given bioenergy's potentially huge scale due to energy needs in Namibia and abroad, issues regarding distribution and ecology could become of major importance, particularly in low-income countries.

Various policy fields regulate impacts and impact channels. In poor countries, the general regulatory framework for bioenergy and managing its effects tends to be deficient, the capacities weak, and weaknesses regarding policy coordination even more deficient than in wealthier countries. High regulatory requirements and low capacities make overall positive effects less likely and negative effects real threats. On the other hand, compared with other renewable energies, bioenergy has huge potential in low-tech, low-capital, natural-resource-rich countries.

This study shows that the challenges are more often found in the details of the business model than in general considerations of the value-chain. Bioenergy's potential and risks increase with the size of the actors involved, particularly the large-scale land users.

Compared with other SSA countries, Namibia is in a relatively comfortable situation with regard to state and private-actor capacities. However, although it has made some progress with the regulatory framework, its overall industrial policy capacity remains weak and implementation capacities, particularly of governmental agencies, limited (Rosendahl, 2010). National and international private actors are more present than is usual in SSA. Coalitions of commercial farmers and entrepreneurs can develop considerable drive to innovate, but steering the bioenergy sector is an enormous challenge, and more so for communal areas where the institutional and economic framework conditions are weak and the stakeholders are ill prepared to deal with massive (foreign) commercial interests in land. Any national bioenergy strategy must take into account that conditions and business models are very different and require differentiated regulation and support.

For Namibia, and even more for SSA countries with fewer capacities, scanty experience and big issues at stake, it is better to slowly introduce bioenergy – through pilot projects accompanied by good research, monitoring and evaluation – before scaling up. For some non-scalable issues (e.g. feed-in tariffs and invasiveness attestation), open, scale- and technology-neutral formulations should be developed to facilitate and regulate the emerging sector. Scaling up can be prepared and framework policies and institutions improved and harmonized in light of the results of the pilot projects. Adjustments and exit strategies should be considered from the beginning.

This general recommendation is in line with recent lessons learnt in Europe about the political economy and governance of bioenergy policies given uncertainties and market and state failures. Purkus, Gawel, & Thrän (2012) urge that careful, flexible and prudential procedures should be elaborated to find the second and third best options instead of setting bold, inflexible goals and strategies. They concur with Collier & Venables (2011) who propose that large-scale land acquisitions be pioneered then lessons extended by bidding mechanisms to other investors. Authors of advice and guidelines for bioenergy policy development in SSA (e.g. Jumbe, Msiska, & Madjera, 2009; DIE, GTZ, & InWEnt, 2010; IRENA, 2011; COMPETE, 2012; Janssen & Rutz, 2012; Global Bioenergy Partnership [GBEP], 2012; UN Energy, 2012; FAO & Bioenergy & Food Security [BEFS], 2012) take into account many of these suggestions, but do not always propose a flexible, evolutionary basis. Some policy and institutional frameworks should be given priority since they guide others, in particular food security and rural development.

One other issue not developed in this study will be crucial for the success of bioenergy in SSA: its costs and competitiveness with other energy sources. Poor countries cannot afford to subsidize energy over the long run. Support should be mainly in the form of upfront public investments in infrastructure and management. This is even truer for fossil energies, whose subsidization constitutes a perverse disincentive for renewable energies and is often economically unsustainable because it creates vested interests and path dependencies that end up being more costly than renewable energy. Renewable energy, including the development of bioenergy, must be cleverer and much more cost-sensitive in SSA if it is to compete with the region's many other pressing needs.

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Annex

Interview itinerary

We spent the first two – of our eleven – weeks in Windhoek conducting a first round of interviews with government institutions, universities, research institutes and NGOs. During the next four weeks we conducted interviews in the Maize Triangle and the Kavango and Caprivi regions, talking with farmers and farmworkers, representatives of the private and public sectors, and NGOs. After that, we held a weeklong round of follow-up interviews in Windhoek. Three weeks were used to analyse the information and draft a preliminary report. Our last week in Namibia was again spent in Windhoek, where we presented our preliminary results in a workshop with our local partner organization, the Desert Research Foundation of Namibia (DRFN), and the Polytechnic of Namibia. More than 50 stakeholders attended, and each region we had visited was represented.

Interview partners and dates

Organization	Name	Interview date
Ministries & governmental institutions in Windhoek		
Namibian Agronomic Board (NAB)	Christof Brock	18 Feb. 2009
Ministry of Agriculture, Water and Forestry (MAWF)	Marina Coetzee	25 Feb. 2009
Ministry of Agriculture, Water and Forestry (MAWF)	Dirk Prinsloo	26 Feb. 2009
Ministry of Lands and Resettlement (MLR)	Robert Ridgway	26 Feb. 2009
National Planning Commission (NPC)	Olivier Vandenbussche	27 Feb. 2009
National Planning Commission (NPC)	Thomas Kroll	27 Feb. 2009
Ministry of Finance (MoF)	Dagmar Honsbein	28 Feb. 2009
Ministry of Labour (MoL)	Ndili Nghimutiwa	30 Mar. 2009

Interview partners and dates (cont.)		
Organization	**Name**	**Interview date**
Ministry of Trade and Industry (MTI)	Lucia Radovanovic	30 Mar. 2009
Ministry of Trade and Industry (MTI)	Wilbard N. Nashandi	30 Mar. 2009
Ministry of Lands and Resettlement (MLR)	Robert Ridgway	31 Mar. 2009
Ministry of Lands and Resettlement (MLR)	Maria Kasita	31 Mar. 2009
Agricultural Bank of Namibia (Agribank)	Hohobeb Masilo	31 Mar. 2009
Namibian Development Corporation (NDC)	Willem A. Kruger	31 Mar. 2009
Directorate of Forestry (DoF)	Josef Hailwa	1 Apr. 2009
Electricity Control Board (ECB)	Siseho C. Simasiku, Rojas Manyame	1 Apr. 2009
Ministry of Mines and Energy (MME)	Noddy Hipangelwa, Nico A. Snyders	2 Apr. 2009
Ministry of Labour (MoL)	Felix Musukubili	3 Apr. 2009
NamPower	David A. Jarrett	3 Apr. 2009
Ministry of Mines and Energy (MME)	Imanuel Nghishangele	27 Apr. 2009
Ministry of Environment and Tourism (MET)	Mr Schikapongo	28 Apr. 2009
Ministry of Environment and Tourism (MET)	Mr. Nghitila	28 Apr. 2009
Ministries & governmental institutions in the Maize Triangle, Kavango and Caprivi		
Roads Authority, Grootfontein	Nico Cavhura	4 Mar. 2009

Interview partners and dates (cont.)		
Organization	**Name**	**Interview date**
Kavango Regional Council, Rundu	Hon. Johannes U. Thighuru	10 Mar. 2009
Ministry of Agriculture, Water and Forestry (MAWF), Rundu	Berfine M. Antindi	11 Mar. 2009
Councillor, Rundu	n.n. guided by John Moremi	11 Mar. 2009
Councillor, Ndiyona	Sebastian Karupu	11 Mar. 2009
Namibian Agronomic Board (NAB), Katima Mulilo	Hon. Geoffrey J. Chillinda	16 Mar. 2009
Agricultural Bank of Namibia, Katima Mulilo	Jonathan Mahareno	17 Mar. 2009
Communal Land Board (CLB) Katima Mulilo	Yukuta Namasiku	18 Mar. 2009
Caprivi Regional Council	Cletius S. Sipapela	19 Mar. 2009
Ministry of Agriculture, Water and Forestry (MAWF), Katima Mulilo	Methew Mushabati	20 Mar. 2009
Ministry of Land and Resettlement (MLR), Rundu	Alfred Sikope	23 Mar. 2009
Agricultural Bank of Namibia, Rundu	Dustin Mungalifa	23 Mar. 2009
Namibian Development Corporation, Rundu	E. M. Likando	25 Mar. 2009
Donors and international organizations in Windhoek		
German Technical Cooperation (GTZ)	Christian Gräfen, Kirsten Probst, Tanja Pickardt	23 Feb. 2009

Interview partners and dates (cont.)		
Organization	**Name**	**Interview date**
European Commission (EC)	Claus-Peter Hager	24 Feb. 2009
German Financial Cooperation (KfW)	Lydia von Krosigk, Sven Neusinger	24 Feb. 2009
German Embassy	Stefan Sckell	27 Feb. 2009
Donors and international organizations in the Maize Triangle, Kavango and Caprivi		
German Development Service (DED) / Department of Forestry (DoF)	Wolfgang Hesse	23 Mar. 2009
German Development Service (DED) / Ministry of Lands and Resettlement (MLR), Rundu	Sebastian Seitz	23 Mar. 2009
Universities, research institutions & NGOs in Windhoek		
University of Namibia (UNAM)	Mutjinde Katjiua	19 Feb. 2009
Polytechnic of Namibia (Polytechnic)	Lamek Mwewa	19 Feb. 2009
Desert Research Foundation of Namibia (DRFN)	Robert Schultz	20 Feb. 2009
Mukwamahlanga Tukondjeni Community Trust (MTCT)	Angelica Bergmann	23 Feb. 2009
Polytechnic of Namibia (Polytechnic)	Ibo Zimmermann, Dave Joubert	24 Feb. 2009
Institute for Public Policy Research (IPPR)	Matthias Schmidt	31 Mar. 2009

Interview partners and dates (cont.)		
Organization	**Name**	**Interview date**
National Botanical Research Institute of Namibia (NBRI)	Gillian Maggs-Kölling, Johan van Eck, Ben Strohbach	1 Apr. 2009
World Wildlife Fund (WWF)	L. Chris Weaver	1 Apr. 2009
Labour Resource and Research Institute (LaRRI)	Hilma Shindondola-Mote	2 Apr. 2009
Polytechnic of Namibia (Polytechnic)	Samuel John	2 Apr. 2009
The Renewable Energy and Energy Efficiency Institute (REEEI)	Selma Shitilifa, Lydia Shekupe Mlunga, Kudakwashe Ndhlukula	2 Apr. 2009
Universities, research institutions & NGOs in the Maize Triangle, Kavango and Caprivi		
Cheetah Conservation Fund (CCF), Otjiwarongo	Bruce Brewer	2 Mar. 2009
Namibian Nature Foundation (NNF), Rundu	Mr. Asser, Mr. Paul	9 Mar. 2009
Women's Group, Rundu	Elfriede Calira	11 Mar. 2009
Mashare Agricultural Development Institute (MADI), Mashare	Ms. Shipepe	12 Mar. 2009
Bagani Research Station, Divundu	Thomas Constanti	13 Mar. 2009
Mukwamahlanga Tukondjeni Community Trust (MTCT), Katima Mulilo	Patricia Siska	17 Mar. 2009
Integrated Rural Development and Nature Conservation (IRDNC)	Mr. Munali	18 Mar. 2009

Interview partners and dates (cont.)		
Organization	**Name**	**Interview date**
RISE	Clemens Shipanga	24 Mar. 2009
Private sector in Windhoek		
Enviro Dynamics (Workshop)	Carol Steenkamp	19 Feb. 2009
Stern Link Financial Services (Pty.) Ltd.	Diederik Jankowitz	223 Feb. 2009
SAMICOR / L.L. Biofuels	Ely Nefussy, Kombadayedu Kapwanga, Alon Vered	25 Feb. 2009
Baumann & Meier Workshop CC	Uwe Baumann	20 Mar. 2009
Consulting Services Africa (CSA)	Carter Hartz, Danie Nel	20 Mar. 2009
Jumbo Charcoal / Consulting Services Africa (CSA)	Ian Galloway	20 Mar. 2009
Solar Age Namibia	Conrad Roedern, Marco Simoni	2 Apr. 2009
AGRA Co-operative Ltd. (AGRA)	n.n.	3 Apr. 2009
VO Consulting	Detlof von Oertzen	24 Apr. 2009
Private sector in the Maize Triangle, Kavango and Caprivi		
Namibia Bioenergy Investments	Terance Spyron	12 Mar. 2009
Caparo Investments	Francois Wahl	16 Mar. 2009
SAMICOR / L.L. Biofuels	Alon Vered, Ricky Lilami	16 Mar. 2009
SAMICOR / L.L. Biofuels	Ricky Lilami	19 Mar. 2009

Interview partners and dates (cont.)		
Organization	**Name**	**Interview date**
Standard Bank Namibia	Devalt Svart	20 Mar. 2009
Carbo Namibia (Pty.) Ltd.	Hans Steyn	25 Mar. 2009
Jumbo Charcoal Okahandja	Brano	27 Mar. 2009
Unions & other institutions in Windhoek		
National Charcoal Producers Association (phone interview)	Willem Enslin	27 Feb. 2009
Namibian National Farmers Union (NNFU)	Laura Imbuwa	27 Feb. 2009
Legal Assistance Centre	Willem Odendaal	2 Apr. 2009
Namibia Emerging Commercial Farmers' Support Program	Bertus Kruger	3 Apr. 2009
Agricultural Employers Association	Giel Schuumbee	3 Apr. 2009
Unions & other institutions in the Maize Triangle, Kavango and Caprivi		
Central North Regional Electricity Distributor (CENORED),	Reimo Bauer	2 Mar. 2009
Kavango Regional Jatropha Growers Association	Mathews M. Mushambe, Ernest Tjembe	9 Mar. 2009
Namibian Broadcasting Corporation (NBC), Rundu	Wilfred Njambe	10 Mar. 2009
National Jatropha Growers Association, Rundu	Vincent Likoro	10 Mar. 2009
Caprivi Regional Farmers' Union	Mathias Semy	16 Mar. 2009

Interview partners and dates (cont.)		
Organization	**Name**	**Interview date**
Caprivi Regional Farmers' Union	Martha	17 Mar. 2009
Namibian Broadcasting Corporation (NBC), Katima Mulilo	Jimmy	18 Mar. 2009
Central-Northern Regional Electricity Distributor (CENORED), Katima Mulilo	T. Iyambo	18 Mar. 2009
Kavango Regional Farmers' Union	Reino Aisindi	23 Mar. 2009
Farmers & farmworkers in the Maize Triangle, Kavango and Caprivi		
Commercial Farmer, Maize Triangle	Maans Fourie	3 Mar. 2009
Farmworkers, Maize Triangle	n.n, Maans Fourie's farm	4 Mar. 2009
Commercial Farmer, Maize Triangle	Friedel Blume	3 Mar. 2009
Commercial Farmer, Maize Triangle	Peter Zensi	4 Mar. 2009
Farmworkers, Maize Triangle	n.n., Peter Zensi's farm	5 Mar. 2009
Commercial Farmer, Maize Triangle	Willem Groenewald	5 Mar. 2009
Farmworkers, Maize Triangle	n.n., Willem Goenwald's farm	5 Mar. 2009
Commercial Farmer, Kavango	John Moremi	9 Mar. 2009
Communal Farmer, Kavango, Gamboa	Agnes Vikongo	11 Mar. 2009

Interview partners and dates (cont.)		
Organization	**Name**	**Interview date**
Communal Farmers, Kavango, Gamboa	Tadeus Ansik, Oswald Kapungu, Agnes Vikongo	11 Mar. 2009
Communal Farmer, Kavango, Ndiyona	Valentino	11 Mar. 2009
Irrigation Scheme, Shankara	n.n.	12 Mar. 2009
Commercial Farmer, Shadi Kongoro / Green Scheme	Floris Smith	13 Mar. 2009
Farmworkers, Shadi Kongoro / Green Scheme	n.n., Floris Smith's farm	13 Mar. 2009
Communal Farmers Shankara	Wilhelm, Bartolomeus, Inocentius, Bonifacius, Cornelius	13 Mar. 2009
Communal Famers, Likoki	n.n.	19 Mar. 2009
Affirmative Action Farmer, Maize Triangle	n.n.	20 Mar. 2009
Commercial Farmer, Maize Triangle	Davi Kok	25 Mar. 2009
Commercial Farmer, Maize Triangle	n.n. (German farmer)	26 Mar. 2009
Affirmative Action Farmer, Maize Triangle	Walter	26 Mar. 2009
Communal Farmers, Maize Triangle	Helmut Keya, Max Katjipi , Albert Hangora, Christofine Rijaro, Sheline Mutjauvikua	27 Mar. 2009
Communal Farmers, Maize Triangle	Wilson Nglama Kanbii, Theo Kazengurura	27 Mar. 2009

Interview partners and dates (cont.)		
Organization	**Name**	**Interview date**
Traditional authorities in Kavango and Caprivi		
Mafwe Traditional Authority	n.n.	19 Mar. 2009
Village Headman, Nambwa	n.n.	19 Mar. 2009
Regional Headman, Nambwa	n.n.	19 Mar. 2009
Mashi Traditional Authority	n.n.	20 Mar. 2009
Area Headman, Ngweze	n.n., Masake J, Mukupi Joseph Mutaya	20 Mar. 2009
Ghiriku Traditional Authority	Hon. Chief Kasian Shiyambi	24 Mar. 2009
Ambulgo Traditional Authority	Hon. Chief Alfons Kaundu	25 Mar. 2009
Source: Authors		

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